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Land, Labor, and Population

1 Diminishing Returns and Demographic Growth

The question of the effect of demographic growth on the economic development of agricultural societies remains open and unresolved. It is a question over which two hardened points of view oppose one another. The first sees demographic growth as an essentially negative force, which strains the relationship between fixed or limited resources (land, minerals) and population, leading in the long run to increased poverty. According to the second, demographic growth instead stimulates human ingenuity so as to cancel and reverse the disadvantages imposed by limited resources. A larger population generates economies of scale and more product and surplus, and these in turn support technical progress.

The first position finds immediate and short-term empirical verification: increased population density creates competition for the use of fixed resources that must satisfy a larger number of people. Historical observation, however, presents a valid objection to this position, as economic progress is generally accompanied by demographic growth. A large population allows for better organization and specialization of tasks; it can easily find more ways to substitute fixed resources, creating systems which a small or sparse population could not maintain. The reconciliation of short- and long-term observations has not proved to be easy.

The second, opposing, theory has to resolve another and perhaps more serious contradiction. Even if we admit that demographic growth stimulates the human spirit of innovation and inventiveness (what economists call "technical progress"), it is hard to imagine how this spirit can expand those fixed

resources (land, space, and other essential natural elements) necessary to human survival and well-being.

Consider an agricultural population isolated in a deep valley. The difference between births and deaths results in slow growth, so that the population doubles every two centuries. Initially the more fertile, easily irrigated, and accessible lands are cultivated – those in the plain along the river. As population grows, and so the need for food, all the best land will be used, until it becomes necessary to cultivate more distant plots on the slopes of the valley, difficult to irrigate and less fertile than the others. Continued growth will require the planting of still less productive lands, higher up the sides of the valley and more exposed to erosion. When all the land has been used up, a further increase in production can still be obtained by more intensive cultivation, but these gains too are limited, as the point will eventually be reached when additional inputs of labor will no longer effectively increase production. In this way demographic growth in a fixed environment (and, it must be added, given a fixed level of technology) leads to the cultivation of progressively less fertile lands with ever greater input of labor, while returns per unit of land or labor eventually diminish.

The concept of diminishing returns is fundamental to the thought of both Malthus and Ricardo[1] and also can be applied to nonagricultural situations. It is easy to imagine that while the contribution of each additional worker to a fixed stock of capital (the workers operating a single machine) may increase overall production, nonetheless the contribution to that increase made by each additional worker will progressively decline.

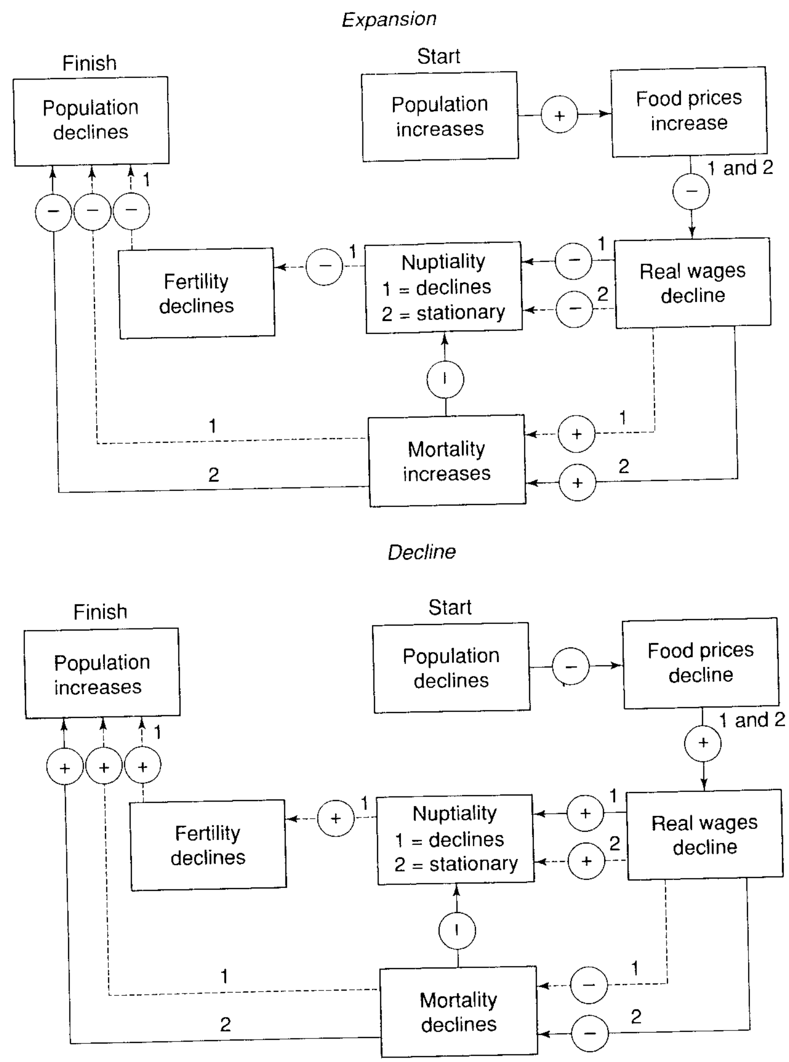
The law of diminishing returns, then, would seem to dictate a per capita decline of production, given the combination of population increase and a fixed supply of land or capital. Worker productivity, however, is not constant, and throughout human history innovations and inventions have continuously caused it to increase. In agriculture, metal tools replaced wooden ones, the hoe gave way to the plow, and animal power was added to human power. Analogous progress has characterized the technical innovations of production: crop rotation, the selection of seed strains, and improvements in fertilization. In short, the introduction of a technological innovation, whether it increases production per unit of land or of labor, entails an increase in available resources. The positive effects of this increase, however, may be only temporary, since continued demographic growth will neutralize the gains achieved. It should also be added that no degree of progress can indefinitely increase the productivity of a fixed resource like land.

In 1798, Malthus described the above relationship in the first edition of his famous *Essay*, asserting the incompatibility of the growth potential of population, "which increases in a geometrical ratio," and that of the resources necessary for survival, especially food, which "increases only in an arithmetical ratio." Because laws of nature require that humans have food, "this natural inequality of the two powers of population and of production in the earth and that great law of our nature which must constantly keep their effects equal form the great difficulty that to me appears insurmountable."[2] Demographic increase strains the relation between resources and population until a check to further growth intervenes. Malthus calls these "positive" checks; famine, disease, or war reduce population size (as happened with the medieval cycles of the plague or the Thirty Years War) and reestablish a more suitable balance with resources. Reachieved equilibrium, however, will only last until another negative cycle begins, unless population can find some other way to limit its reproductive capacity. This "preventive" and virtuous check exists in the form of celibacy or at least the delay of marriage, practices that reduce the reproductivity of populations wise enough to choose this alternative. The fate of populations depends upon the battle between positive and preventive checks, between careless and responsible behavior, between being a victim of constraint and necessity or making an active choice.

The Malthusian model, though repeatedly revised and updated over the years, is still basically contained in its initial formulation, and may be summarized as follows:

1 The primary resource is food. Its scarcity causes mortality to increase, slowing (or reversing) population growth and reestablishing equilibrium.
2 The law of diminishing returns is unavoidable. Cultivation of new land and intensification of labor in response to demographic growth add progressively smaller increments to production for each additional unit of land or labor.
3 Production or productivity increases resulting from invention or innovation provide only temporary relief, since any gains achieved are inevitably canceled out by demographic growth.
4 Awareness of the vicious cycle of population growth and positive checks may lead a population to check its prolificity (and so demographic increase) by means of nuptial restraint.

Figure 3.1 depicts the relationship between population and resources according to which equilibrium is reestablished after a period of growth or decline. In both cases the figure shows two paths, according to whether or not the preventive check is operating. As population grows so does the demand for food, and prices consequently rise. At the same time labor is less well paid as its supply increases. The combination of increased prices and decreased wages results in a still greater decrease in real wages, which is to say a worsening of the population's



Arrows indicate the presumed direction of causality, + and – symbols indicate positive and negative effects on the next step. Dotted lines indicate a weaker relationship than do solid lines. The role of fertility is strong for path 1 and weak for path 2.

Figure 3.1 The Malthusian system of positive and preventive checks during phases of demographic expansion and decline standard of living. This worsening cannot continue indefinitely and must eventually lead to a new equilibrium imposed either by the wise choice of the preventive check (path 1), the consequences of its refusal, namely increased mortality (path 2), or a combination of the two. Whichever path is followed, a worsening standard of living leads to a reduction of population (or at least slower growth) as a result of increased mortality or reduced nuptiality and fertility and so to the reestablishment of equilibrium between population and resources.

Innovations and discoveries only delay operation of the restabilizing mechanism by introducing a discontinuity, without, however, altering its basic functioning. The above model applies particularly to agricultural economies, the growth of which is limited by the availability of land, and to poor populations, which spend a good part of their income acquiring food. Until the time of Malthus and the Industrial Revolution, almost all the countries of the world fit into these categories; many poor countries still do today.

The application of the Malthusian model to industrial societies (which was done in the 1970s with considerable public, if not scientific, success by the Club of Rome) presents no logical problems. However, Malthus' forceful logic becomes less compelling when dealing with industrial processes which are subject to continual technological innovation and employ resources which are for the most part renewable or replaceable.

2 Historical Confirmations

According to the Malthusian scheme, population must suffer periodic mortality increases in the absence of the virtuous preventive check because of the declining standard of living. However, if the preventive check is operating, then population growth can be controlled and both the accumulation of wealth and a general improvement of living standards become possible.[3] According to Malthus the preventive check was stronger in his day than it had been in ancient Europe, an implicit proof of human progress. Preventive checks, however, act slowly and only in highly civilized societies. Unfortunately, the positive check seems to have been historically more prevalent, as demonstrated by the frequency and intensity of catastrophes and mortality crises. Mortality crises, it is true, were often caused by epidemic cycles largely independent of living standards (see chapter 2, section 3 on the plague), but in modern times subsistence crises have been frequently accompanied by mortality increase. Increases in the price of grain – which made up two-thirds of the preindustrial population's caloric intake – by factors of two, three, four, and more above that of normal years, were followed after several months of violent mortality

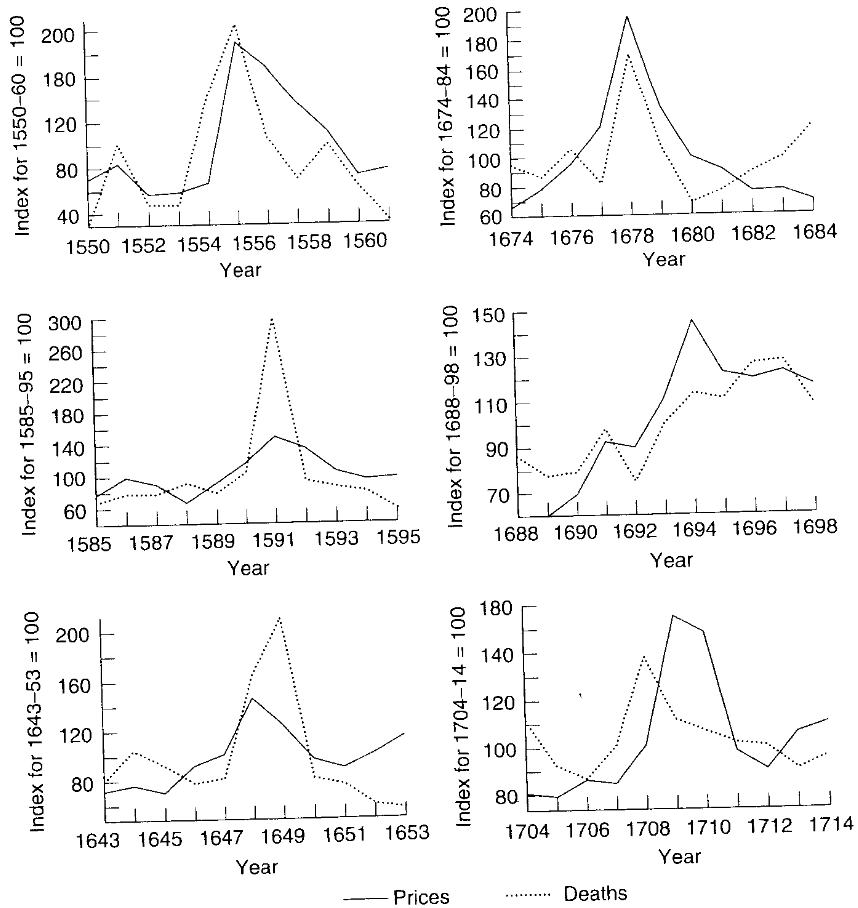


Figure 3.2 Sienese death and grain-price indices (sixteenth and seventeenth centuries)
Sources: For prices, G. Parenti, *Prezzi e mercato a Siena* (1546–1765) (Cya, Florence, 1942), pp. 27–8. For deaths, an unpublished study by the Department of Statistics of the University of Florence.

increases. One or more bad harvests, generally caused by weather conditions, caused jumps in the price of grain, a situation possibly made worse by a lack of reserves, the impossibility of substitution with other foods, obstacles to trade, and the basic poverty of the populations affected. The periodic elimination of excess population in crisis years is one of the more frequent arguments cited in support of the Malthusian model. Figure 3.2 charts the price of wheat in Siena and deaths in the same city (together with several other localities in Tuscany) for a number of periods, centered on years of large price increases coinciding with peaks in mortality between the middle of the sixteenth century and the beginning of the eighteenth.[4] Similarly, years of want are often years of nuptiality decline, since marriages are postponed until conditions improve, a situation that leads also to temporary fertility decline.

The situation of the various European countries is not much different from that of Siena. The sixteenth, seventeenth, and early eighteenth centuries are characterized by subsistence crises, with the attendant adverse demographic consequences, at a rate of two, three, four, or more per century.[5] The great crises of 1693–4 and 1709–10 doubled the number of deaths in France relative to normal years in the period and left a lasting mark on both the demographic structure and historical memory of the populations affected.[6]

The negative effects of a decline in living standards should be more persistent and the operation of the Malthusian model more clearly in evidence in the long run than in the short. In fact, if we ignore the effects of epidemic crises unattributable to food shortages (plague and smallpox, for example), then it turns out that the demographic impact of subsistence crises does not adequately explain the cyclical succession of growth and decline. These cycles are better explained by the less transitory action of the positive and preventive checks – that is, by the long-term modification of mortality and nuptiality in reaction to periods of improving or worsening living standards. Wage and price series provide a clue to the relationship between population and the economy, since by these measures the latter two quantities progress in keeping with the Malthusian model over the long run (see figure 3.3). During the negative phase of a demographic cycle – as, for example, in the century after the Black Death or during the seventeenth century – the decline or stagnation of population, and therefore demand, contribute to a reduction of prices and at the same time to an increase in the demand for labor, and consequently wages. Between the early fourteenth and the late fifteenth centuries, for example, wheat prices more than halved, only to rise again afterward in both France and England. As Slicher van Bath writes: "Then came the recession of the fourteenth and fifteenth centuries. The population had been reduced by epidemics, and because the area of cultivation was now larger than necessary for the people's sustenance, cereal prices fell. Through the decline in population, labour became scarce, so that money wages and real wages rose considerably."[7] Strong demographic recovery in the sixteenth century reversed the situation: increasing demand forced up the price of grain and other foods while real wages declined,[8] a trend which reached a critical point at the beginning of the seventeenth century.[9] The demographic slowdown of the seventeenth century and the catastrophic decline of the German population as a result of the Thirty Years War are among the causes

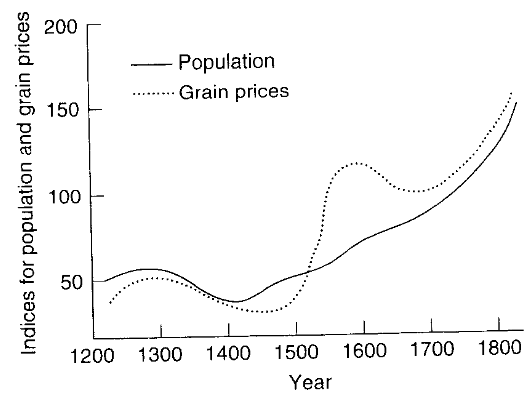


Figure 3.3 Population and grain prices in Europe (1200–1800; 1721–45 = 100)
Sources: B. H. Slicher van Bath, *The Agrarian History of Western Europe*, AD 500–1850 (Edward Arnold, London, 1963), p. 103.

of a new inversion of the cycle (accompanied by declining demand and prices and increasing wages) that continued until the mid-eighteenth century, when demographic growth reversed the situation once again.

The English case – from the sixteenth to the eighteenth centuries – seems to conform well to the Malthusian model. Changing population size and an index of real wages are shown in figure 3.4.[10] Statistics reveal an apparently direct link between population and prices – in keeping with the idea that demographic growth or decline lead to an increase or decrease in prices – particularly at the two points of inversion occurring in the middle of the seventeenth and eighteenth centuries. The figure highlights the inverse relationship between demographic and wage movement, though there is a discrepancy regarding the timing of the turning points. Finally, figure 3.5 clearly reveals that of the two factors in demographic change – mortality, expressed by estimates of life expectancy at birth, e_0, and fertility, expressed by total fertility rate (*TFR*) – the first varies independently of the standard of living (expressed by real wages) while the second (reacting to changing nuptiality) seems to follow its variations after a short delay.

The English example would appear to conform to path 1 (figure 3.1) of the Malthusian model, according to which the balance between population and resources is restored by means of changing nuptiality and fertility rather than the dreary check of mortality.

Other studies covering long chronological periods, while not so rich in data, nonetheless provide similar interpretations. The social life of the area

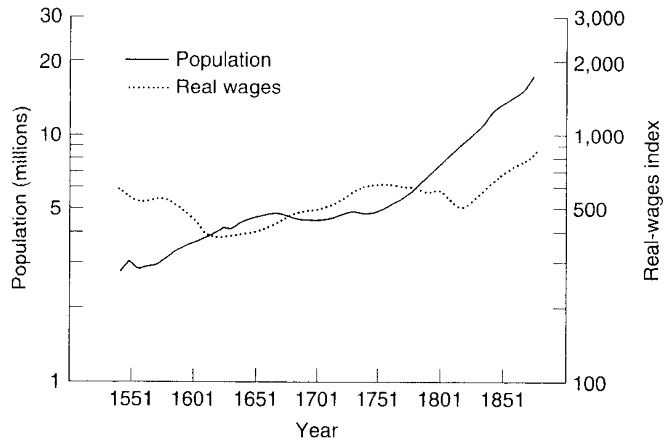


Figure 3.4 Population and real wages in England (1551–1851)
Source: E. A. Wrigley and R. S. Schofield, *The Population History of England*, 1541–1871 (Edward Arnold, London, 1981), p. 408.

of Languedoc in southern France is characterized by marked economic–demographic cycles.[11] A first cycle was completed prior to the plague of 1348. As in much of Europe, population expanded and marginal land – rugged and not very productive – was progressively settled. Signs of frequent famine and demographic slowdown are evident at the end of the thirteenth and in the first half of the fourteenth centuries, followed by plague and population decline. This decline had several sociodemographic effects – for example, the recombination of family nuclei into extended families and land redistribution, both suited to an agricultural system suddenly rich in land and poor in labor. The most significant economic effect for our purposes, however, was the reduction of prices and the increase in wages until demographic recovery gained momentum and accelerated in the sixteenth century. Once again land became scarce; new and progressively less productive land was tilled; real wages declined; society became poorer; and, in the period spanning the seventeenth and eighteenth centuries, population declined. Le Roy Ladurie interprets these alternating cycles of growth and decline in Malthusian terms. Population grows more rapidly than resources, and in the long run, in the absence of technological improvements, positive checks intervene. The case of Languedoc differs from that of England in that it follows path 2 of figure 3.1, according to which mortality is the regulating mechanism.

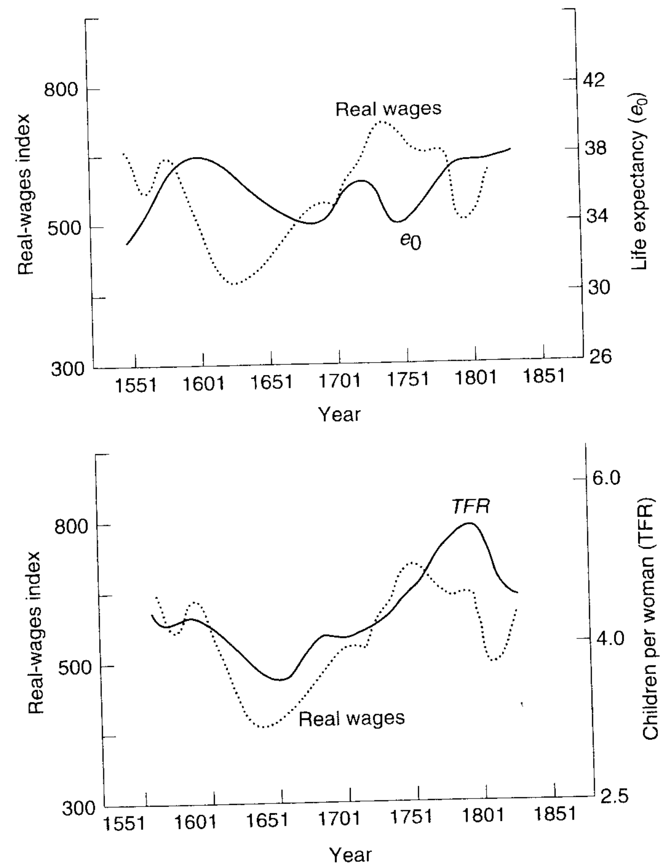


Figure 3.5 Real wages, fertility (*TFR*), and life expectancy (e_0) in England (1551–1801)
Source: Adapted from E. A. Wrigley and R. Schofield, *The Population History of England, 1541–1871* (Edward Arnold, London, 1981).

Similar interpretations exist for other regions of both southern and northern Europe.[12] Common to all of these is the observation that demographic growth and the process of diminishing returns lead to a decline in per capita production and so increase poverty and that this spiral, or "trap," can be avoided or at least attenuated by innovation or by the control of demographic growth.

3 Demographic Pressure and Economic Development

The logic of diminishing returns implies a continual contest between the growth of resources and population, unless the latter is controlled by reproductive restraint and so permits the accumulation of wealth and increased well-being. Demographic growth, in any case, acts as a check to economic development.

The opposing theory to that of Malthus, according to which population increase stimulates development, has an even longer history. Economists of the seventeenth and much of the eighteenth centuries, worried by the negative economic effects associated with the depopulation of a number of countries (especially Spain and Germany) and convinced that the poverty of many others rich in resources was connected with population scarcity, viewed demographic growth favorably: "With rare exceptions they were enthusiastic about 'populousness' and rapid increase in numbers. In fact, until the middle of the eighteenth century, they were as nearly unanimous in this 'populationist' attitude as they have ever been in anything. A numerous and increasing population was the most important *symptom* of wealth; it was the chief *cause* of wealth; it *was* wealth itself – the greatest asset for any nation to have."[13] In the context of the limited development and low-density population of the period, demographic growth meant a multiplication of resources and therefore the increase of individual income.[14] This opinion was, as I have said, fairly widespread, and only at the end of the eighteenth century did the negative effects associated with the first phase of the Industrial Revolution induce Malthus, and many others with him, to take the opposite point of view.

Can demographic growth generate economic development? If "fixed" resources are abundant or can be substituted, then there is no reason why not, an observation that social and economic history confirms. It is easy to see how, within certain limits, development may be checked or absent for small populations, characterized by low density, limited trade, minimal possibilities for division or specialization of labor, and inability to make substantial investments. Historically, areas depopulated or in the process of losing population have almost always been characterized by backward economies. Many European governments in the seventeenth and eighteenth centuries took action (often unsuccessfully) to populate sparsely inhabited areas or areas where demographic decline had lowered the standard of living.[15]

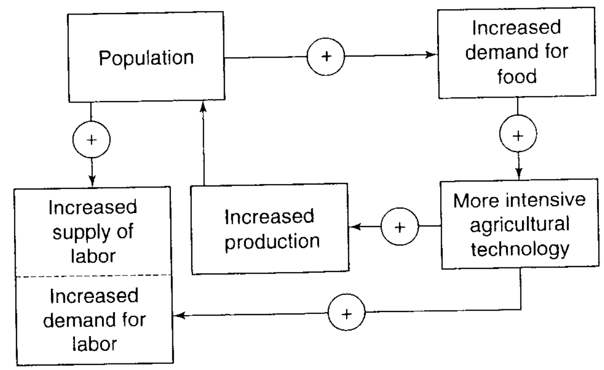


Figure 3.6 Population and agricultural intensification

It is important to understand the logic of the link between development and demographic growth. How can increasing population pressure and the consequent straining of available resources possibly constitute the prerequisite for development? A recent theory proposed by Ester Boserup explains this relationship with reference to agricultural economies.[16]

The variable population density of rural areas is naturally associated with the fertility of the land: high density in areas of rich, easily irrigated soil; decreasing density in areas less well suited to cultivation. This interpretation can, however, be reversed so that demographic growth is seen to create the conditions necessary for the adaptation of progressively more intensive methods of cultivation. Population pressure is then the cause and not the consequence of agricultural innovation.

The various systems of land cultivation spread across a continuum that stretches from forest-fallow systems (slash and burn preparation of the terrain followed by one or two years of cultivation, and then a long fallow period of 20–25 years during which the forest reestablishes itself and the fertility of the soil is restored) at one end to multiannual cropping on the same piece of land at the other. Between the two extremes brush-fallow cultivation is identical in method to forest-fallow, but shorter, as a covering of shrubs reestablishes itself after six to eight years. In a short-fallow system (one or two years) there is only time for a grassy covering to grow back, while annual cropping allows but a few months for the soil to rest. Demographic growth determines the transition to progressively more intensive and shorter fallow cultivation systems which permit the feeding of a progressively larger population in a fixed area. This intensification process, however, is accompanied by an ever greater labor requirement and often also by declining worker productivity. For example, land preparation and the sowing of seed are extremely rudimentary in a slash and burn system: hatchet and fire clear the terrain of forest, ash fertilizes the soil, a pointed stick is all that is needed to sow the soft earth, and productivity per hour of work is high. Shorter fallow periods require more laborious soil preparation, and the simple action of fire must be replaced by work with hoe or plow; fertilization, weeding, and irrigation all become necessary. In a forest-fallow system, "fire does most of the work and there is no need for the removal of roots, which is such a time-consuming task when land has to be cleared for the preparation of permanent fields. The time used for superficial clearing under the system of forest fallow therefore seems to be only a fraction – perhaps ten or twenty per cent – of the time needed for complete clearing."[17] Tools, also, change at the various stages: while a pointed stick suffices for the sowing of seed in a slash and burn system, a hoe is needed to clear the soil of shrub when fallow is shorter and a plough to eradicate weeds when it is shorter still. When animal power is introduced for plowing, the livestock produce fertilizer, but at the same time must be fed and cared for, tasks requiring additional labor. In order to obtain the same product, each farmer must work longer; in other words, his productivity per hour worked (in the absence of technological innovations) tends to decline. When population becomes too large in relation to available land, farmers are forced to use new techniques which, by virtue of increased inputs of labor, allow for greater production per unit of land. In many cases, so goes the argument, certain populations do not adopt more intensive techniques not because they are unaware of these alternatives but because land availability renders them disadvantageous. In fact, intensification would mean lower production per unit of labor.

This process of agricultural innovation differs from that according to which innovations or discoveries are "immediately" adopted because they are labor-saving. In the first case, innovation is a consequence of demographic growth and the fact that a certain threshold of population density has been attained. In the second, innovation is independent of demographic factors.

The link between agricultural systems and population density is also supported by the fact that the above process of agricultural innovation seems to have been reversed in periods of population decline (several of which are discussed in chapter 2): lower density favors a return to less intensive systems. "Many of the permanent fields which were abandoned after wars or epidemics ... remained uncultivated for centuries after. The use of labor-intensive methods of fertilization, such as marling, were abandoned for several centuries in France and then reappeared in the same region, when population again became dense."[18] More recent examples of this "technological" regression may be found in developing countries, for example in Latin America, "when migrants from more densely populated regions with much higher technical levels become settlers in ... sparsely populated regions."[19] The slash and burn agriculture practiced in equatorial forests by new colonists – in the Amazon, for example – is an unfortunate contemporary example of this phenomenon.

Boserup's model (synthesized schematically in figure 3.6) refers generally to the slow transformation of historical societies under the pressure of gradual population increase, the latter seen as an independent variable, external to the model.[20] It loses much, although not all, as we shall see below, of its explanatory force when applied to mixed economies or to developing countries experiencing modern demographic acceleration. This model does not rule out the operation of other factors, but posits demographic growth as one of the driving forces of economic transformation. It overturns the Malthusian model as population becomes not a variable dependent upon development but one which itself determines that development.

4 More on Demographic Pressure and Development: Examples from the Stone Age to the Present Day

The positive theory of demographic pressure has been applied, with intriguing results, to the "rapid" transition from hunting and gathering to agriculture, which I discussed earlier. This transition allowed the human race – which for hundreds of thousands of years had depended on those animal and vegetable products supplied spontaneously by the ecosystem – to develop, in just a few thousand more, a system for the man-made production of resources.

According to the traditional theory, this transition is explained by the development and diffusion of innovations and inventions. The invention of new techniques of animal domestication, planting, and harvesting led to increased and more stable production and so provoked demographic acceleration.[21] In other words, people modified the environment and so established the conditions for population growth. Mark Cohen, like Boserup, turns the process around.[22] When, 11,000 to 12,000 years ago, hunter-gatherer societies had settled all the land then available, demographic growth forced them to enlarge their range of gathering to include inferior foods, less nutritional and lacking in flavor. Then, beginning 9,000 years ago, hunter-gatherers were forced to enlarge still further this range of food, cultivating not tastier foods but those easily reproduced, and so the transition to agriculture began. This argument is based on two primary arguments and a series of corollaries.

According to the first argument, agriculture consists of a series of practices and techniques which were known to hunter-gatherers but not adopted because they were unnecessary: "Any human group dependent in some degree on plant materials, possessing the rudiments of human intelligence, and having any sort of home-base camp structure ... will be almost bound to observe the basic process by which a seed or shoot becomes a plant ... Agriculture is ... a combination of behaviors ... including such things as the creation of clearings in which certain plants thrive; the enrichment of certain soils; the planting of seeds; the irrigation of plants; the removal of competing species; the practice of conservation measures; the transporting of species beyond their original ecological boundaries; or the selection of preferred types. None of these behaviors alone constitutes agriculture; taken together they *are* agriculture."[23]

The second argument involves the level of nutrition and the work required to obtain this level with the transition to agriculture. In the first place, this transition entailed a deterioration of both the quality and variety of diet, as the food acquired by fishing, hunting, and gathering is much richer in nutrition and flavor than that of sedentary agriculture, dominated by a monotony of grain. Consequently, this transition would not have been expedient in the absence of the demographic growth that made it necessary. In addition, the work of a sedentary farmer was considerably more onerous than that of a hunter-gatherer, who often considered the search for food not so much a form of labor as a natural way of life.

This theory is based primarily on observation of groups of hunter-gatherers that have survived to the present day. The hypothesis regarding the ligh[illegible] workload entailed by this survival model is confirmed by the Bushmen of th[illegible] Kalahari, among whom the adult males devote on average two or three hou[illegible] day to obtaining food, by the Arnhem Land Aborigines, who average thre[illegible] five hours, and by the tribes of Tanzania, at barely two.[24] Similar observa[illegible] were made in the nineteenth century by Grey.[25] Comparisons between [illegible] tive farmers and their hunter-gatherer predecessors presumably also confi[illegible] lesser effort exerted by the hunter-gatherers for acquiring adequate [illegible] conclusion, "agriculture permits denser food growth supporting den[illegible] lations and larger social units, but at the cost of reduced dietary quali[illegible] reliability of harvest, and equal or probably greater labor per un[illegible] Agriculture spreads, then, when demographic growth requires gre[illegible] tion per unit area. Keeping in mind the fact that there existed a re[illegible] mechanism (migration) which distributed excess population amon[illegible] ducing demographic pressure, one can understand why the transiti[illegible] culture (driven by demographic growth) took place in a relatively shor[illegible] time as compared to the duration of human history.

Cohen's approach has provoked intense debate and many attempts at confirmation. In particular, attention has been focused on the hypothesis that the period leading up to agricultural transition was characterized by a decline in living standards and nutritional levels. Confirmation, however, remains elusive, and both archaeological finds and paleopathological studies are inconclusive on this point.[27]

The theory according to which the first known demographic revolution led to the invention of agriculture shares with that of Boserup the belief that population acts as a stimulus to development. Later demographic developments – the period of growth in medieval Europe prior to the plague, for example – also provoked changes in the organization of production in keeping with the above model. "The new system, which spread in the period between the ninth and fourteenth centuries, was a three-course rotation of all the fields in a village, in which two cereal crops were followed by one year of fallow. The stubble and fallow were utilized for supervised grazing by domestic animals belonging to all the villagers. Stubble-grazing animals fertilized the fields with their droppings, helping to compensate for loss of soil fertility by shorter fallowing, and for loss of natural pastures due to expansion of the cultivated area. Even so, it is possible that crop yields were lower than they had been under the long-fallow system, and it is likely that there was some shift of diet from animal to vegetable food as population continued to increase. When the Black Death later reduced population densities, an opposite shift to less vegetable food took place, as arable fields, made superfluous by the decline of population, returned to pasture."[28] In the Low Countries – the most densely settled area of Europe – the agricultural system was able to avoid the recurrent bouts of famine and starvation typical of other parts of Europe. And it is in the Low Countries, according to Boserup, that major [illegible]vations such as short fallows and root crops with high caloric content per [illegible] of land were first introduced.

[illegible]dence from present-day agricultural societies using traditional techniques [illegible]firms the theory of the propulsive role of demographic growth. For [illegible] between 1962 and 1992, in the developing countries, a positive [illegible] has been found between changes in labor/land ratios (generally [illegible] land productivity, also on the increase. Population pressure on [illegible] in most countries, determining a Boserupian response of [illegible] yields. An influential study employs a series of cases taken [illegible], Africa, and Asia in the period 1962–92.[29] In these, the [illegible] pressure has been much greater than in the past owing to [illegible]wth. The cases analyzed illustrate the response of agricultural [illegible] rates of 2–3 percent per year; in almost all cases urban growth [illegible]ction of rural demographic excess (or excess rural population), [illegible] nonagricultural sector has actually come to dominate.

Given approximately equal technological levels, the work required for the cultivation of a given crop on a given unit of land increases with increasingly intensive cultivation systems. For example, comparing forest-fallow cultivation – employing the slash and burn technique and long fallow periods – to annual cultivation, the yearly total of hours worked per hectare jumps from 770 to 3,300 in Cameroon.[30] The increased labor requirement is the result of both the greater amount of work needed for each phase of cultivation (preparation of the soil, weeding, and so forth) and the larger number of phases (irrigation and fertilization, for example). Three operations are sufficient for slash and burn agriculture: preparation of the soil by burning, which requires 300–400 hours per hectare in Liberia or the Ivory Coast; planting with a stick or hoe in the fire-softened terrain; and harvesting. Virtually no work is performed in the period between sowing and harvesting, since no fertilization, weeding, or irrigation are required. As cultivation intensifies, the latter operations become indispensable and progressively more laborious. Considering all 52 of the cases studied by Pingali and Binswagen, and calculating indices of cultivation and labor intensity,[31] one notes a positive correlation between the two variables: a 10 percent increase in cultivation intensity corresponds on average to a 4.6 percent increase in hours worked per hectare. The same analysis reveals that the 10 percent increase in cultivation intensity corresponds to a 3.9 percent increase in production per hectare. Productivity per hour worked, then, declines slightly, but if we also take into account the work hours not strictly employed in cultivation (such as the raising and care of livestock and the maintenance of irrigation systems and of tools), the decline in productivity per hour worked is greater. This productivity decline (calculated in the absence of innovations) can, of course, be compensated for by sufficient investment and by new technology.

The experience of developing countries confirms many aspects of the theory. Agricultural intensification implies more work per unit of cultivated terrain and, given a constant level of technology, more work per unit of production. This trend has been effectively countered in recent history by technological innovation, but it is conceivable that in earlier epochs, when the pace of such innovation was either slow or static, the adoption of new methods of cultivation came about as a result of necessity and at the price of greater workloads.

5 Space, Land, and Development

For much of human history, the well-being of a population has depended upon the availability of space and land, and on the constraints imposed by their lack or limited supply. The ways in which populations have succeeded in overcoming or

sidestepping these constraints by means of innovation and adaptation have been the leading determinants of survival and growth. The models described above, whether Malthusian or Boserupian, depend on space; in the first case primarily as a determining factor of demographic change and, in the second, as a dimension which responds to and is altered by population growth or decline. In the course of the history of population, these models have alternated, overlapped, and intersected; nor is it easy to make out their separate influences. In order to study long-term demographic growth, we must take "space" into account and all that it implies, in particular land, the products of the land (food, manufactured goods, energy), and those characteristics which determine settlement patterns. Demography has for too long ignored or at best paid scant attention to these themes and so deprived itself of valuable interpretative tools. Indeed the relevance of space for the understanding of demographic trends should be both directly and indirectly evident throughout this book, whether in relation to the Neolithic revolution, the settlement of new territories, or the events in Ireland and Japan.

Let us take Europe as an example, a continent – or perhaps more appropriately the western extension of the large Eurasian continent – for which we have access to abundant information for studying the relationships between space and demography. It is a continent marked by at least three fundamental characteristics. The first is its relatively easy access; it is almost entirely surrounded by sea, is penetrated by numerous waterways, and includes important orographic features that regulate but do not prevent communications. The second is its favorable climate, for the most part temperate and supportive of a wide range of crops. The third is the great variability of its environmental conditions which require adaptation on the part of the populations but at the same time favor specialization.

The area of Europe (taken to extend to the Urals, the Caspian Sea, and the Caucasus) measures 9.6 million sq km, of which about half belongs to Russia. It would be superficial in this context to examine the complex relations between space and population in such a vast and varied area, though there are many interesting points to be made. According to Cavalli Sforza and Ammerman, it was because of the availability of space that agriculturalists progressively migrated northwest from Asia Minor to Europe, bringing new settlement and cultivation techniques and either causing or at least encouraging the Neolithic revolution there. Similarly, the increasing pressure exerted by nomadic peoples against the eastern borders of the Roman Empire must be ascribed to the conquest of space and resources.

In order to understand better the relationship between space and demographic change, at least three lines of analysis need to be investigated. The first concerns the occupation of uninhabited or sparsely populated regions within a settled area; the second the transformation of existing space by means of deforestation, land reclamation, and swamp draining; and the third the expansion outside of settled areas through emigration and the colonization of new territories. These three processes are intimately linked and can conceptually be put in chronological order (though in fact they can all happen at the same time) according to the growing economic, social, and human costs they require.

The occupation of uninhabited or sparsely populated regions

This sort of expansion accompanied the medieval demographic growth of the eleventh to thirteenth centuries, a period during which European population multiplied by a factor of two or three. According to Grigg, "In AD 900 much of Europe was covered by forest, but the following centuries saw the removal of woodland to allow cultivation. Between AD 1000 and 1300 much of the lowland forest was removed in central and western Europe, and cultivation also extended into mountain areas, notably in the Vosges, Alps and Pyrenees."[32] It was a widespread process as already settled territories were expanded by means of the cultivation of new land, often accompanied by the consolidation of population in towns, castles, and new cities.[33] The expansion of cultivated land came about in varied ways, though in the majority of cases it was the individual peasant who put to the plow open space bordering already cultivated fields or else cleared woodland. In other cases new settlements were organized by landlords.[34] This process is a well documented one, in Italy, Spain, France, Germany, and elsewhere. Obviously, the increasing demands for resources made by an expanding population were also satisfied to some extent by land reclamation, settlement at higher elevations, and costly land transformations (within the limits of available technology and usually by means of that intensification of agriculture we have already discussed). Still, it is hard to imagine that medieval expansion would have been as dynamic as it was without an abundance of easily acquired land.

Transformation and land reclamation

At considerably higher cost, land reclamation helped to sustain medieval population growth. Dams were built to control stream waters and to protect lowlands from flooding by both rivers and the sea: "Coastal areas saw much reclamation, and embankments were built to protect low-lying land both from the sea and from estuarine flooding in Lincolnshire and Norfolk, on the Elbe, the Loire, the coast of Flanders, and most notably in the Zuiderzee."[35] Similar hydraulic work was carried out in the Po Valley, including projects financed by cities in Lombardy, Emilia, Romagna, and in the Venetian plain.[36]

Land reclamation took on larger proportions during the demographic recovery that followed the crisis of the fourteenth and fifteenth centuries. In England wet and swampy areas, both internal (in Lancashire and in the Fenlands) and along the coasts of Sussex, Norfolk, and Essex, were drained.[37] Similar work was carried out in France, along the northern coast with the help of Dutch workers and also in the south along the malarial and swampy coasts of Provence and Languedoc.[38] And in Italy reclamation activity took off again as well: "all of the lower Po Valley was affected by the great reclamation movement in the sixteenth century. To the west the first rice paddies were created in the eastern part of Piedmont between Novara and Vercelli, but the greatest activity was in the east; massive and surprising transformations took place on either side of the Po: in the Venetian *terra firma*, in the Duchies of Parma, Reggio, Mantua, and Ferrara, and in Emilia."[39] Yet it was in the Netherlands, in response to population growth and the increase in grain prices between the late fifteenth and mid-seventeenth centuries, that the reclamation of land from sea and marsh by means of dikes, canals, and pump-works took on formidable dimensions. "Between 1540 and 1565, 125,000 hectares of polders were diked; one-half of this was in Zeeland and North Brabant, one-third in the Netherlands, the remaining sixth in Friesland and Groningen."[40] There were also reclaimed lands in the interior of the country: "The area brought into cultivation was remarkable: between 1550 and 1650 the population of the Netherlands increased by some 600,000 but the area reclaimed was some 162,000 hectares."[41] If we assume that one hectare can sustain on average two or three people, then the added land would have fed between one-half and three-quarters of the added population. In the Netherlands land reclamation followed demographic growth apace. Elsewhere the demographic awakening of the second half of the eighteenth century was accompanied by the revival of reclamation projects as well: in England and Ireland, Poitou and Provence, Schleswig-Holstein and Prussia, and Catalonia and the Italian Maremma.

External expansion

The third element in the complex relationship between space and population is the existence of accessible space outside of already-settled areas. Europe has been both a receiver and a supplier of population in this regard. Prior to the Middle Ages, population flowed in from the steppes to the east and the Mediterranean to the south. In the period since the Middle Ages, it would be difficult to understand the development of European demography and society without taking into account the availability of inhabitable spaces to the west and east and so the phenomena of emigration and colonization. The accessibility of these spaces and the force of attraction they exert is one of the two major factors behind the great migrations; the other is the existence of forces of expulsion tied to economic difficulties in the sending regions. We shall discuss at greater length below the great nineteenth-century transoceanic migrations, which took place in a period of rapid economic and industrial change, but for the moment let us restrict our attention to Europe between the Middle Ages and the Industrial Revolution and focus on three great movements. The first is the German colonization of the territory east of the Elbe River between the eleventh and the fourteenth centuries. The second includes the Iberian migration to Central and South America and the British migration to North America as well as the relatively minor movements of the Dutch and the French to their respective colonies in the period from the sixteenth to the eighteenth centuries; these movements constitute the prelude to the great migrations of the nineteenth century. The third is the expansion of the Russian frontier to the east and to the south.

The drive to the east – *Drang nach Osten* – was a phenomenon of great proportions as it determined the peopling of large areas east of the Elbe and then successively of Poland, the Sudetenland, and Transylvania. It was a colonization process begun in the twelfth century by Dutch and Flemish pioneers – in part organized, in part spontaneous – who moved into open areas sparsely inhabited by Slavs. It is estimated that this migration involved 200,000 people who, in the course of the twelfth century, occupied the region between the Elbe and the Oder, and that the thirteenth-century wave that helped populate Silesia and Pomerania was of a similar size. It was a relatively modest migratory flow but one of considerable importance in the long run: at the end of the nineteenth century the Germanic population east of the Elbe–Saale line was about 30 million.[42] In the eighteenth century, by calling on several tens of thousands of German colonists, Catherine the Great of Russia produced a new wave of migration into the valley of the Volga in an attempt to push the border southward. Between 1764 and 1768, 104 colonies were founded on the banks of the Volga for 27,000 immigrants. Other settlements in the Crimea, North Caucasus, Kazakhstan, and Siberia followed.[43] From a demographic point of view, the interest of these migrations lies not so much in their size, which was modest in both absolute and

relative terms, but in their makeup: the migrants were for the most part young workers, many without families; they represented a significant portion of the reproductive-age population and so an outlet for demographic increase. Their progeny was considerable: as with the French Canadian pioneers (see chapter 2, section 5), their reproductivity was high, because of both the selective effects of migration and the abundance of available resources better exploited by large families. A few hundred thousand Germanic colonists, then, became, a few centuries later, tens of millions, and the few tens of thousands who migrated to Russia founded colonies which grew into large settlements by the end of the nineteenth century.

The second great migratory outlet was the American continent and, to a lesser extent, other overseas settlements. At the end of the eighteenth century, as the colonial system was collapsing, the American continent was home to modest but significant European settlements: about 4 million in Latin America and 4.5 in North America.[44] These settlements, fed by migrations from Spain and the British Isles and to a lesser degree Portugal, were small in comparison to the physical dimensions of the continent but nonetheless constituted one-third of its population. As compared to the population of Europe (excluding Russia) they amounted to only about one-fifteenth.

On the basis of indirect estimates derived from maritime traffic, the Spanish contribution is thought to be 3,000–5,000 emigrants per year for the 150 years ending in the mid-seventeenth century. They came almost exclusively from Castile and constituted a loss (according to the highest estimate) of one per thousand per year, a significant figure given their young age structure and the weak demographic growth of the period. After 1630, and in conjunction with the general (including demographic) crisis, emigration declined and reached a minimum between 1700 and 1720.[45] The drain on England was greater, amounting to a net figure of 7,000 emigrants a year during the seventeenth century from a population that numbered little more than 4 million at its beginning.[46] The emigration from the Netherlands was comparable to that from England; it is estimated that 230,000 net emigrants went to Asian locations between the beginning of the seventeenth century and the end of the eighteenth, to which were added 15,000 to Latin America and the Caribbean and 10,000 to the United States.[47] France, the most populous country in Europe (see chapter 2, section 5), contributed relatively little to these migrations. Transoceanic migration between the beginning of the sixteenth century and the end of the eighteenth was numerically significant and constituted the demographic and political base for the great migrations of the nineteenth century; it made possible, then, an enormous expansion of European space beyond the Atlantic barrier that had enormous long-term demographic consequences.

The third movement consisted of the shift of the Russian border to the south and east. The peopling of Siberia in the nineteenth century – which takes us beyond the chronological limits here imposed – resembled that of the American continent, though the numbers were smaller. As McNeil writes: "By 1796, therefore, when the Empress Catherine II died, the Russian flood had engulfed the once-formidable Tartar society . . . All the vast steppe region north of the Crimea and west of the Don had been occupied by landlords and settlers, and their political and social institutions had been effectively assimilated to those prevailing in the Russian empire as a whole . . . Yet new towns had arisen (Kherson, 1778; Nikolaev, 1788; Odessa, 1794) and throve as administrative centers and grain ports; and with urban life the manifestations of higher culture – flavored by a distinctly cosmopolitan tincture owing to admixture of Greeks, Bulgars, Poles, Jews, and a few western Europeans – soon appeared."[48]

These notes on an enormously complex and little-known story should give some idea of the intimate relation between demographic change and the availability of space, whether internal or external, to the relevant populations. It is an argument with natural ties to the migrations which have traversed the continent in various directions. It helps us, in turn, to understand how in one millennium the availability of new spaces not strictly defined by political boundaries played a great and varied role in shaping demographic change. Space, then, has made possible the expansion of the European economy into a wider world.

6 Population Size and Prosperity

In the preceding pages I have discussed several possible dynamic relations between population and economic development. It is also worth taking a moment to consider the effect of the simple "number" of inhabitants on societal well-being. I have already touched upon this argument in passing; it merits, however, something more than the observation that the level of complexity of social organization is also a function of numerical size. Many scholars have grappled with the question of whether there exists an "optimum" population size,[49] but this academic exercise is not particularly helpful for understanding the historical reasons for demographic development. The concept of an optimum population, which may be defined as that theoretical population size at which individual well-being is maximized (and above or below which well-being declines), is an essentially static concept and applies poorly to dynamic populations.

Population size acts by means of two mechanisms well known to classical economists. The first is linked to the principle of division of labor and so to the more efficient use of individual abilities. The second derives from the observation that the complexity of societal organization is also a function of demographic dimensions, both absolutely and relative to a given unit of territory (density).

The benefits of division of labor were masterfully demonstrated by Adam Smith, and before him by William Petty. Referring to the advantages of large cities, Petty wrote: "In the making of a Watch, If one Man shall make the Wheels, another the Spring, another shall Engrave the Dial-plate, and another shall make the Cases, then the Watch will be better and cheaper, than if the whole Work be put upon any one Man."[50] Smith's examples of the blacksmith making nails and of the advantages to be gained from dividing up the work required for the production of pins are classic: "One man draws out the wire, another straights it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head, to make the head requires two or three distinct operations, to put it on is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into paper; and the important business of making a pin is, in this manner, divided into about eighteen distinct operations, which in some manufactories, are all performed by distinct hands,"[51] and while a single worker might turn out at most 20 pins a day, a factory employing a team of 10 workers manages to produce 12 lb a day, or 48,000 pins, 4,800 per worker. Division of labor, however, is a function of the size of the market. If the market is small, division is moderate, as are the advantages to be gained. Smith observed that in the Highlands of his native Scotland, where families were widely scattered, each performed the tasks of butcher, baker, and brewer for itself. Smiths, carpenters, and masons were few, and those families 8 or 10 miles from town did much of this work themselves.[52]

Where it has been impossible to adequately divide labor, this situation has contributed in some measure to the backwardness of scattered groups; to the development difficulties encountered by small, isolated communities, the dimensions of which do not allow specialization; to the failure of colonization undertaken by small nuclei; and to the instability of small island populations even when the environment is favorable. The maximum of inefficiency according to this formula is that population consisting only of Robinson Crusoe.

The second advantage to be gained from population size or density are the economies of scale acquired at increasing population levels. Better systems of resource utilization and production are only feasible when population attains a certain density in relation to the territory inhabited. We have already considered an example according to which the processes of agricultural intensification respond to the incitement of demographic growth. In our own time, a country like Canada is considered, by representatives of both the government and the citizenry at large, too "empty" to maintain that development which its extension and natural wealth would seem to ensure. Other classic examples include the development of irrigation systems, the establishment of cities, the improvement of communications, and, in general, those investments in infrastructure which require a critical mass of resources and a critical mass of demand – neither of which are obtainable from small groups and limited markets. These infrastructures can be developed at a lower cost per capita in a larger population.

The development of irrigation systems in Mesopotamia allowed the few hunter-gatherers living in the Zagros Mountains in 8000 BC to evolve into a large population of plain-dwellers in the following millennia. "This dense population used intensive systems of agriculture based upon flow irrigation; multicropping was also introduced. Fields were prepared by plows with moldboards and iron shares, drawn by oxen. The irrigation system used waterwheels for lifting water to fields located above the major river, which provided the water. Thus over a period of some eight thousand years, Mesopotamia became densely populated ... Gradually, the population changed from primitive food gatherers to people who applied the most sophisticated systems of food production existing in the ancient world."[53] The transformation of the Italian Maremma into swampland that accompanied the medieval population decline was a result of the reverse process which saw the deterioration of water control systems.

Considerations of this sort have also been applied to the development of road networks, which is strongly correlated to population density.[54] Clearly the advantage and usefulness of a road is a function of how heavily it is traveled. Once built, it exerts multiple effects on development, speeding up communication, helping trade, and allowing the creation of a larger market. The differences in prices for basic goods in primitive societies are largely explained by difficulties of transportation and uncertain communications.

City growth, also, has obvious links to demography. I take for granted that the creation of cities allows for greater specialization and more efficient organization of the economy. While these advantages may well be compromised in the present day by the ever more evident "diseconomies" of scale created in the great urban centers, for the primarily rural economies that we are discussing the situation was altogether different. Clearly the maintenance of an important centralized population, not directly involved in food production, implies the creation of an agricultural surplus by the rural population; and the wealthier the latter, the greater the available resources. The early growth of cities in Mesopotamia, northern India, and China is certainly a function of the large populations allowed by the fertility of the land and agricultural

abundance. It is once again Ester Boserup who provides an original explanation for this situation, proposing a causal chain: Demographic growth drives agricultural intensification, but it is not so much the level of per capita production – which increases with increasingly intensive cultivation – as it is increasing population density that allows for the creation of the surplus resources requisite for the birth of cities. More farmers within a given radius from the city imply a larger product and a larger surplus for support of a more numerous urban population. "Even the best technologies available to the ancient world, when used on the best land, did not allow one agricultural family to supply many nonagricultural families ... The size of the population available to supply an urban center was far more important than how much food could be delivered or sold per agricultural worker."[55]

The links between division of labor, economies of scale, and demographic dimensions are easily grasped and demonstrated by numerous historical examples. Less easily demonstrated is another thesis, upheld by a number of scholars, which employs the following logical sequence: When resources are available, development is a function of what Kuznets calls "tested knowledge."[56] Employing a restrictive hypothesis, the "creators" of "new knowledge" (investors, innovators) exist in proportion to population size. The creation of "new knowledge," however, is probably helped by factors of scale (the existence of schools, universities, and academies that multiply both the efficiency of already acquired knowledge and also the opportunities for the creation of new knowledge) and so enjoys increasing returns as population grows. In this way, all things being equal, population increase leads to increased per capita production.

As Kuznets himself confesses, this is a hazardous argument,[57] though he is not its sole advocate. Indeed, it was Petty who remarked: "And it is more likely that one Ingenious Curious Man may rather be found out amongst 4 Millions than 400 Persons."[58]

7 Increasing or Decreasing Returns?

During the last 10,000 years the human race has managed to multiply by a factor of 1,000 and at the same time increase the per capita availability of resources. Those who argue for the inevitability of decreasing returns maintain that this has come about because the limits of fixed resources have never been reached, either because these limits have been repeatedly pushed back as new land is cultivated and sparsely populated continents inhabited or because resources have been used more productively thanks to innovations and discoveries. Nonetheless, for long historical periods the bite of diminishing returns has severely tested the ability of population to react. Moreover, certain resources would seem to be not only limited but non-substitutable, and so in the long run neither innovation nor invention can avert the onset of diminishing returns and impoverishment.

According to the opposing view, there is no reason to believe that the onset of diminishing returns is inevitable. Kuznets expresses this position well in historical terms, asking: "Why, if it is man who was the architect of economic and social growth in the past and responsible for the vast contributions to knowledge and technological and social power, a larger number of human beings need result in a lower rate of increase in per capita product? More population means more creators and producers, both of goods along established production patterns and of new knowledge and inventions. Why shouldn't the larger numbers achieve what the smaller numbers accomplished in the modern past – raise total output to provide not only for the current population increase but also for a rapidly rising supply per capita?"[59] In other words, diminishing returns from fixed resources are more than compensated for by the increasing returns of human ingenuity and by the ever more favorable conditions created by demographic growth.

This dilemma is unresolvable only if we insist on finding hard and fast rules to explain complex phenomena. Time is a factor of primary importance. The bite of diminishing returns can create insurmountable obstacles in the short and medium run, lasting a few decades or a few generations. The costs generated by these obstacles are not easily evaluated. Nor are they necessarily reflected by mortality fluctuations, as population is characterized by a high level of resistance to hardships and historically the infectious and epidemic disease component has been largely independent of the human condition. They are, however, reflected in a general increase of poverty that in the long run can only be checked or reversed by innovation. The price paid in terms of human suffering can be high, though historically one is more impressed by the ability of societies to reverse a negative trend. If we transfer this dilemma to the present day, it takes on dramatic proportions. Rapid demographic growth may in the long run be accompanied by unexpected development, but meanwhile the medium-term problems are serious. Even innovation has its price. The green revolution in India provides a good case. High-yielding seeds introduced in the 1960s meant more wheat production, an expensive staple consumed mainly by urban middle classes, while the poor ate rice or bread of inferior quality. The poor would supplement their rice diet with pulses (dhal), rich in proteins. But since wheat was more profitable, the farmers started growing wheat at the

expense of pulses. Between 1960 and 1980 the production of cereals increased 72 percent against 57 percent for the total population and a decline of 17 percent of the production of pulses. So the diet of the poor deteriorated. In the long run, however, the green revolution meant more jobs and more income for the poor, offsetting the initial negative effects of a worsening diet.[60]

So the time scale is important: what is bad for the medium term may be good for the long term, and vice versa. Should we judge historically in terms of *generations*, centuries, or millennia, or with greater attention to problems foreseeable in our own lifetime?