9. An Evolutionary Theory of the Industrial Revolution

> "Europeans have for thousands of years been living in densely populated societies with central governments, police, and judiciaries. In those societies, infectious epidemic diseases of dense populations (such as smallpox) were historically the major causes of death…..In contrast, New Guineans have been living in societies where human numbers were too low for epidemic diseases of dense populations to evolve. Instead, traditional New Guineans suffered high mortality from murder, chronic tribal warfare, accidents, and problems in procuring food. Intelligent people are likelier than less intelligent ones to escape those causes of high mortality in traditional New Guinea societies……natural selection promoting genes for intelligence has probably been far more ruthless in New Guinea than in more densely populated, politically complex societies, where natural selection for body chemistry was instead more potent." (Diamond, 1997, pp. 20-21).

Introduction

We saw in chapters 3-5 that material living conditions did not improve over the eons-long Malthusian era. Indeed considering the annual work input it could be argued that people were worse off in England in 1800 than in many earlier societies. Yet while the material conditions people were living in did not change, there is every indication that people themselves were changed by their long exposure to the Malthusian economy in settled agrarian societies. We saw in chapter 5 that the evidence from pre-industrial England shows that in the fertility and mortality conditions of such institutionally stable societies, there was strong selection towards individuals who deferred consumption and better endowed their children with material goods. I argue below that the arrival of settled agrarian societies where overwhelmingly deaths were from disease, and where assets were private property, allowed the operation of strong selective pressures towards those who choose to work more, and to endow their children with more assets

and education. These selective pressures on behavior in turn influenced such basic economic variables as the interest rates that economies operated with, and the amounts of work people undertook. These changes in behavior created the cultural environment in which the Industrial Revolution and modern economic growth was possible.

Did Evolution of Human Behavior End with the Neolithic?

Ironically Malthus's reflections on the determinants of living conditions had a profound influence on the formulation of Charles Darwin's *Theory of Evolution*. Darwin himself notes that it was after reading Malthus's *Principles of Population* in 1838 that he the insight as long as offspring inherit something of the characteristics of their parents, then in populations in a Malthusian equilibrium there would be a selection over time of particular traits. As long as any trait tends to be passed from parent to child, whether through genetic means, or through culture, it can be potentially selected for in the Malthusian era. Despite this initial connection between Malthusian theory and evolutionary theory, the idea that selective pressures helped create modern human societies fell out of favor.

Even *Evolutionary Psychologists*, who assume that important human traits are controlled by our genes, and that our genes were determined by the processes of natural selection, have dismissed selection as an important element in societies formed since the Neolithic Revolution. For they assume that the genetic evolution of complex human traits takes a very long time. Thus the genetic substrate to current human behavior is a set of traits acquired in what Bowlby (1969) dubbed the *Environment of Evolutionary Adaptedness*: the 99% of human's evolutionary history which was spent as foragers. In this period our ancestors lived in small bands of 20-30 individuals who foraged or hunted for each day's subsistence. Natural selection slowly sculpted

our reasoning and our tastes to maximize the number of progeny in this environment, "like a stone being sculpted by wind-blown sand" (Cosmides and Tooby (1997)). In this case the formation of human tastes was largely over by the time of the Neolithic Revolution of 10,000 years ago. We are thus potentially ill adapted for the agrarian and industrial societies that followed. "Our modern skulls house a stone age mind" (Cosmides and Tooby (1997)). We cannot explain modern behavior patterns by showing that they promote fitness in any society since the Neolithic Revolution: that is in any society within recorded history. Maladaptive behavior will be observed in modern societies, but there will be very little tendency for this to be corrected in successive generations.

Once we allow for the possibility of cultural evolution, however, much of this criticism looses its force. As long as three conditions are met: learned behaviors affect the number of offspring surviving to the next generation, children copy the behaviors of parents, but there are sometimes mutations in children's copying of parents behaviorsthere can be evolution of behaviors that is more rapid than genetic evolution. Also while complex genetic traits may take many generations to be selected for through natural selection, simple traits such as the degree of time preference exhibited by individuals could evolve much more quickly, yet still have a profound effect on the operation of societies.

Another criticism has been that culture is so plastic that there is no reliable transmission of traits from parents to children. Cultural variations between societies and across time are so great, that knowing how evolutionary pressures shaped early man cannot contribute anything to our understanding of modern societies. Pretty much any set of behaviors can be learned and sustained in a society. In modern societies, for example, there is a universal avoidance and abhorrence of incest. Socio-biologists have taken this as a demonstration that culture can be

constrained by selection forces, which are presumed to have favored the choosing of mates from outside the immediate family. But we can find dramatic exceptions to this modern norm. Keith Hopkins, for example, pointed out that in Roman Egypt a large fraction of marriages were brother-sister pairings, so that even such supposedly universal norms as the avoidance of incest can be overcome by cultural imperatives. There is, however, ample evidence of the strong correlations in characteristics between parents and children in societies where sufficient data is available to observe these relationships.

Selective Pressures in the Agrarian Societies

A second challenge to the idea that selective pressures in agrarian economies could have made an Industrial Revolution more likely is that represented by the quote above from Jared Diamond. This would be the argument that there were selective pressures in settled agrarian societies, even after the Neolithic Revolution, but not of the right type to make an Industrial Revolution. Prior to settled agriculture survival would depend on intelligence, perseverance, diligence and ingenuity. With settled agriculture selection would be mainly for disease resistance. One seeming source of support for Diamond's contention is figure 1, which shows the estimated output (measured as a percentage of the maximum) in kilograms of meat per day spent hunting of male Ache. There is a very long period of learning before hunters reach their maximum productivity in their early 40s. In contrast the measured strength of Ache males as a function of age is shown. Clearly hunting skill involves a lot more than just brute strength. In contrast the same diagram shows the earnings of farm laborers in England, from a sample of workers whose ages can be identified for a farm in Derby in the 1830s. This profile shows that farm workers achieved their maximum earnings early in life, and that their earnings are a

function of their likely physical strength. Thus the argument would be that in pre-industrial Europe for most males earnings would relate more to their brute strength than to more elaborate measures of ability, while in hunter gatherer society male outputs could be a much more complex outcome of skills and ability to learn.

However, while settled agriculture made basic production tasks simpler and more routinized, and thus removed some of the premium for skills that existed in the forager world, it increased inequalities dramatically in other ways through the social division of labor and through the increased importance of extra-somatic property in generating income. Urban skilled building workers, for example, earned about twice the wage of simple farm laborers in pre-industrial England after 1350, and an even greater premium before then. Access to these higher earnings depended on investments in training. The share of all income earned through ownership of property was about 50% in pre-industrial England. Thus the command over resources depended on skills, but even more importantly on the inheritance and accumulation of property. The rise of land and capital as important sources of income marked on important break with the forager world that came before, and created hitherto unknown selective pressures. Further as a world developed of ever more sophisticated markets and exchanges, the premium that was attached to rational planning and action was correspondingly higher. The development of agrarian economies with political stability, and a complex division of labor with its accompanying complicated patterns of exchange gave a premium to a certain type of ability to plan and conceive that did not exist before.

We saw above in chapter 5 that there is strong evidence of selective pressures on family behavior in seventeenth century England. Parents with occupations that paid higher earnings left more surviving children. Here we look at this selective pressure in more detail. We saw that

reproductive success was correlated with wage income. But it was also correlated with literacy. In both town and countryside, as table 1 shows, literate testators left more surviving children than the illiterate. Given the huge range in numbers of surviving children per testator, from 0 to 13, the sample sizes are too small for London and for the towns to find statistically significant differences in numbers of survivors with literacy. But for the sample of testators whose residence was the countryside the difference is statistically significant. The literate were leaving more survivors.

This raises the question of what features exactly of families were responsible for higher reproductive success? Is it occupation, literacy, or wealth? To investigate this further I consider a sample of wills where we can also calculate some approximation to the total value of the estate. To do this I have to attribute a value to land bequests where the amount is not specified. While many wills state that land is bequeathed, only in a minority of 62 out of 347 cases where land was bequeathed is the amount specified. To infer the area in the other 285 cases I regressed the land area in the 62 cases where the area was specified on the sum of monetary assets specified on the amount of cash bequeathed, the number of houses bequeathed, the both the cash bequeathed and the number of houses interacted with an indicator for the person being a yeoman. The estimated expression is

$$AREA = -3.22 + 0.0714 \times CASH + 4.506 \times HOUSES + 10.54 \times DYEOMAN + 7.761 \times \text{DLIT}$$

R-squared = 0.49

N = 62

We then constructed a monetary measure of the wealth of the testator at the time of death as

ASSETS (£) = CASH BEQUESTS + HOUSES×75 + ESTIMATED LAND AREA×10, based on the assumed average value of houses and land in these years. For male testators in Suffolk where we have enough information to do regression analysis on the numbers of survivors, estimated assets averaged £284 (about 16 times the yearly wages of a carpenter). Of these estimated assets £82 was cash or bonds, £86 housing, and £116 farmland.

To measure the influence of assets on numbers of surviving children I regress the numbers of children specified in the will on the following variables: an indicator variable for whether the testator was literate (DLIT), an indicator variable for whether the testator lived in a town (DTOWN), indicator variables for 5 types of occupation (DOCC1, DOCC2, DOCC3, DOCC4, DOCC5), an indicator variable for whether the testator had been a widower (DWID), and indicator variables for the assets in the range £50-100, £100-200, £200-500, £500+ (DASS1, DASS2, DASS3, DASS4). The indicator variable for widowers was used as a partial measure of the likely age of the testator. The resulting estimates were as shown in table 2. What shows up very clearly is that other things equal town residence correlates with fewer surviving children, but the other major correlate is the assets bequeathed by the testator. Testators with £500 or more in assets would leave, all other things equal, about 1.24 more surviving children than those with no assets.

The reproductive advantage of those bequeathing larger stocks of assets is not mainly because they are more likely to get married, or again because those with larger stocks of assets are just being observed later in the life cycle. The last three columns show the estimated coefficients when we regress reproductive success on the same measures, using only those who were, or had been, married by time of death. Even looking just at the married assets matter almost as much, and now literacy is a statistically significant predictor of reproductive success.

This strong association of assets and reproductive success is surprising since we have such a weak measure of the assets bequeathed. The implication would be that the real effects of wealth on reproductive success must be even stronger than the ones observed here.

Unfortunately I do not have information on the wills of the children to check to what extent parental characteristics were passed on to children. We do know that the greater the assets of parents at death, the greater the average bequest per child, despite there being more surviving children in these families. Thus at least at some point in their lives such children are well endowed with material assets relative to the average person.

There is also a strong correlation between literacy and the asset holdings of the testator. Table 3 reports the results of a probit regression with male literacy as the dependant variable and residence, widowhood, occupation, and assets as the independent variables. The table reports the change in the marginal probability of the person being literate when the indicator variable switches from 0 to 1. As we would expect from the time trends shown in figure 6 towards increased literacy, proxies for the age of the testator are associated with literacy. Town residents were more literate, and those whose occupation was farming less literate. But assets are also an important predictor of literacy. Other things equal someone who bequeaths an estimated £500 or more in assets has a .45 greater probability of being literate than someone who bequeaths less than £50 in assets. Thus in pre-industrial England asset accumulation and literacy went hand in hand.

At least in the conditions of pre-industrial England it is thus plausible that families which accumulated more assets, worked harder, and invested more in acquiring labor market skills for their children, were growing as a share of the population.

Selective Pressures and the Decline of Interest Rates

Along with this evidence of selection pressures in England there is sign that some of the basic parameters underlying European economies were changing in the years 1200-1800. One of the basic features of any society is the interest rate, the return earned by capital. In modern economies the real, risk free return on capital is 2-3% per year. Why the interest rate should be stable at about this level has been a matter of puzzlement to economists. For it implies a basic underlying rate of time preference in individuals. A higher value is given to consumption of a good now rather than the same good later. This time preference cannot be derived from any consideration of rational action, and requires economists to posit it as a basic parameter of people's preferences.

Rogers (1994) argued that the underlying rate of time preference exhibited by people must have an evolutionary origin, and gives an ingenious argument for why it would be 2-3%. Suppose in the Malthusian era that someone has to choose between investing resources in themselves to produce more children currently, or in investing them in children already produced to increase the fertility of the children? Two crucial considerations matter in that calculation, in evolutionary terms. The first is that parents share only half their genes with their children. Thus if $1 spent on oneself produces as much of an increase in surviving offspring as $1 given to a child, better for the survival of your genes to spend the money on yourself. Indeed you would only be indifferent if the $1 produced twice as many surviving offspring if given to your child than spent by yourself.

The second dimension to this choice, however, is that your child's fertility occurs on average 25-30 years after your own. If you live in a world where borrowing and lending is possible, the $1 you save from your reproductive years and pass on to your child will amount to

$$\$1\times(1+r)^T$$

when the child receives it, where T is the average generation length. Thus as long as

$$\$1\times(1+r)^T = \$2$$

you would be in evolutionary terms, where we are in a Malthusian world with stable population, indifferent between spending the money to benefit your own fertility and spending it to benefit your child's fertility. This implies that the interest rate that should make people evolutionarily indifferent between spending on themselves and on their children is given by

$$r^* = \exp\left(\frac{\ln 2}{T}\right) - 1 .$$

In turn through selective pressures this interest rate will eventually prevail in the Malthusian economy. For if $r < r^*$ no-one will want to save and pass on income to their children, while if $r > r^*$ everyone will want to save and pass on income. Since the average generation length T is between 25 and 30 then,

$$2.3\% < r^* < 2.8\%.$$

This we can call the "Rogers Bound" on time preference rates, and it accords well with modern evidence on real rates of return.

The Rogers theory of time preference, however, is predicated on the existence of substantial stocks of assets such as land and capital within the economy which are privately owned, and which allow the possibility of transferring resources to offspring for use years later.[1] But in hunter gatherer society land is not privately owned, and the stock of capital goods extremely small, normally what a person can carry as they move from day to day. Thus the Rogers calculus cannot come into play. Indeed in a society with little or no privately storable

[1] Rogers seems to assume that the investment could take the form of greater transfers of resources to each child for immediate consumption. But since these somatic investments do not accumulate over time, their reproductive value would be independent of the rate of return on capital

goods the selection pressures will favor those who are impatient and consume as much as they can get immediately. Thus for 99% of human evolutionary history there could have been little or no selective pressure towards the "Rogers bound" of time preference rates. Indeed if the world before the Neolithic Revolution was similar to that of modern forager societies, then people at the time of the Neolithic Revolution should have had high rates of time preference.

Even early agriculture may not have been sufficient to produce the conditions for selection for low time preference rates. In shifting cultivation societies land is still a free good, and the patches of farmland created from the forest quickly lose their value through weed infestations and decline of fertility. Only with the arrival of substantial livestock holdings and permanent fields do we get the possibility of selection for lower rates of time preference. Even once the actual capital exists there also have to be systems of property rights which allow its reliable transmission between parents and children. For at least some early agriculturalists seem to have had property rights rules giving all members of the community usufruct rights to land. Or in other setting land distribution is determined period by period through the application of military force. In this case it is not possible for parents to pass on many resources to their children. Parents who attempt to do so, rather than maximizing the numbers of offspring they themselves have, would produce a smaller share of the next generation.

Thus societies at the dawn of settled agriculture should have exhibited high time preference rates, as measured by interest rates. But suppose that for genetic or cultural reasons people in these early agrarian societies differed in their rates of time preference, and in their life cycle savings behavior. Those who passed on more assets to their children would, by the Rogers argument, be increasing their share of the population if access to resources was an important component of an individuals' fitness. These characteristics of individuals could also be

associated with other traits such as investing more in the education of children, or with preferences for greater amounts of work input.

Did Selection Pressures Change English Society between 1200 and 1800?

England by 1600 certainly had the conditions for such a selection. 98% of land by value was private property passed on by inheritance. Further land and house rents constituted at least 35% of all income, and other capital goods such as animals, furniture, mines, and inventories would probably have brought the property share in income up to 50%. Even back in the 13th century economic conditions are such that property is a large share of income, property rights are stable, most property is privately owned and can be transmitted reliably to children, and thus their should be selective pressure towards those with lower time preference rates.

There is plenty of evidence that the rate of time preference exhibited by the average person, one indicator of potentially much more far reaching changes in peoples modes of behavior, was changing in the long Malthusian era. For England evidence on interest rates goes back to 1170. Figure 2 shows the rate of return on two very low risk investments in England from 1170 to 1900. The first is the gross return on investments in agricultural land, *R/P*, where *R* is the rental and *P* the price of land. This can differ from the real return on land,

$$r = \frac{R}{P} + (\pi_L - \pi)$$

where π_L is the rate of increase of land prices and π is the general rate of inflation. $(\pi_L - \pi)$ is the rate of increase of real land values. But the rate of increase in real land values in the long run has to be low in all societies, and certainly was low in pre-industrial England. If the rate of increase of real land prices was as high as 1% per year from 1300 to 1800, for example, it would

increase the real value of land by 144 times over this period. Thus the rent/price ratio of land will generally give a good approximation to the real interest rate in the long run.

The second rate of return is that for "rent charges." Rent charges were perpetual fixed nominal obligations secured by land or houses. The ratio of the sum paid per year to the price of such a rent charge gives the interest rate for another very low risk asset, since the charge was typically much less than the rental value of the land or house. The major risk in buying a rent charge would be that since it is an obligation fixed in nominal terms, if there is inflation the buyer gets a lower real rate of return. Again the gross rate of return shown is *R/P*, where *R* = annual payment, *P* = price of rent charge. The real rate of return, r, in this case is

$$r = \frac{R}{P} - \pi$$

Before the twentieth century the rate of inflation tended to be low, typically much less than 1% per year. Thus the gross rate of return on rent charges gives almost as good measure of the long run real rate of rate of return as the ratio of land rents to land prices.

What we see in figure 2 is a marked secular decline in real rates of return. These rates were typically above 10% in the years before 1300. But by the eve of the Industrial Revolution real rates of return had fallen to 4% or less, close to modern levels. This movement towards lower rates of return on capital in England reflects a more general movement across many societies: similar declines occurred in Germany, France, Flanders, and Italy in these years. Thus table 1 shows the gross return on rent charges in these countries by half century from 1300 to 1800, while table 2 shows the gross rate of return on land ownership.

Medieval Europe was not the only Malthusian society where rates of return were very high. Indeed in general all societies before 1400 for which we have sufficient evidence to calculate interest rates show high rates by modern standards. In ancient Greece loans secured by

real estate generated returns of close to 10% on average all the way from the fifth century BC to the second century BC. Thus the temple of Delos, which received a flow of funds in offerings, invested them at a standard 10% mortgage rate throughout this period.[2] Endowments in Roman Egypt in the first three centuries AD were invested on land security at a typical rate of 12%.[3] Evidence from temple endowments in medieval India suggests even higher rates of return of about 15%.

While the rates quoted above are high, those quoted for earlier agrarian economies are even higher. In Babylonia between 1900 BC and 732 BC the normal rates of return on loans of silver (as opposed to grain) was 10-25%.[4] In the sixth century BC the average rate on a sample of loans was 16-20%.

Nor can these high interest rates be explained, in cases such as England, by the constraints on economic actors. Three things might influence interest rates in pre-industrial societies.

(a) Insecurity of property.

(b) The rate of growth of average incomes.

(c) The risks of death

The last two of these we know cannot systematically explain high pre-industrial interest rates. Higher average growth rates of income should drive up rates of return but in the world before 1800 the average rate of income growth was close to 0, and if anything there was more average income growth after 1700 than before. Finally death rates only potentially matter if people think only of themselves in investing, and not of their children. And while death rates in the pre-

[2] Compound interest was not charged, so since some of the loans ran for a number of years the actual rate charged was somewhat lower than 10%. See Larsen (1933), pp. 368-379.
[3] Johnson (1933).
[4] Homer and Sylla (1996), pp. 30-31.

industrial world for working adults were higher than in the modern world, was saw in chapter 5 that there is no evidence of any downward trend in death rates before 1800.

Economists will tend to automatically assume that high interest rates in these early societies must therefore reflect the insecurity of property rights. But two things argue against this. First the degree of insecurity of property rights required to get from a 3% interest rate to a 20% interest rate is huge. Investors would have to typically lose one sixth of the assets lent each year to explain such rates. There is no evidence that property was typically so insecure in the Malthusian era. Indeed in cases such as England before 1300 the evidence is that property rights were very secure. Witness of this is that the documents that show the rates of return before 1350 were typically from sources that were compiled in the fifteenth century or later, often hundreds of years after the institution concerned first acquired the property. The second problem with a property rights interpretation is that even if property rights were generally insecure in early societies, there would have been some periods of security. Yet not only were average rates of interest very high, we also rarely see any individual loans at interest rates that were commonplace in the Netherlands in the seventeenth century, or England in the eighteenth century.

When we move to consider forager societies the evidence becomes much more indirect, because often there is typically no explicit capital market, or lending may be subject to substantial default risks given the lack of fixed assets with which to secure loans. Anthropologists, however, have devised other ways to measure people's rate of *time preference*, where this is the percentage increase in consumption a person needs to receive to persuade them to consume a good in one years time as opposed to now. They can, for example, look at the relative rewards of activities whose rewards occur at different times in the future: digging up

wild tubers or fishing with an immediate reward, as opposed to trapping with a reward delayed by days, as opposed to clearing and planting with a reward months in the future, as opposed to animal rearing with a reward years in the future. A recent study of Mikea forager-farmers in Madagascar found, for example, that the typical Mikea household planted less than half as much land as would be needed to feed their families through the year. Yet the returns from shifting cultivation of maize on forest land were enormous. In a typical year such plots would yield at a minimum 74,000 kcal. per hour of work. Foraging for tubers yielded an average estimated return of 1,800 kcal. per hour. Yet the Mikea spend much more time foraging than cultivating. This implies extraordinarily high time preference rates.[5] James Woodburn claimed that Hadza of Tanzania showed a similar disinterest in benefits coming only in the future, "In harvesting berries, entire branches are often cut from the trees to ease the present problems of picking without regard to future loss of yield."[6]

While agrarian society seems to have been selecting for observable characteristics such as the rate of time preference, it may also have been selecting for other less directly observable characteristics that favor economic success in agrarian societies. These would include a preference for work and material goods versus leisure, an increase in the social and economic status of women, and the ability to rationalize and conceptualize. For the emergence of complex market economies with many commodities traded over many time periods and locations makes economic success much more dependant on such abilities than in earlier forager societies. As noted in earlier chapters there are signs of significant increases in both numeracy and literacy in Europe in the interval 0-1800. The regression results we saw above for English testators in the seventeenth century do not allow me to distinguish whether selection was for accumulation

[5] Tucker (2001), pp. 299-338. It seemed that maize and manioc cultivation also had a higher variance of yields, and so was riskier than foraging.
[6] Woodburn (1980), p. 101.

behavior alone, or for literacy alone, or for both, since literacy and legacies were closely correlated. But it is possible that selection pressures were operating directly on literacy in early modern England.

Selection Pressures in Other Malthusian Economies

If these selection pressures which I have shown for pre-industrial England were equally strong in all economies in the Malthusian era, then while it would help explain why an Industrial Revolution became more likely over time, it would not explain why the Industrial Revolution was British as opposed to French, Chinese, Indian, Japanese or Iranian.

One thing we observe, though, is that not all pre-industrial societies experienced the same kinds of selective pressures on family behaviors. In the frontier society of New France in the seventeenth century, for example, there was no selection towards those with assets or literacy. And indeed in contrast to England literacy rates did not rise in New France in these years. Figure 3 shows the literacy rates of men and women at marriage for the decades from the 1660s to the 1710s. Two things stand out. First is the generally low level of literacy. Second are the rather modest gains over time, especially for men, compared to the developments in England in the same years. Could this be the result of composition effects, with the *illiterate* more successful in populating the colony?

The data on surviving children here come from reconstituted family data elicited from parish records. Reconstituting the native-born population has been particularly successful, because parishes were established early in the colony's history, and few records have been lost through neglect or disaster. Charbonneau et al. (1993) estimate that 20,680 non-aboriginal people were born in the Quebec area before 1700, 19,580 of which are documented in this data

set. Marriage and death information is known in about 85 percent of cases (Charbonneau et al. (1993: 62)). The parish records have been supplemented by census and notary records, which provide extra information on family composition, literacy (ability to sign one's name), and occupation or status.

Three sets of individuals that likely were wealthy have been identified. The first is members and offspring of the nobility (Gadoury, 1991). French royalty conferred noble title, which was inherited through the male line. The nobility were afforded privileges not enjoyed by the typical resident.[7] The second is members and offspring of the `bourgeois' class (Noguera, 1994). `Bourgeois' was often a self-appointed title taken by men with relatively high status occupations, such as large-scale merchants or crown appointed officials. The third set is people who were able to sign their name on their marriage record.

When we look at the experience of high status males as opposed to low status, we find in contrast to England in the seventeenth century, that the low status group had a reproductive advantage. As table 6 shows the marriage and family formation experiences of high status (broadly defined) and low status individuals were distinctive. High status men who married tended to be older when they first married (28.2 years, on average, compared to 27.5 years for low status). Their wives were also older, by half a year. They did not live as long (61.8 years compared to 62.5 years) and they were more than twice as likely to have been born in an urban area (which may have contributed to their shortened lives). A slightly lower proportion of high status husbands were born in New France (58 percent versus 63 percent). Most of the high status

[7] For example, the King of France offered some nobility large land grants, called seigneuries. Not all seigneurs were member of the nobility (Harris, 1966). The aristocracy also qualified for pensions and some received fur-trade licences. In addition, a substantial portion of those that did not inherit title served as officers in the military and were given (lucrative) officers' commissions. For more information on the nobility, see Gadoury (1991), Dechêne (1992), or Greer (1997: 51).

individuals could sign their name (90 percent), and 29 percent were of noble or bourgeois descent.

Low status husbands fathered more children from their first marriage than did high status husbands (8.04 children, compared to 7.43). When all marriages are taken into account, however, high status men were slightly more prolific (9.08 children versus 9.01). They were able to close the fertility gap because their chances of remarrying were 33 percent higher than the rate experienced by low status men. Considering their surviving children, on the other hand, high status husbands fare even less well. Considering all marriages, high status husbands had fewer surviving offspring—4.04 children compared to 4.50 children for low status. As a proportion of their total progeny, this implies a survival rate of 44 percent versus 50 percent for low status men. The difference is especially notable given that high status men tended to die earlier than their low status counterparts.

Overall married men in New France were producing many more surviving children, 4.4 on average, than their relatively higher status counterparts who were leaving wills in England in the seventeenth century. Married male testators in England in this period had an average of only 3.5 surviving children. The differences are even greater then these numbers would suggest since only the English data includes as survivors children who were themselves dead at the time of the testator's death but who had left grandchildren mentioned in the will. The fact that England was a society closer to Malthusian equilibrium than New France, whose population was growing rapidly, may help explain why there was less evidence of selective pressures in New France towards those of higher status.

This may narrow the class of societies experiencing selective pressures towards lower rates of time preference, and towards more investment in children, but it still leaves the puzzle of

why cultural forms in England would have evolved faster towards a configuration favoring more rapid productivity advance than those in China, India, Japan or Egypt, all extremely long settled agrarian societies. There is one way in which England was relatively unusual in its experience from 1100 to 1800, and that is in the extraordinary political and social stability that it achieved. As we saw in chapter 5, this was a society where deaths from violence or natural disasters were extremely rare from the thirteenth century on. Other settled agrarian societies were not so fortunate. But all this suggests that while we can perhaps explain why an Industrial Revolution of some sort was becoming more likely the exact timing and location of the Industrial Revolution still involved random and unpredictable elements.

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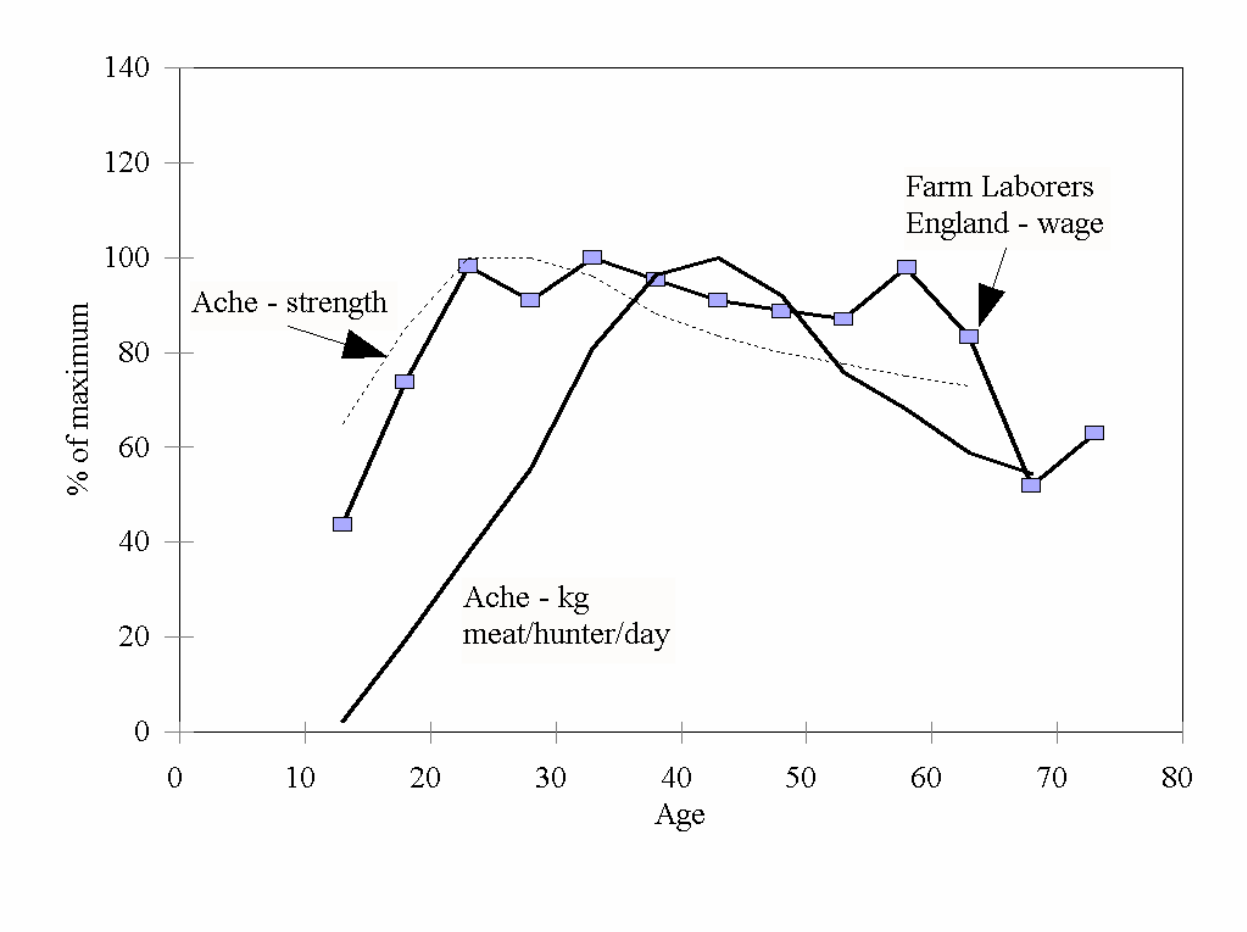
Figure 1: Earnings (or product) versus age, males.



Note: The wage profile of farm laborers in England is from a sample of about 100 workers in the 1830s. The output of Ache hunters per day is for the 1980s, 1990s, as is the strength measure.

Sources: Walker, Hill, Kaplan and McMillan (2002), p. 9, Burnette (1999).

Table 1: England, surviving children as a function of literacy

Residence	% literate	Testator signed Number	% married	Testator signed Children	Testator made mark Number	% married	Testator made mark Children
London	82	129	74	2.10	29	62	1.69
Other towns	69	87	87	2.93	39	87	2.15
Countryside	61	223	88	3.26	346	91	2.84

Table 2: The Determinants of the Number of Surviving Children, Males

Variable	**Full Sample** Average Value	**Full Sample** Coefficient Estimate	**Full Sample** Standard Error	**Married** Average Value	**Married** Coefficient Estimate	**Married** Standard Error
CONSTANT	-	2.026	0.211	-	2.416	0.224
DWID	0.178	1.238**	0.242	0.175	0.882**	0.241
DLIT	0.442	0.303	0.201	0.439	0.460*	0.209
DTOWN	0.181	-0.699**	0.258	0.148	-0.602*	0.271
DASS1	0.152	0.305	0.309	0.138	0.248	0.327
DASS2	0.136	0.629*	0.320	0.175	0.448	0.332
DASS3	0.251	1.030**	0.274	0.257	0.995**	0.287
DASS4	0.247	1.240**	0.211	0.164	0.970**	0.308
N		692			621	
R^2		.078			.068	

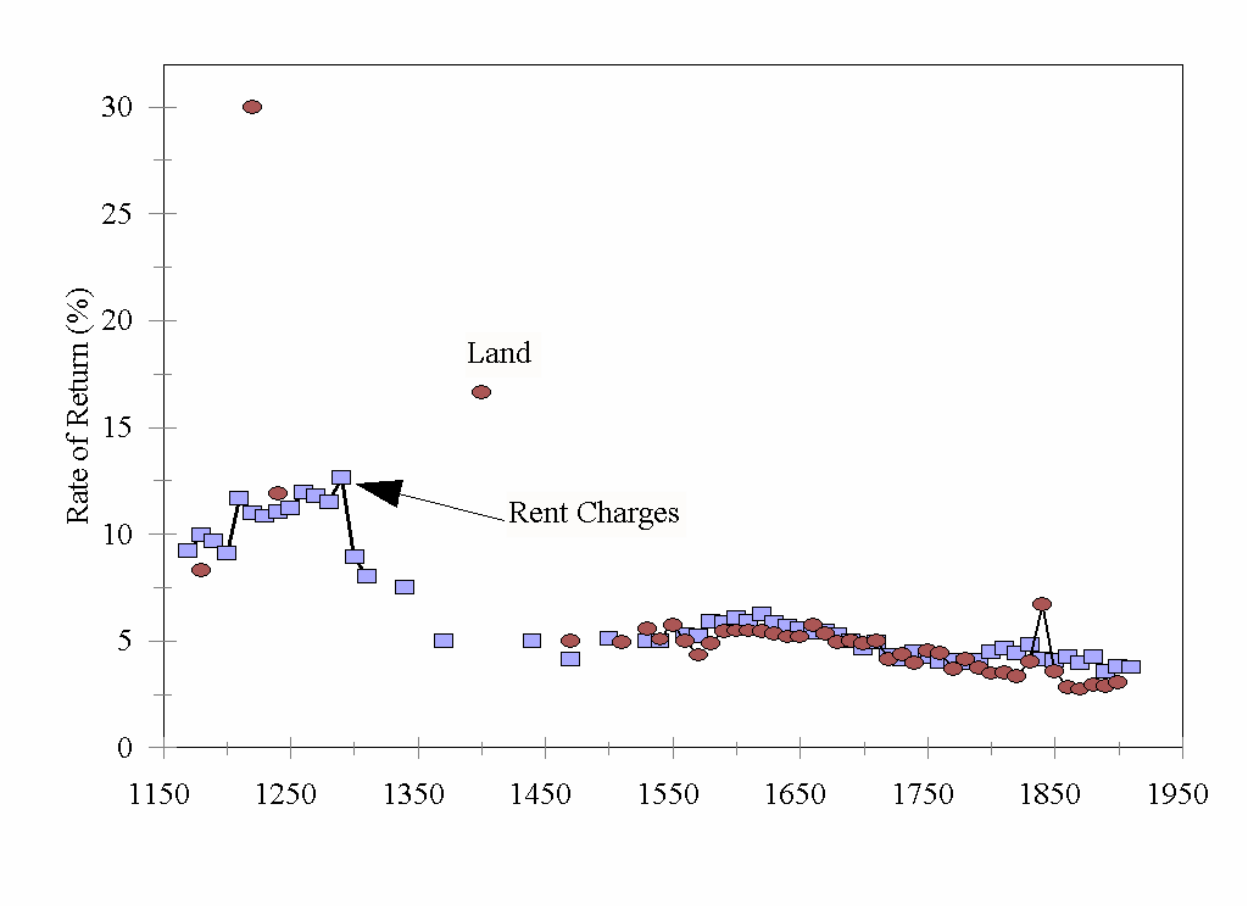
Note: * = statistically significant at the 5% level, ** = statistically significant at the 1% level

Table 3: The Correlation Between Characteristics of Testators and Literacy, England 1620-36

Variable	DF/dx	Full Sample Standard Error	z
DWID	-0.105*	0.058	-1.99
DFARM	-0.178**	0.042	-4.21
DTOWN	0.138*	0.051	2.35
DSINGLE	0.090	0.067	1.36
DASS1	0.005	0.069	0.07
DASS2	0.176*	0.068	2.54
DASS3	0.226**	0.057	3.83
DASS4	0.453**	0.050	7.67
N		692	
Pseudo R^2		.135	

Note: dF/dx is for a discrete change of dummy variable from 0 to 1. z is the test of the underlying coefficient being 0.

Figure 2: The Rate of Return on rent charges and land by decade, England, 1170-1914



Note: The observations are 10 year averages. There are very few observations on the rate of return on land before 1500.

Source:

TABLE 4: THE RATE OF RETURN ON CAPITAL, 1150-1800 – RENT CHARGES

PERIOD	England (%)	France (%)	Germany (%)	Flanders (%)	Italy – wheat rents (%)	Italy – money rents (%)
1150-99	9.5				-	-
1200-49	10.8				9.6	-
1250-99	11.7				10.0	-
1300-49	8.6	**11.0**	**10.2**		13.9	7.3
1350-99	5.0	-	9.7		10.2	6.1
1400-49	5.0	-	8.5		10.3	8.5
1450-99	-	9.2	6.5		11.6	-
1500-49	5.1	8.2	5.3			
1550-99	5.6	8.3	-			
1600-49	6.0	6.6	-			
1650-99	5.4	-	-			
1700-49	4.5	4.2	-			
1750-99	4.1	4.8	-			

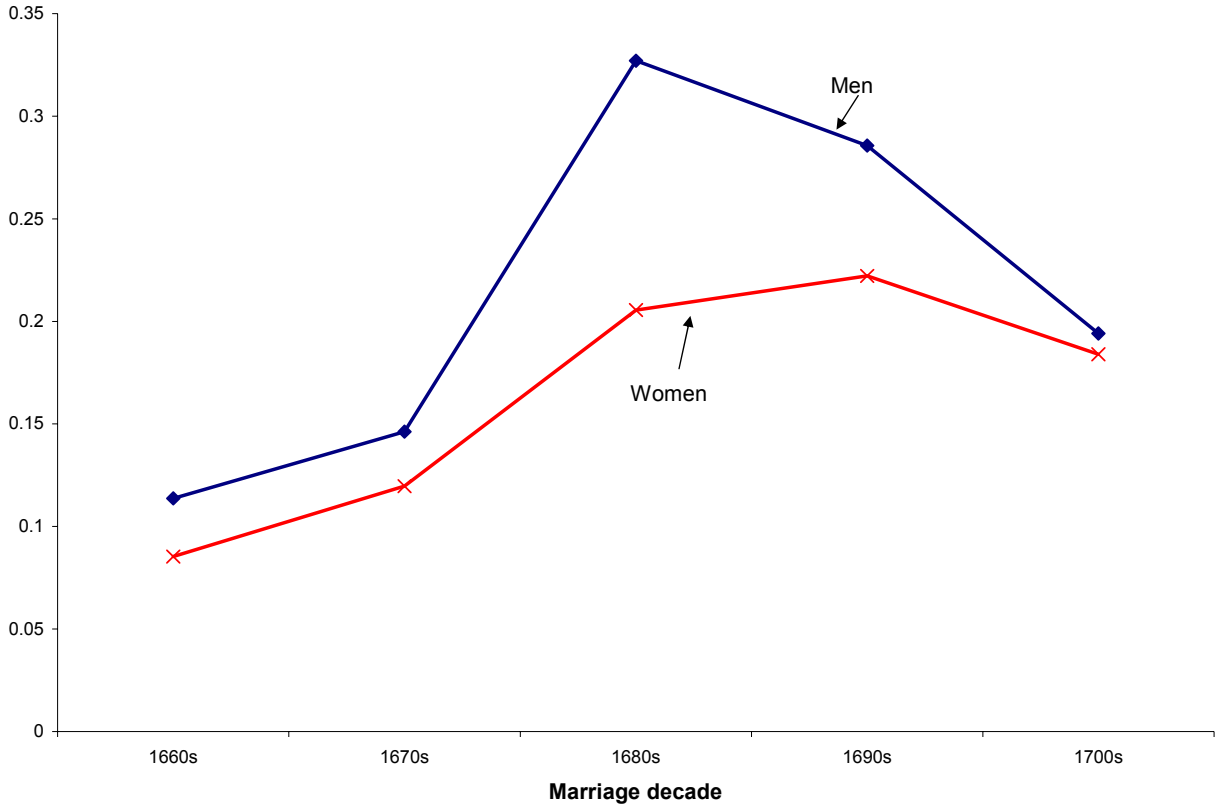
Source: Clark (1987), table 3. Herlihy (1967), pp. 123, 134, 138, 153.

TABLE 5: THE RATE OF RETURN ON CAPITAL, 1150-1800 - LAND

PERIOD	England (%)	France (%)	Germany (%)	Italy (%)
pre-1351	9.7	10.0	10.7	
1351-1400	9.4	-	8.1	
1401-1450	5.6	-	9.6	
1451-1500	5.0	6.4	7.6	
1501-1550	5.5	-	-	
1551-1600	5.8	4.3	-	
1601-1650	5.4	3.9	-	
1651-1700	5.4	4.4	-	
1701-1750	4.3	3.8	-	
1751-1800	3.6	2.7	4.7	

Source: Clark, "The Cost of Capital," table 3.

Figure 3: Literacy in New France



Sample: Men and women marrying in New France (evidence from marriage registers or contracts). For men, the number of observations in each decade (consecutively) is: 132, 342, 795, 1,274, 1,283. For women, the equivalent numbers are: 129, 326, 798, 1,211, 1,288.

Table 6: New France, Husband's characteristics, by status, full sample

	High Status	Low Staus
Birth year	1664	1666
	(12.19)	(13.34)
Age at First Marriage (years)	28.2	27.5
	(5.65)	(5.45)
Marriage age of wife (years)	20.4	19.8
	(5.50)	(4.86)
Life span	61.8	62.5
	(15.91)	(16.38)
Born in New France	0.58	0.63
Urban marriage	0.53	0.25
High status (narrow)	0.29	0.00
Signed marriage record	0.90	0.00
High status (broad)	1.00	0.00
Remarried	0.60	0.45
Children (first marriage)	7.43	8.04
	(4.68)	(4.32)
Children (all marriages)	9.08	9.01
	(5.05)	(4.53)
Children outliving father (first marriage)	3.37	4.09
	(2.76)	(2.69)
Children outliving father (all marriages)	4.04	4.50
	(2.83)	(2.70)
N	823	2,236
N (remarried)	347	765
N (marriage age wife)	819	2,225

Notes: Standard deviations in parentheses.