The Surprising Dynamism of the Malthusian World: Institutions, Preferences and Modern Growth

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One startling change in the economic system in the centuries leading up to the Industrial Revolution was a very substantial decline in interest rates. The magnitude of this decline is little appreciated, its cause is a mystery, and its connection to the shift to an economic system with persistent efficiency advance is unknown. This paper seeks to document better these trends in pre-industrial interest rates, using data from England 1170-2000 as an illustration. It also offers an evolutionary explanation of changing time preferences for these trends, an explanation that can potentially tie interest rate declines to the subsequent Industrial Revolution.

Introduction

There is plenty of evidence that material living conditions for the average person did not improve before 1800 and the Industrial Revolution, despite substantial but slow technological growth. Figure 1, for example, shows the real wage of building workers in England from 1200 to 1869 (standardized to a notional 10 hour day after 1860) for building workers from 1200 to 2000 in England. Real wages in 1800 were no higher than their average level over the previous 600 years. The economy thus seemed caught in stasis. But yet there are signs several important elements of the economy were very different in 1750, at the eve of the Industrial Revolution, than in 10,000 BC. One profound and unexplained change was in interest rates. Real interest rates in most countries in Europe before 1400 were above 10% a year, while in the modern world the real interest rate on the equivalent investment would be 2%. This paper documents this, and asks how we can explain this dramatic change.

Interest Rates Before 1800

Measuring real interest rates is not easy in the modern world of relatively high and variable inflation rates. But before 1900 generally prices showed little secular trend and measuring real interest rates was much easier. Table 1, for example, shows the average rate of price inflation in England by century from 1200 to 2000: though it should be noted that England was known among pre-industrial societies for the sound currency management. As can be seen for the 700 years from 1200 to 1900 inflation was generally at very modest rates. Even in the 16th century, the period known as the Price Revolution, the average rate of inflation was less than is the norm in the 1990s in the UK, US and other industrialized countries.

For England evidence on interest rates goes back to about 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. Table 1 shows that in the long pre-industrial era the average rate of land price inflation differed little from that of price inflation (on average land prices rose at .24% per year more than the rate of price inflation in England from 1200-1800, despite the fact that the population in 1800 was about three times that in 1200).

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

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

Since the inflation rate before 1800 averaged 0.45% per year 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.

Medieval England was not the only Malthusian society where rates of return were very high. Tables 2 and 3 show the returns on land purchases and rent charges for other areas in Europe before 1800. We see the same evidence of high medieval rates followed by some decline towards the Industrial Revolution era. 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. The temple of Delos, which received a steady inflow of funds in offerings, invested them at a standard 10% mortgage rate throughout this period.[1] Endowments in Roman Egypt in the first three centuries AD were invested on land security at a typical rate of 12%.[2] 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 Sumer, the precursor of Ancient Babylonia, between 3000 BC and 1900 BC rates of interest on silver loans were 20-25%. In Babylonia between 1900 BC and 732 BC the normal rates of return on loans of silver (as opposed to grain) was 10-25%.[3] In the sixth century BC the average rate on a sample of loans in Babylonia was 16-20%, even though these loans were typically secured by houses and other property.

When we consider forager societies the evidence on rates of return becomes much more indirect, because there is 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 rates. 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

[1] 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.

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.[4] 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."[5]

Why were interest rates declining before the Industrial Revolution?

Prior to 1800 and the Industrial Revolution societies were Malthusian. Population grew to the point where material living standards fell low enough so that births just equaled deaths. Life expectancy at birth and material living standards were both determined by the birth rate. Since there is no sign of any change in average birth rates over the pre-industrial era, life was consequently no better in material terms in 10,000 BC than it was in the most sophisticated societies, such as England, in 1800, even though there had been an enormous advance in the level of technology. In particular there is no evidence of any improvement in living conditions in the long interval between the arrival of settled agrarian societies in the Neolithic Revolution of circa 8,000 BC and the Industrial Revolution.[6]

The real rate of return in a society, r, can be thought of as composed of three elements: a rate of pure time preference, ρ, a default risk premium, d, and a premium that reflects the growth of overall expected incomes year to year, θg_y. Thus

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[2] Johnson (1933).
[3] Homer and Sylla (1996), pp. 30-31.
[4] 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.
[5] Woodburn (1980), p. 101.
[6] Clark (2003) shows that empirically there is good evidence for the claim that Neolithic material living conditions

$$r \approx \rho + d + \theta g_y.$$

People as economic agents display a basic set of preferences – between consumption now and consumption in the future, between consumption of leisure or goods – that modern economics has taken as primitives. Time preference in consumption cannot be derived from any consideration of rational action, and economists posit it as a basic parameter of people's preferences. $(1-\rho)$ thus measures the marginal utility of consumption in the next period relative to consumption in this period, when consumption across both periods is the same. The "growth premium" in interest rates reflects the fact that if all incomes are growing it is harder to persuade people to lend money and defer consumption. Thus Hansen and Prescott when they fit their recent two sector model of the Industrial Revolution to English historical data predict, counterfactually, a rise in the return to capital once the modern rapid TFP growth technology dominates (Hansen and Prescott (2002)).

Assuming ρ is given as part of an unchanging "human nature," higher interest rates in societies before 1800 must reflect a combination of higher default risks and income growth effects. But in the Malthusian economy income growth is not an issue. It was on average zero. Thus the income effect implies a growth in interest rates as we move from the Malthusian to the modern economy, which of course we do not observe. Indeed given the absence of income growth, interest rates circa 1300 are about 8-10% higher than would be expected.

Thus the only conceivable cause for high interest rates in the pre-industrial world, aside from a change in time preference rates, would seem to be default risks in investing. These risks can be considered as having two forms. First the risk that the investor themselves may not be around to collect the benefits. Second the risk that the investor would be unable to collect on the

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were as good as those of 1800.

investment.

Life Expectancy

One form of insecurity in investment is the unexpected death of the investor. Life expectancy was lower in pre-industrial societies than in modern society. The length of life itself on average should make no difference to the inherent underlying rate of time preference. But pre-industrial savers did face a much higher annual risk of death throughout their adult lives than do modern savers. The life span was more uncertain. Had they been interested only in their own welfare they might have regarded the expected return from investing as being relatively low in the pre-industrial era. Of course altruism towards children would reduce the implied disincentives from an uncertain lifetime.

However important these effects on savings behavior, they will not, however, explain the very significant decline in rates of return between 1300 and 1800 found in Europe. For there is very little sign within these years of any significant gains in life expectancy. In the Malthusian world life expectancy at birth, e_0, is given by the simple formula

$$e_0 = \frac{1}{B}$$

where B is the birth rate per person per year. We know for England in the years 1540 to 1750 that there was little change in birth rates, and from indirect evidence we suspect that this holds true back to the 13th century.

The Security of Property

If we want to maintain that the rate of pure time preference was constant over time this leaves only one possible source to explain the large decline in interest rates, and that is that early societies had a pervasive insecurity of property. Somehow all across medieval Europe in the years before the onset of the Black Death in 1347-9 there had to be this general inability to obtain secure possession of assets. I argue below that this interpretation cannot be sustained, at least for medieval England, and hence by implication for all these societies.

One obstacle to this interpretation is that the degree of insecurity of property rights required to get from a 2% real interest rate to a 10-11% real interest rate is huge. Investors would have to typically lose one twelfth of the capital sums lent each year to explain such rates (if they were risk neutral). There is no evidence that property was typically so insecure in the Malthusian era. There were periods of insecurity, but nothing that could explain such high rates of return.

A second deficiency of this interpretation is that different parts of England in the middle ages had very different jurisdictions and legal structures. Sometime before 1200, for example, London had secured from the Crown a large set of privileges. The first of these was that the city was allowed to pay a lump sum for taxes to the King "the farm of the city", and arrange its own collection within the city of this annual sum. The town was also allowed to appoint its own judges even in cases before the crown courts so that Londoners would only ever be judged by Londoners. Land cases were to be settled according to the law of the city, even in the king's courts. Londoners were free from trial by battle, the Norman tradition that resulted in some property cases being determined by armed combat as late as the 1270s.

In the reigns of Richard I and John (1189-1216) the kings' fiscal problems led them to sell off to many other towns similar rights and privileges to those of London. Thus by 1200 or soon thereafter there were a host of local legal jurisdictions in urban areas in England under which property would be held. If the high returns on land and rent charges were the result of deficiencies in property laws and their enforcement, then we would expect some of these jurisdictions to perform much better than others. In those with the best defined property rights returns would be lowest. In the sample of rent charge returns I have for the years before 1345 I have enough data on a small group of cities and towns to compare their average rate of return with the national average. The results are shown in table 4. There is little difference between returns in the five specific locations and the national average rate of return. If property right insecurity explains high medieval rates of return different jurisdictions amazingly created systems with roughly the same degree of insecurity.

The third problem with a property rights interpretation is that even if property rights were generally insecure in early societies, there would have been periods of greater and lesser security. Thus we would expect if the confiscation risk was the source of high early interest rates that interest rates would fluctuate from period to period, and would be connected to political developments. Yet not only were average rates of interest very high, they tended to be high and relatively stable over time where they can be measured reasonably well as with rent charges. Thus in figure 2 note that the rate of return on rent charges in the decades from the 1180s to the 1290s all fall within about 1% of the average rate of 10.4%. If these returns are so high because of the radical insecurity of property why did they not show any substantial deviations between decades, despite the huge changes in political regimes in this era?

In the thirteenth century, for example, the reigns of John (1199-1216) and Henry III (1216-1272) were ones of greater turmoil in England. There was open rebellion in the last years of John's reign by the barons and again in the 1260s under Henry III. Edward I (1272-1307) ushered in nearly 40 years of stability and strong central government. But his son Edward II (1307-1327) was again a weak ruler who was eventually deposed and murdered by his wife and her lover and replaced as ruler by his son. But there is no correspondence between the periods of calm and stability, as under Edward I, and the prevailing interest rate. It is always high before 1300, whatever the high politics, but shows signs of declining in the turbulent years 1307-1327 (see figure 2). Similarly if we look, as in figure 3, at the price farmland typically traded for in the years before 1349 we again find that measured prices fluctuated little from decade to decade, despite the small sample of transactions that this series is based upon, where I typically have less than 50 observations per decade.

For comparison with this experience consider the prices and the return on land holding in the district of Zele in Flanders in what is modern Belgium from 1550 to 1750. The countryside there was subject to many long and destructive military campaigns between 1550 and 1750. In the years 1581-92 the struggle for Dutch independence took place mainly in Flanders. Zele lies between Ghent and Antwerp. Ghent was recaptured from the rebels by the Spanish in 1584 and Antwerp in 1585 after fierce fighting. A truce between the Dutch and the Spanish was not arranged until 1609. In 1621 the truce ended and the war between the Spanish and the Dutch was not finally over until 1648. There was also warfare in Flanders in the period 1674-98 during the wars between the French and various opponents including the Dutch, the Spanish and the English. Finally in 1701-14 Flanders was again ravaged by armies in the War of the Spanish Succession). Figure 4 shows the average annual price of arable land in Zele between 1550 and 1749, deflated by the price of wheat.[7] While there are long run movements in land values, it is very clear from figure 4 that in all three war periods land prices fell sharply. In some years in the war of independence from 1581 to 1592 real land prices fell to less than 6% of their value at

[7]The price of wheat is from Abel (1980), pp. 432-3, which gives the average wheat price in silver in Bruges, Dixmude, Nieuport, Anvers, and Brussels measured in terms of silver. This was converted into nominal values

the outset of the war. In the later war with Louis XIV land prices fell by more than 50% at their minimum. The average fall in prices in the first war (1581-92) was an 84% decline, and in the second war period (1674-98) a 28% decline. The third period saw less drastic impacts on real land prices. If the real net output of the land stayed the same over time this would imply that the real return on capital rose by large amounts in the War years. It also shows that we can detect in the pre-industrial era certain types of uncertainty that would influence the returns on capital through the movements of asset price series. Medieval England shows none of the signs of insecurity manifested in this series for Zele.

We also know for the land in Zele the rent per year. Thus we can calculate the implied rate of return on land ownership year by year. This return is shown in figure 5. These returns again clearly show the influence of the war years with much higher returns on land purchases in the years 1581-92. But notably, despite the problems of war, the average return on land is only about 4% outside the years of the greatest conflicts. The Netherlands and Belgium were the first areas in Europe to come close to modern rates of return in the pre-industrial era. And even in the worst years of the Spanish re-conquest in 1581-92, when many Protestants were fleeing from areas like Zele to the Dutch Republic, the average return on capital invested in land was still below the steady rate of 10% found in medieval Europe.

Another measure of the stability of England in the years before 1800 is the numbers of English soldiers dying in armed clashes. From the history of battles and campaigns, great and small, I have estimated for each decade in England the death rate per 100,000 per year from organized violence. Figure 6 shows these estimated rates by decade from the 1170s to the 1900s. This is generally modest being at the average rate of 13 per 100,000 in the years 1200-1800, in a

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using van der Wee (1963), pp. 128-9.

society where the average death rate from all causes per 100,000 would be above 2,500. Typically in England before 1800 slightly less than 1% of males would die in organized violence. But there is little downward trend in these estimated death rates from 1200 to 1800. The death rate from armed conflicts in the 13th century is estimated at 12 per 100,000, and by the 18th century the estimated rate was still 8 per 100,000.

Another potential lower level measure of the security of person and property is the murder rate in England which can be estimated from court records all the way back to 1200. Murder rates, as historians have noted, were very high in medieval England compared to later years, and compared to many modern societies. The average recorded rate for the years before 1300 was 21 per 100,000 compared to a current rate in the UK of about 1.4 per 100,000. Figure 7 shows these rates for the available samples of localities, and here we see a marked decline throughout the years before 1800. England was becoming at the level of the neighborhood a much less violent place over time. To place this in modern context, the current US murder rate is about 4 per 100,000, Columbia 630, South Africa 51, Jamaica 32, Venezuela 32, Russia 19, and Mexico 13. Thus medieval England had murder rates on a par of those of modern Russia. But while medieval England was violent by the standards of the modern world, it had low rates of violent death compared to hunter gatherer societies. Still less than 1% of deaths in medieval England were caused by murder. Table 6 shows the estimated percentages of deaths in England for males as a result of homicide and accidents in the years before 1800. Deaths from violence and accidents as a percentage of all deaths while they were high by the standards of England in later centuries, were extremely low by the standards of hunter-gatherer societies. While violence and accidents are common causes of death in forager societies, in pre-industrial England almost everyone died in their bed of illness.

All these are signs of a very institutionally stable society over long periods in England. But also a society with a high risk free return to capital. Thus we are left with a major puzzle. Why did medieval societies, such as England, which displayed reasonable institutional stability, exhibit such high real rates of return on capital? And why did rates of return decline significantly in the years leading up to the Industrial Revolution?

The Evolution of Time Preference

The argument I make here is that people in the hunter-gatherer societies that preceded settled agriculture were evolutionarily adapted to have high rates of time preference, and that the long period of settled and institutionally stable agrarian societies that preceded the Industrial Revolution produced a substantial change in the preferences of individuals: preferences about consumption now versus later, about work versus leisure, and about how quickly they resorted to violence.

Rogers (1994) argued that the underlying rate of time preference exhibited by people has an evolutionary origin, and gives an ingenious argument for why it is about 2.5%. To simplify exposition of Roger's argument consider a pre-industrial society which is in a stable population equilibrium. Given the low rates of technological advance before 1800 that implies that the population growth rate was close to zero, and the average person would have two children only who survive to reproductive age.

Parents in such a society have a choice about how many children to produce, and how much capital to endow them with. One strategy would be to use all resources for reproduction, and give the children nothing in the way of physical capital. Another would be to have fewer children and endow them with more capital to aid in the children's subsequent efforts at reproduction. Suppose that producing a child costs \$100 in resources (including the time of the parents). Is it better for the parents to have the child themselves, or to pass on the \$100 to their children and have them produce a child?

The first consideration, which suggests that in evolutionary terms it is better for the parents to do the reproducing themselves, is that parents together share all their genes with their children but only half their genes with their grandchildren. In terms of survival of genes one child is the equivalent of two grandchildren. Thus \$100 spent by parents to produce a child is equivalent in terms of genes passed on to \$200 given to a child to aid their reproduction. If that was the only consideration it would always be best for parents to maximize their direct offspring.

The second dimension to this choice, however, is that childrens fertility occurs on average 25-30 years after their parents. If you live in a world where borrowing and lending is possible, the \$100 you save from foregoing a chance to reproduce and passing the money on to your child will amount to

$$\$100 \times (1+r)^T$$

when the child receives it, where r is the real rate of return and T is the average generation length. Thus as long as

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

\$100 spent to produce a child is the equivalent, in evolutionary terms, of \$100 passed on to a child to aid their reproduction efforts. This implies that the interest rate that should make people evolutionarily indifferent between spending on themselves and on their children is given by

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

Through selection pressures this interest rate will eventually prevail in the Malthusian economy. For if $r < r^*$ those who utilize resources now, who are relatively impatient, increase the numbers of children they have will succeed better in reproducing themselves. While if $r > r^*$ those who pass on resources to the next generation, who accumulate more, will have greater reproductive success in the long run.

Since the average generation length T is between 25 and 30 then,

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

This I can call the "Rogers Bound" on time preference rates. It is of course close to modern real rates of return.[8]

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.[9] 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 Rogers' calculus cannot come into play. Indeed in a society with little or no privately storable 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

[8] One thing Roger's does not consider is what assets the partner of a child brings to a marriage. Suppose that mating is assertive, with partners with larger income potential matching up. Then $100 given to a child not only secures enhanced fertility, but also a partner with more income potential which further boosts fertility. In this case there would be net gains from passing on assets to offspring even at any interest rate above 0.

[9] 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

Neolithic Revolution should have had high rates of time preference. For typically these societies have strong social norms that require sharing of many food supplies within the social group, norms that also individuals typically try and escape by quickly consuming privately any good that they are required by custom to share. If the Rogers argument for the determination of time preference rates is correct then the selection towards individuals with lower time preference rates had to have occurred within the period of settled agrarian societies.

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 settings land distribution was determined period by period through the application of military force. Thus New Guinea hill tribes such as the Dani, until recently had a densely settled system of agriculture with sweet potato gardens the main food source. Land was a valuable capital resource since almost all the forest land had been brought into cultivation, and the various groups lived in close proximity. But there was incessant conflict between different coalitions of settlements over the land that lay between villages, with access determined by success in battle. Access to land was determined by military conflict, not by any stable property rights system.[10] In these cases also, 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. 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, prefering for greater amounts of work input, and eschewing violence in arguments with their fellow citizens.

England by 1200 certainly had the conditions for such a selection. Figure 8, for example, shows the estimated share of income which was derived from wages by decade in England from 1200 to 1869. Even back in the 13th century more than 30% of income typically was estimated to derive from land ownership or capital goods such as housing. Property was a large share of income, property rights were stable, most property was privately owned and could be transmitted reliably to children. Thus from at least the middle ages in England there should have been selective pressure towards those with lower time preference rates.

Thus the argument here would be that the creation of institutionally stable agrarian societies with secure property rights within the Malthusian era created the conditions for a different type of selection across individual characteristics: a selection that emphasized economic competition as the determinant of successful reproduction. While I focus here on time preference rates, this

[10] See, for example, Heider (1979).

would include also such other characteristics as a preference for work and material goods versus leisure, and avoidance of interpersonal violence.

Evidence of Selection by Economic Characteristics, England 1585-1636

Is there micro level evidence that net fertility was linked with the economic characteristics of families before 1800? The data used here to examine this question are summaries of the written wills of male testators from England in 1585-1636.[11] These wills contain some or all of the following information: occupation of testator, marital status (married, widowed, single), place of residence, number of children of each gender,[12] literacy of testator (measured by whether the will was signed), money bequeathed, and to whom (spouse, children, the poor, apparently unrelated persons), number of houses bequeathed and to whom whether land was bequeathed (generally the amount is not specified), other goods bequeathed that have an ascertainable value such as silver spoons, horses, cattle, sheep, pigs, and grains.

The example below is the summary of a typical will from Suffolk in 1623

JOHN WISEMAN of Thorington, Carpenter (signed with X), 31 January 1623.

> *To youngest son Thomas Wiseman, £15 paid by executrix when 22. Wife Joan to be executrix, and she to bring up said Thomas well and honestly in good order and education till he be 14, and then she is to bind him as apprentice. To eldest son John Wiseman, £5. To son Robert Wiseman, £5 when 22. To daughter Margery, £2, and to daughter Elizabeth, £2. To son Matthew Wiseman, £0.25. Rest of goods, ready money, bonds, and lease of house where testator dwells and lands belonging to go to wife Joan. Probate, 15 May 1623. (Allen (1989), p. 266)*

Wills could bequeath very small amounts, such as the following:

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[11] There are also "non-cuperative" wills which record the spoken testamential intent of the deceased.
[12] If a child was dead at the time of the will, but had left grandchildren then this child was counted.

WILLIAM STURTENE of Tolleshunt Major, Husbandman, 14 November 1598.

> *To Francis my son 10s. To Thomas Stonard my son-in-law 1 cow in consideration of money which I owe him. To William and Henry his sons and Mary his daughter each a pewter platter. To Elizabeth my wife the rest of my goods. Probate, 3 February 1599. (--------, p. 171)*

Some important information is almost never present, however, such as the age of the testator. Since we shall see that one major predictor of the number of surviving children is the assets of the testator we need to make sure that this is not just a life cycle effect where wealth proxies for the age of the testator. There are proxies, however, for age that we will use below to control for possible life cycle effects in our results.[13]

The will was dated when written, and also the date of probate is given so the maximal time between the writing of the will and the death of the testator can be estimated. The interval is generally less than a year: 80% of wills were made within one year of probate. We used all wills where probate was less than five years after the date of the writing of the will.

Table 6 shows the number of children, sons and daughters mentioned in wills by the residence of the testator. As can be seen the average numbers of children per testator were modest. For any population to be just reproducing itself the numbers of children surviving each male at time of death would have to exceed 2. It has to exceed 2 since some of these children are minors who would die before they would reach the age where they would be potentially writing wills. Testators in London were thus not reproducing themselves. These outside London were potentially, but not assuredly reproducing themselves.

[13] Since completing this earlier study I have discovered that for some of the testators it will be possible to learn their age, as well as their date of marriage.

Potentially some children were omitted from wills by being left no bequest. But the numbers of omitted children in these years must be small. Daughters were much more likely than sons to be excluded from wills. Where they can be valued bequests to daughters are generally smaller than for sons. Also daughters often received gifts at marriage that seem to have been regarded as being their share of the inheritance. If any children were omitted they would be disproportionately daughters. Yet only in rural areas is their any evidence of omitted daughters, in terms of more sons being mentioned than daughters. And the implied numbers of omitted daughters is small – less than 10% of all daughters. English wills of this period seem to give a good picture of the reproductive success of the testators.

Wills were also not made by a random sample of the population, but were instead made by those who had some property to bequeath.[14] But the custom of making wills seems to have extended fairly far down the social hierarchy. Males making wills are grouped into 7 social categories in table 7. The higher income occupations are overrepresented compared to lower income occupations. Thus "yeoman" typically meant in this period a farmer who owned his own land, while "husbandman" denoted someone who rented the land they cultivated, or a skilled farm laborer. But a significant number of people of the very lowest occupations in terms of incomes and status were making wills. There were numbers of laborers, sailors, and shepherds among testators. The occupational categories as a whole correlate fairly well with other measures of social status, literacy and assets bequeathed. But within each social group there are wide variations in the economic position of the testator. There were some laborers as rich as the

[14] It would seem that the work of the Cambridge Group on family reconstitution from parish registers would provide a more representative measure of reproductive success. But before 1740 these measures are not linked to the literacy of the testator. And the occupations and the assets of the bequeathed are again impossible to discern on a systematic basis. Thus the Cambridge group can only look at reproductive success through the average behavior of villages of different types.

average craftsman or trader, and some craftsmen as rich as the average merchant, cleric or attorney. Many husbandmen were richer than the average yeoman. Similarly some laborers were literate, and many yeomen illiterate.

The estimated assets of testators were constructed from the information in wills by adding together the cash payments directed by the testator, with the estimated value of houses, land, animals, grain, specified by the testator in the will. While land was bequeathed in 625 of our sample wills, in only 98 cases, less than one in six, was the area specified. To infer the area in the other 527 cases we regressed the land area in the 98 cases where the area was specified on the number of houses bequeathed (HOUSES), the amount of cash bequeathed (CASH), the value of the goods bequeathed (STOCK), an indicator for the literacy of the testator (DLIT), and an indicator for whether the person was a yeoman (YEOMAN). The estimated expression for the area is

$$\underset{}{AREA} = \underset{(2.125)}{-2.069} + \underset{(1.249)}{4.596}\times HOUSES + \underset{(0.0121)}{0.0428}\times CASH + \underset{(0.149)}{0.258}\times STOCK$$

$$\underset{(2.441)}{4.472}\times \mathrm{DLIT} + \underset{(2.348)}{8.757}\times DYEOMAN$$

$$\text{R-squared} = 0.45$$
$$\text{N} = 112,$$

with the standard error of each estimated coefficient below in parentheses. In constructing the value of the stock left a standard set of values was used: horses £5, cattle £4, sheep £0.5, pigs £2, wheat (bu.) £0.21, barley/malt (bu.) £0.10, oats (bu.) £0.07, peas/beans (bu.) £0.12, silver spoons £0.38. To normalize for changes in the price level over the years 1585-1836 the “CASH” variable in the above equation was constructed as the actual cash bequests in the will normalized by the average price level in each decade.

We then constructed a monetary measure of the wealth bequeathed by the testator at the time of death by adding to the value of the money and stock bequeathed an estimated value for houses (£40 each) and for land (£10 per acre). For male testators where we have enough information to estimate assets bequeathed the average value of assets equaled £230 in 1630s prices. The yearly earnings of a carpenter in this period would be about £18, so this is equal to about 13 times the wage of a skilled manual worker.

What kind of individuals left more children in this society? To investigate this we first look at married testators, and then consider separately the frequency of marriage. Next we consider whether marriage was any more frequent for some classes of testators.

The first thing that appears is that illiterate testators, indicated by those who signed their will with a mark, left fewer children at death. Table 8 shows the estimated coefficients of a negative binomial regression of the numbers of children on various characteristics of testators, including literacy and occupational status, controlling for the residence of the testator. As can be seen married testators in London left typically about 20% fewer children than those in rural areas. Testators in smaller towns typically have about 10% fewer surviving children. But controlling for these effects the illiterate also have about 10% fewer children. Once we include in the regression occupational status, which as we see in table 4 is highly correlated with literacy, the effects of literacy lessen. Instead occupation, which we saw was highly correlated with literacy, becomes the important explanator of the number of survivors. Figure 9 shows the numbers of surviving children by these broad occupational class controlling just for residency as inferred from the regression.

If men changed occupational category as part of the life cycle, starting as husbandmen and then becoming yeomen when they in accumulated or inherited more property, then these results might not indicate that occupation status at age 20 was truly a predictor of the likely numbers of surviving children. To control partially for such effects in table 8 we also look at occupation as a predictor of numbers of children for a group of married men who are on average much older. These are men whose wills indicate they were widowed at least once (though many had remarried by the time of their will). In this smaller group of an average much older men the effects of status on surviving children are even stronger in quantitative terms, as table 6 shows.

As we noted above the occupational labels used to form people into status classes are rather loose. There are husbandmen who are literate and wealthier than yeomen who are illiterate. There are carpenters who work for others and own no assets, and there are carpenters who are employers and engage in building and leasing property. The estimated value of bequests is an alternative measure of the economic status of males. We sorted males with information on bequests into seven asset classes: £0-9, £10-24, £25-49, £50-99, £100-199, £200-499, £500-. We then looked at the association between the size of bequests and the numbers of children. As table 9 shows the association between assets and surviving children is even stronger than for occupational status, even though we have a very imperfect measure of assets. Figure 10 shows the estimated numbers of children per male of each bequest class. For all married men someone with less than £10 in bequests would typically have two children, while someone with £500 or more, four children. These effects are found also if we just limit the sample to widowers. Assets predict survivors much better than occupation. For a sample restricted to married men with asset information and occupations (1,237 men) the Pseudo R^2 for assets is 0.029, while for status it is 0.008.

We know that the life cycle accumulation of assets explains a negligible amount of these results for several reasons. First there is little sign in this sample that bequeathed wealth increased much through the life cycle. As noted one indication of age is that a testator has been widowed at least once. Yet if we regress the estimated amount bequeathed against status, literacy, location, and an indicator for at least one dead spouse, the estimated coefficient on the indicator is negative, and quantitatively and statistically significant.[15] This implies that older married men were not marked by larger stocks of assets. Second, while we find in later samples that age is positively associated with probate inventory wealth, age turns out to explain a tiny share of the variation in wealth across individuals. Lindert (1985), for contains information on a large sample of deceased in 1875, their ages, occupations and probate wealth (wealth aside from real estate). Age is significantly correlated with probate wealth. But the amount of the variation in wealth that age explains is tiny. On its own age explains about 2% of probate wealth variation. Occupation in contrast explains about 19% of the variation. And indeed if we add age variables to the regression once occupation is already included it increases the R^2 by a mere .006. Assuming that asset accumulation over the life cycle was similar in 1580-36 to 1875 the amount of the variation in assets that age explains will be trivial. Thus if assets are a good predictor of the numbers of surviving children it must be for reasons other than that they are just a proxy for the age of the testator. 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.

So far we have considered only the numbers of surviving children amongst those known to have been married at some point. But since 9.8% of those testators with information on bequests

[15] Loss of a wife may, however, reduce the earnings of a male. Thus the negative effect here cannot be assumed to be a pure effect of age.

died as single men, we also have to consider whether the propensity to get married varied by asset class. The last column of table 6 shows the results of a probit estimation where the dependent variable is an indicator for whether a male testator was single or not, and the independent variables are location, an indicator for illiteracy, and indicators for ranges of estimated amounts bequeathed. Controlling for illiteracy, those with greater assets were less likely to die single. Illiteracy is however positively correlated with marriage, and negatively correlated with assets.[16] The net effect however is that those with assets were less likely to die single. Thus the positive correlation between numbers of surviving children and wealth is strengthened when we consider the probability of marriage also.

Thus in seventeenth century England we see evidence of selective survival of the offspring of individuals of certain characteristics. These are individuals who accumulate wealth, or inherit it and do not dissipate it, and individuals with higher levels of literacy and higher earning jobs.

Were the numbers of surviving children linked to the likely income of the person in these years? To investigate this we consider both married testators, and all testators included those unmarried. Figure 9 shows the numbers of surviving children by broad occupational classes, controlling just for residency (since numbers of surviving children were lower in London and other urban areas).

As we noted above the occupational labels used to form people into status classes are rather loose. There are husbandmen who are literate and wealthier than yeomen who are illiterate. There are carpenters who work for others and own no assets, and there are carpenters who are employers and engage in building and leasing property. The estimated value of bequests is an

[16] The positive correlation of illiteracy and marriage may stem from the fact that in this period illiteracy was declining over time, so that other things equal illiteracy would be a proxy for age.

alternative measure of the economic status of males. We sorted males with information on bequests into eight asset classes: no specific bequests, £0-9.99, £10-24.99, £25-49.99, £50-99.99, £100-199.99, £200-499.99, £500-. We then looked at the association between the size of bequests and the numbers of children. Figure 11 shows the estimated numbers of children per male of each bequest class. For all married men someone with less than £10 in bequests would typically have two children, while someone with £500 or more, four children. Assets predict survivors much better than occupation.

The strong positive association of bequeathed assets with numbers of surviving children might be explained by assets proxying for the age of the testator, if assets were steadily accumulated over the course of men's lives. But we can rule this out as an explanation of the association between assets and surviving children for a number of reasons.

First, we know from other data from the pre-industrial era, in particular David Weir's study of Rosny-Sous-Bois in 1747, that while there is some association between age and assets for heads of households, age explains a tiny fraction of the variation in assets or incomes (Weir (1995), p. 11). Further the association in Weir's data is not linear, but rather an inverted U. Average assets per household are about the same from the 30s to the 60s, but they are smaller for those in the 20s or in the 70s. Such a pattern of variation of assets with age would not explain the patterns we discover above.

Second there is evidence from within our English sample that bequeathed wealth did not increase much with age. Looking just at men who have been married at least once, an indicator for the age of the testator which is independent of their success in producing offspring, is whether at least one wife predeceased them. Married men who have been widowed at least once on average will be considerably older than married men who have never been widowed.

Widowers on average had 29% more children than married men whose first spouse was still alive. Thus being a widower is an indicator for older testators.

Since in any marriage one spouse has to die first, this indicator for age should be independent of anything about the testator's circumstances other than those things dependent on their age. Thus if testators tended to accumulate not just surviving children with age, but also assets to bequeath, then looking at married men, those widowed being on average older should have more assets. In practice widowers, all other things controlled for, left modestly smaller bequests than equivalent males whose wife was still alive. This may be because of dissaving by older testators in the years prior to their deaths.

Thirdly, while we find in later samples that age is positively associated with probate inventory wealth, age turns out to explain a tiny share of the variation in wealth across individuals. Lindert (1985), for contains information on a large sample of deceased in 1875, their ages, occupations and probate wealth (wealth aside from real estate). Age is significantly correlated with probate wealth. But the amount of the variation in wealth that age explains is tiny. On its own age explains about 2% of probate wealth variation. Occupation in contrast explains about 19% of the variation. And indeed if we add age variables to the regression once occupation is already included it increases the percentage of variation explained by a mere 0.6%. Assuming that asset accumulation over the life cycle was similar in 1580-36 to 1875 the amount of the variation in assets that age explains will be trivial. Thus if assets are a good predictor of the numbers of surviving children it must be for reasons other than that they are just a proxy for the age of the testator. 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.

Thus in seventeenth century England we see evidence of selective survival of the offspring of individuals of certain characteristics. These were individuals who accumulate wealth, or inherit it and do not dissipate it, and individuals with higher levels of literacy and higher earning jobs. But interestingly wealth was a much better predictor of reproductive success than other markers of social position such as occupation. We see here that the most successful males were nearly doubling their share in the population in each generation.

Did these males who were more successful in their reproduction pass on these advantages to their offspring? If there was to be any evolution of the average characteristics of the population it must be that the offspring inherit some of the characteristics that made the parents successful. Unfortunately the mobility of the population and small fraction leaving wills makes tracing reproductive success through generations impossible with the samples we have. However, we do know that the children of wealthy parents did receive substantially more assets by inheritance than those of poor parents, so unless they dissipated these over the course of their adult lives they would retain some reproductive advantage.

Not all pre-industrial societies displayed these same reproductive advantages for individuals who were successful in accumulating assets. The hunter gathering group the Ache of Paraguay have been extensively studied by evolutionary anthropologists. Since this was a group that moved every day in search of game, non-human capital assets were minimal in this society. Reproductive success in this group was still correlated with economic success. But it was the success of males in bringing in meat to camp each day. All the adult males hunted, and controlling for age, Ache hunters who brought home more meat had higher fertilities. The most successful hunters at the mean age of 31.5 would be predicted to have .31 children per year compared to 0.20 for the least successful. Survival rates were about the same for children of successful and unsuccessful hunters.

In the more warlike Yanomami society a major predictor of reproductive success was having killed someone. Male Yanomami sired more children by a given age if they had murdered someone than if they had not.[17] Table 10 shows the numbers of children male Yanomami had fathered by age of the male as a function of their status as a "killer" or "non-killer."

In the frontier conditions of New France (modern day Quebec) in the seventeenth and early eighteenth centuries population growth in contrast to England was very rapid. While in England c. 1600 the average married male would have In this society there is no sign that those of higher economic and social status were any more successful in reproducing than those lower in the economic hierarchy. Indeed the opposite held. Those who were illiterate and of lower social status reproduced more successfully (Clark and Hamilton (2004)). But in contrast to England New France was a society with high wages and abundant unexploited land. Uncleared land was free to those willing to clear it, and the subsequent dues owed by those who created cultivated land were modest. The Malthusian constraints had not yet begun to bind there, as in 17th century England.

Conclusion

Economics takes as givens such basic parameters of consumption choice as time preference, or preferences between work and leisure. This paper argues that modern rates of time preference which underlie the real interest rate may not be timeless features of human nature which evolved

[17] Of course, this raises the question of whether murder is a successful reproductive strategy for males, since some of those who fail in the attempt will die themselves, and not be reported upon here.

in the pre-historic hunter-gatherer past, but recent traits picked up in historic time, in part created by the emergence of societies with stable property rights and capital-intensive methods of production. In this respect I follow the argument made by Rae (1834) that societies differ in their average degree of time preference.

The decline of interest rates in Europe just before the arrival of the Industrial Revolution suggests some connection between these two developments. In modern accounts of the Industrial Revolution interest rates play little role directly. The crucial determinant of the Industrial Revolution being a rise in innovative activity, rather than the enhanced accumulation of physical capital. Thus if the decline in interest rates before the Industrial Revolution is in any way to explain the Industrial Revolution it must be because this was a marker of a general evolution of preferences in societies such as England in the pre-industrial era. But if something as basic as time preference was changing markedly in the pre-industrial era as a result of selection for surviving offspring, then other less observable aspects of people's psychology may well also have been adapting to the new structure of economic competition.

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Table 1: Inflation Rates, England, 1200-2000

Period	Inflation Rate (%) π	Land Price Growth Rate (%) π_L	$\pi_L - \pi$
1200-1300	0.49	0.53	0.04
1300-1400	0.08	0.15	0.07
1400-1500	-0.06	-0.28	-0.22
1500-1600	1.32	1.97	0.65
1600-1700	0.36	0.53	0.17
1700-1800	0.50	1.21	0.71
1800-1900	-0.40	0.18	0.58
1900-1950	2.3	2.0	-0.30
1950-2000	5.9	7.7	1.80

Sources: Price level, Clark (2004).

Table 2: The Rate of Return on Capital, 1150-1800 – Rent Charges

PERIOD	England (%)	France (%)	Germany (%)	Italy – rents in wheat (%)	Italy – rents in money (%)
1150-99	9.6	-	-	-	-
1200-49	10.2	-	-	9.6	-
1250-99	10.9	-	-	10.0	-
1300-49	8.9	11.0	10.2	13.9	7.3
1350-99	6.6	-	9.7	10.2	6.1
1400-49	5.0	-	8.5	10.3	8.5
1450-99	4.2	9.2	6.5	11.6	-
1500-49	5.0	8.2	5.3	-	-
1550-99	5.4	8.3	-	-	-
1600-49	5.9	6.6	-	-	-
1650-99	5.3	-	-	-	-
1700-49	4.4	4.2	-	-	-
1750-99	4.0	4.8	-	-	-

Source: Clark (1988), table 3. Herlihy (1967), pp. 123, 134, 138, 153 (for Pistoia, Italy).

Table 3: The Rate of Return on Capital, 1200-1800 – Farm Land

PERIOD	England (%)	Flanders (%)	Germany (%)	Italy (%)
1150-99	9.5	-	-	-
1200-49	10.6	-	-	8.6
1250-99	10.6	-	-	10.6
1300-49	7.3	10.0	10.7	12.9
1350-99	7.5	-	8.1	8.1
1400-49	16.7[a]	-	9.6	9.6
1450-99	5.4	6.4	7.6	-
1500-49	5.3	-	-	-
1550-99	5.1	4.3	-	-
1600-49	5.4	3.9	-	-
1650-99	5.2	4.4	-	-
1700-49	4.4	3.8	-	-
1750-99	3.9	2.7	4.7	-

Sources: Clark (1988), table 3. Herlihy (1967), pp. 123, 134, 138, 153 (for Pistoia, Italy).

Notes: [a]One observation.

Table 4: Rent Charge Returns 1170-1350 by location (%)

Location	Number of Observations	Mean Return	Median Return
ALL	535	11.0	10.1
Canterbury	30	11.8	12.2
Coventry	48	11.4	10.0
London	84	10.3	10.0
Oxford	68	10.2	10.0
Stratford-upon-Avon	8	11.7	12.3
Sudbury	8	11.1	12.3

Notes: In calculating the mean returns 21 observations implying rates of return below 4% or above 25% were dropped. The mean without dropping these observations for the entire sample would be 11.5%.

Table 5: Causes of Death: Hunter Gatherer versus Agrarian Societies

Group	e_0 (assumed)	% deaths illness or degenerative	% deaths accidents (falls, drownings, etc)	% deaths homicide (excluding executions)
Foragers				
Ache, Forest period	37	31.4	13.1	55.5
Yanomamo, 1970-4	-	80.2	7.2	12.6
!Kung before 1973	35	88.3	11.7	
New Guinea (Hewa, Gebusi, Goilala)	35	-	-	21.7
Agta	21	-	-	6.8
Pre-Industrial England				
Bedford, 1270-76	35	98.2	1.0	0.8
Nottingham, 1530-38	35	98.6	0.7	0.7
London, 1300-49	25	98.5	0.6	0.9
London, 17th c	25	99.0	0.9	0.1
London, 18th c	25	99.2	0.7	0.1
USA, 2000[a]	-	95.4	3.9	0.7
Brazil, 1995 [b]	-	89.0	6.8	4.2
Colombia, 1998 [b]	-	78.4	7.5	14.1

Notes: Assuming the population of Bedford in 1270-6 was 50,000 and the population of London in 1300-49 was also 50,000. The English figures exclude judicial executions, but a relatively small percentage of felonies resulted in executions.

Sources: Hill and Hurtado (1996), p. 174, Hair (1971). [a]U.S. National Center for Health Statistics, Vital Statistics of the United States. [b]W.H.O.

Table 6: Surviving Children per Male Testator, England, 1585-1636

Residence	Number of wills with information on children	Children per testator	Sons per testator	Daughters per testator
London	174	1.95	0.83	1.07
Town	287	2.24	1.12	1.10
Rural	1,569	2.86	1.48	1.38
ALL	2,030	2.69	1.37	1.31

Note: The numbers of sons and daughters in each row do not always add up to the total numbers of children since in a few cases the number of children is known, but not the number of sons or daughters.

Source: Clark and Hamilton (2004).

Table 7: Occupations Grouped into Social Categories

Social Group	Numbers of wills giving asset information	Fraction of testators literate	Average value of assets bequeathed (£)	Minimum estimated value of assets bequeathed (£)	Maximum value of assets bequeathed (£)
Gentry	53	0.89	702	20	5,896
Merchants, Professionals	83	0.88	277	0	1,914
Yeomen, Farmers	590	0.50	358	0	2,548
Traders	82	0.57	101	0	471
Craftsmen	242	0.40	97	0	495
Husbandmen, Shepherds	299	0.25	83	0	580
Laborers, Sailors, Servants	86	0.14	52	0	263
Unknown	313	0.49	156	0	941

Source: Clark and Hamilton (2004).

Table 8: Literacy, Status and Survivors, England

Independent Variable	Children, all married	Children, all married	Children, widowed
Illiterate	-0.106**	-	-
	(0.036)		
Gentry	-	0.310**	0.478*
		(0.111)	(0.230)
Merchants, Professionals	-	0.395**	0.474*
		(0.102)	(0.219)
Yeomen, Farmers	-	0.379**	0.460*
		(0.087)	(0.191)
Unknown	-	0.275**	0.471*
		(0.092)	(0.198)
Traders	-	0.176*	0.510*
		(0.114)	(0.254)
Craftsmen	-	0.225*	0.520*
		(0.094)	(0.206)
Husbandmen	-	0.202*	0.387
		(0.091)	(0.202)
London	-0.201**	-0.210**	-0.256*
	(0.059)	(0.068)	(0.130)
Town	-0.104*	-0.087	-0.141
	(0.049)	(.053)	(0.108)
Constant	1.210	0.869	0.916
	(0.025)	(0.083)	(0.183)
N	1,431	1,431	269
Pseudo R^2	0.003	0.008	0.011

Note: In columns 3 and 4 the constant refers to the average number of survivors for a laborer in a rural parish (2.38 and 2.50 respectively).

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

Table 9: Literacy, Assets and Survivors, England

Independent Variable	Children, all married	Children, widowed	Indicator for testator single
Regression Type	Negative binomial	Negative binomial	Probit
Illiterate	-0.005	-0.005	-0.282**
	(0.040)	(0.087)	(0.113)
Bequests, £10-24	0.174*	0.460**	0.188
	(0.080)	(0.157)	(0.165)
Bequests, £25-49	0.378**	0.443**	-0.216
	(0.069)	(0.148)	(0.172)
Bequests, £50-99	0.341**	0.398**	-0.310
	(0.064)	(0.150)	(.160)
Bequests, £100-199	0.423**	0.486**	-0.383*
	(0.062)	(0.139)	(.160)
Bequests, £200-499	0.534**	0.478**	-0.359**
	(0.057)	(0.129)	(.140)
Bequests, £500-	0.660**	0.626**	-0.587**
	(0.063)	(0.151)	(0.184)
Town	-0.109	-0.153	0.230
	(.062)	(0.145)	(0.150)
Constant	0.766	0.938	-0.954
	(0.053)	(0.122)	(0.111)
N	1,237	213	1,436
Pseudo R^2	0.029	0.026	0.032

Note: In each case the constant refers to the average number of survivors for a literate testator in a rural parish with fewer than £25 in bequests.

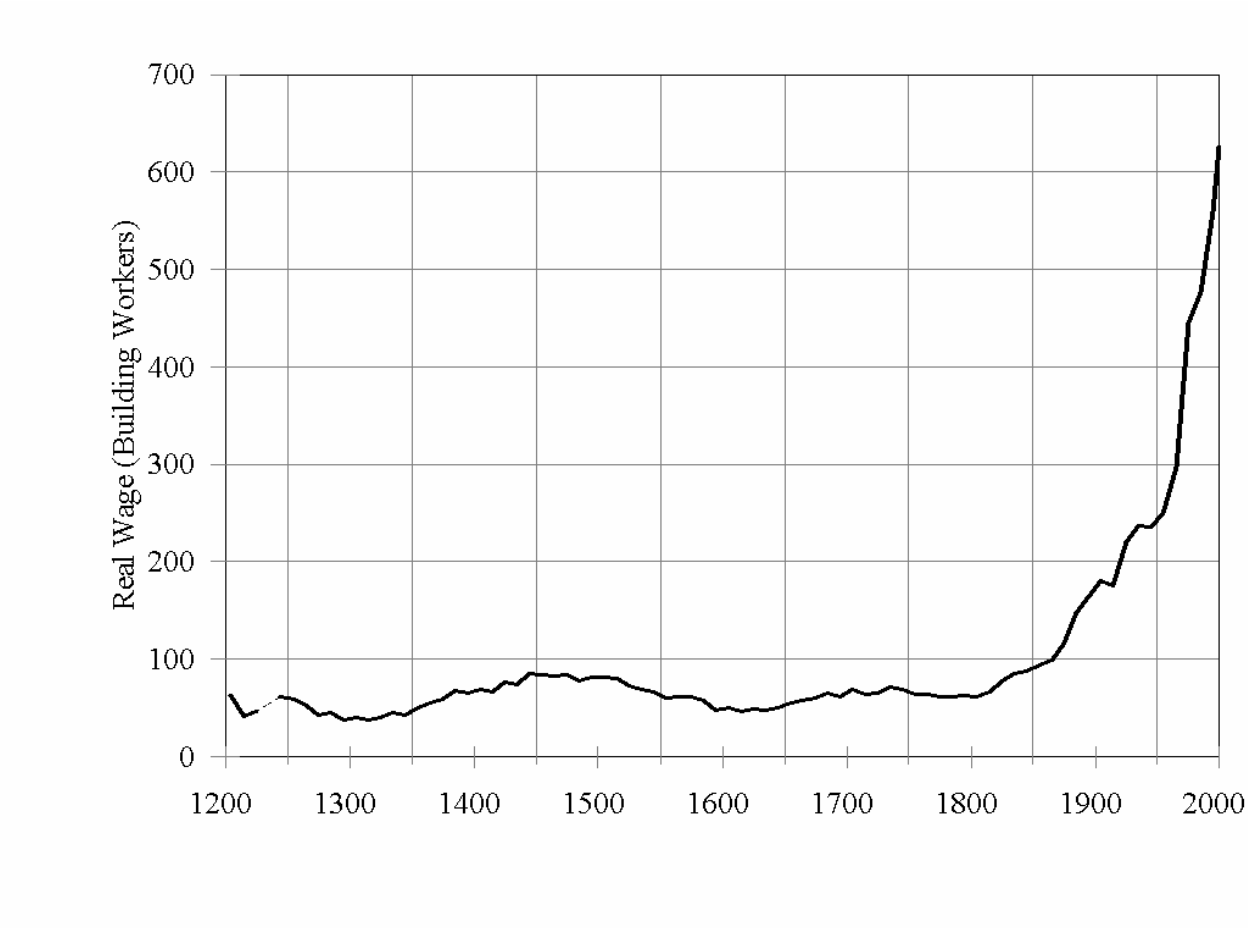
* = statistically significant at the 5% level, ** = statistically significant at the 1% level

Table 10: Reproductive Success of Male Yanomami, 1987

Age	**Killers** n	**Killers** Average Offspring Born	**Non-killers** n	**Non-Killers** Average Offspring Born
20-24	5	1.00	78	0.18
25-30	14	1.57	58	0.86
31-40	43	2.83	61	2.02
41+	75	6.99	46	4.19

Source**:** Chagnon (1988).

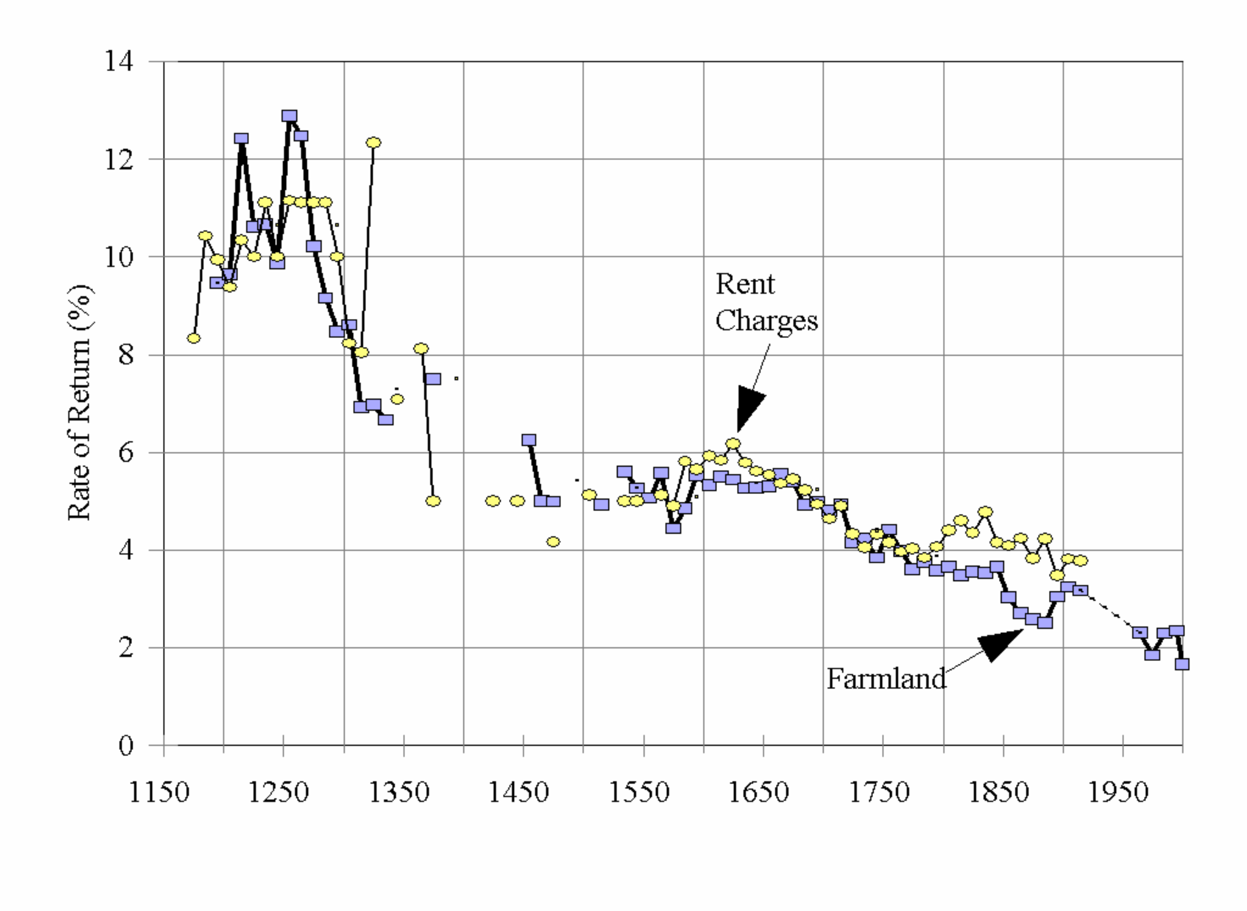
Figure 1: Real Day Wages of Building Workers, England, 1200-2000



Note: The day is standardized to 10 hours after 1860. 1860-9 = 100.

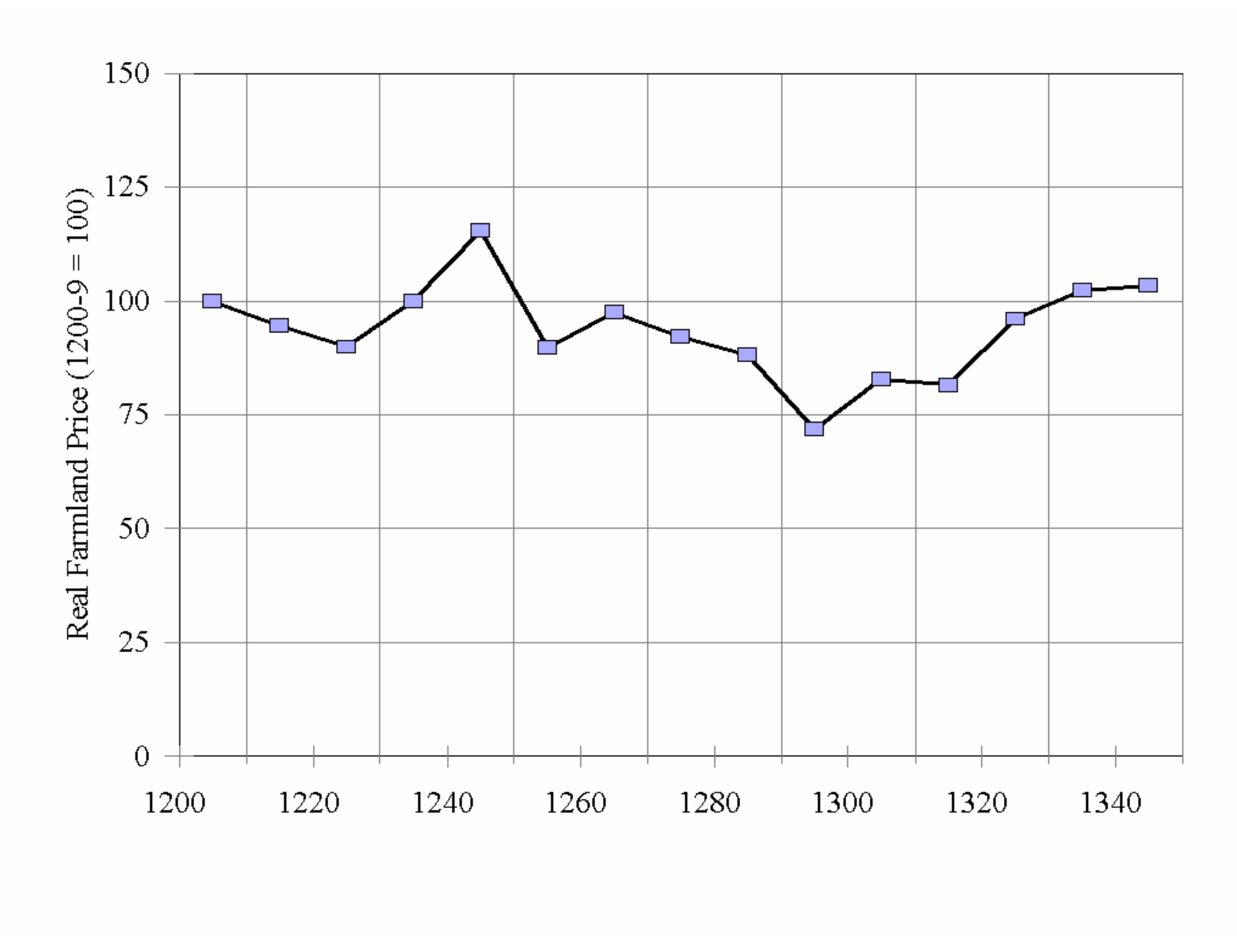
Source: Clark (2004a).

Figure 2: The Return on Land and on Rent Charges, 1170-2003 (by decade)



Notes: For the years before 1350 the land returns are the moving average of 3 decades because in these early years this measure is very noisy.

Figure 3: The Real Price of Farmland per Decade in England, 1200-1349



Notes: The chart shows the price per acre of farmland deflated by the general price level.

FIGURE 4: REAL FARMLAND PRICES, ZELE, 1550-1749

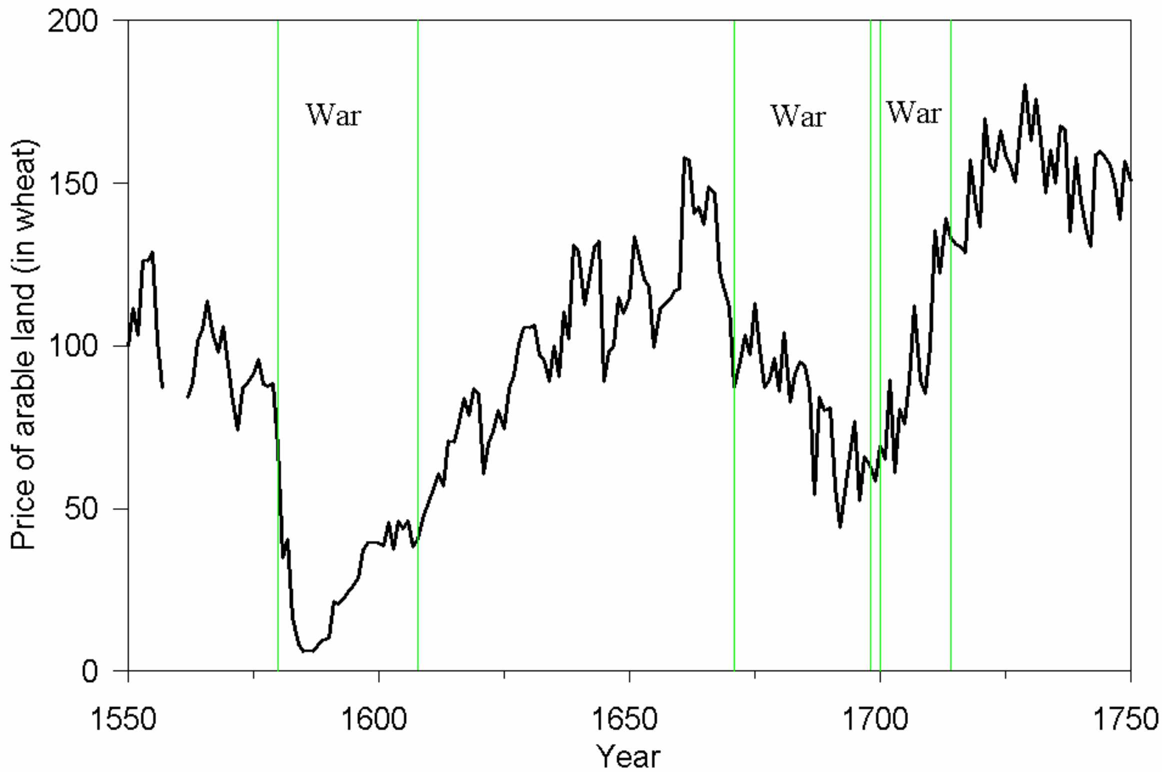


FIGURE 5: RETURN ON LAND HOLDING, ZELE 1550-1750

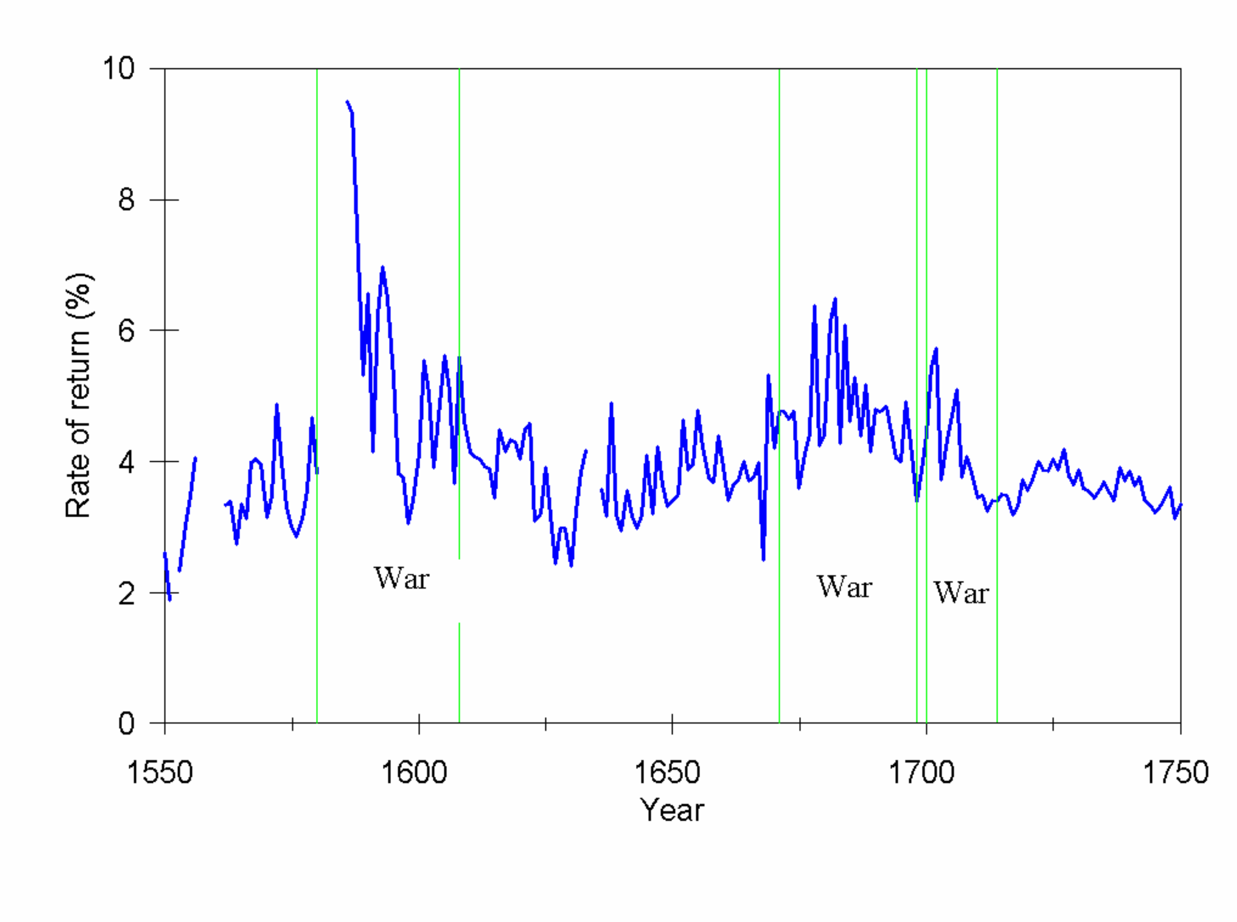
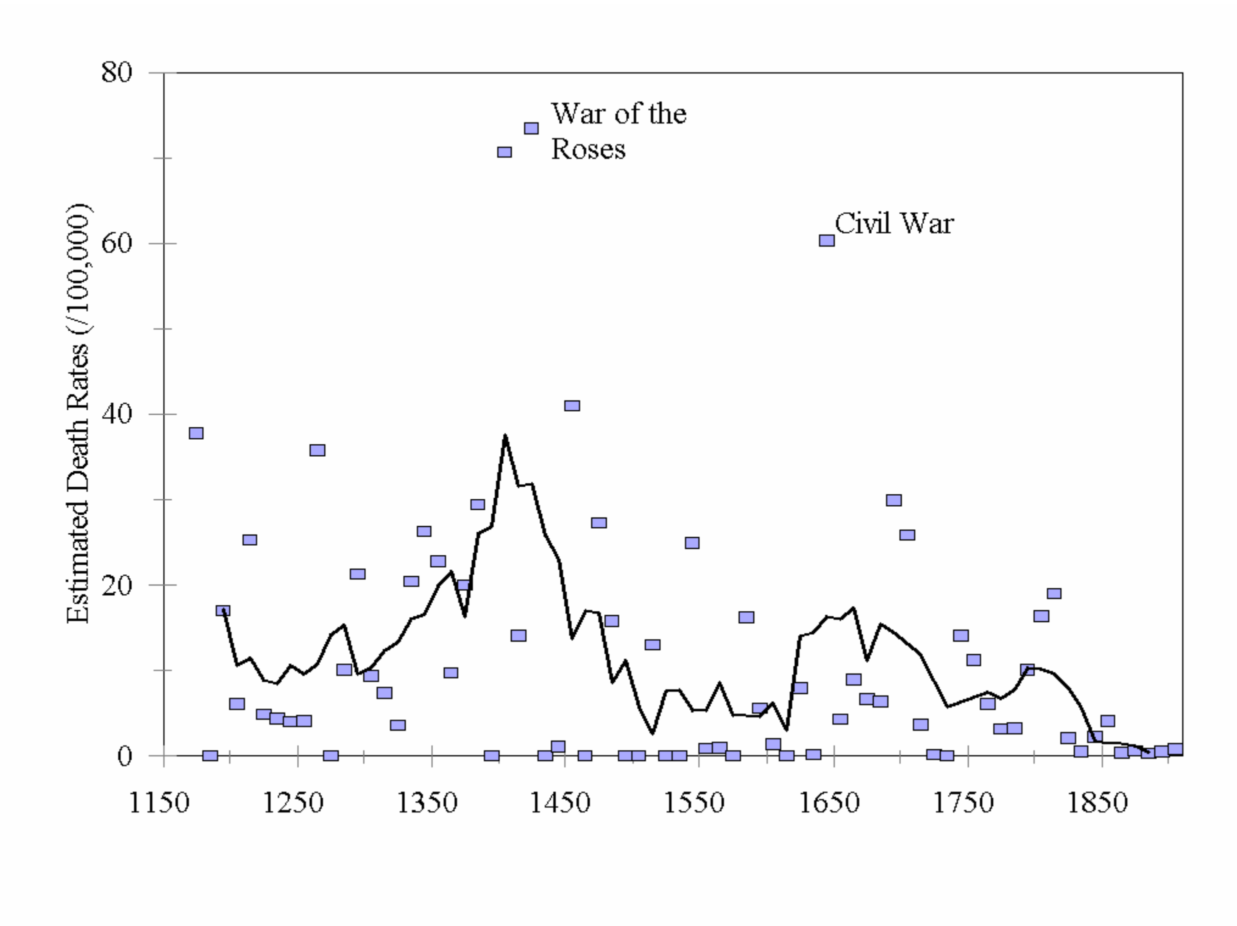


Figure 6: The Death Rate from Military Conflicts, England 1170s-1690s



Notes: The line shows a 50 year moving average of combat death rates in England.

Figure 7: Unorganized Violence: The Murder Rate, England 1190s-2000

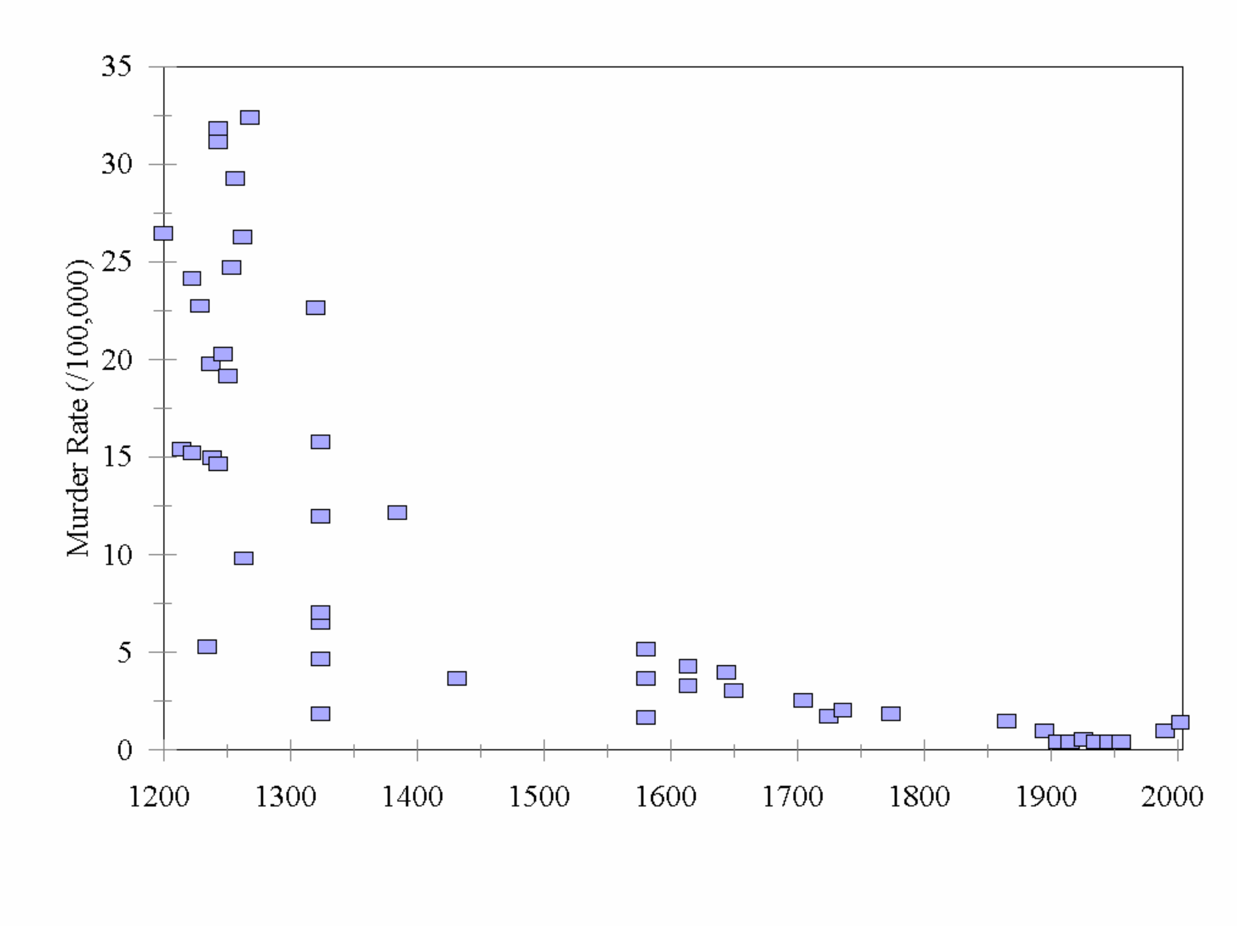
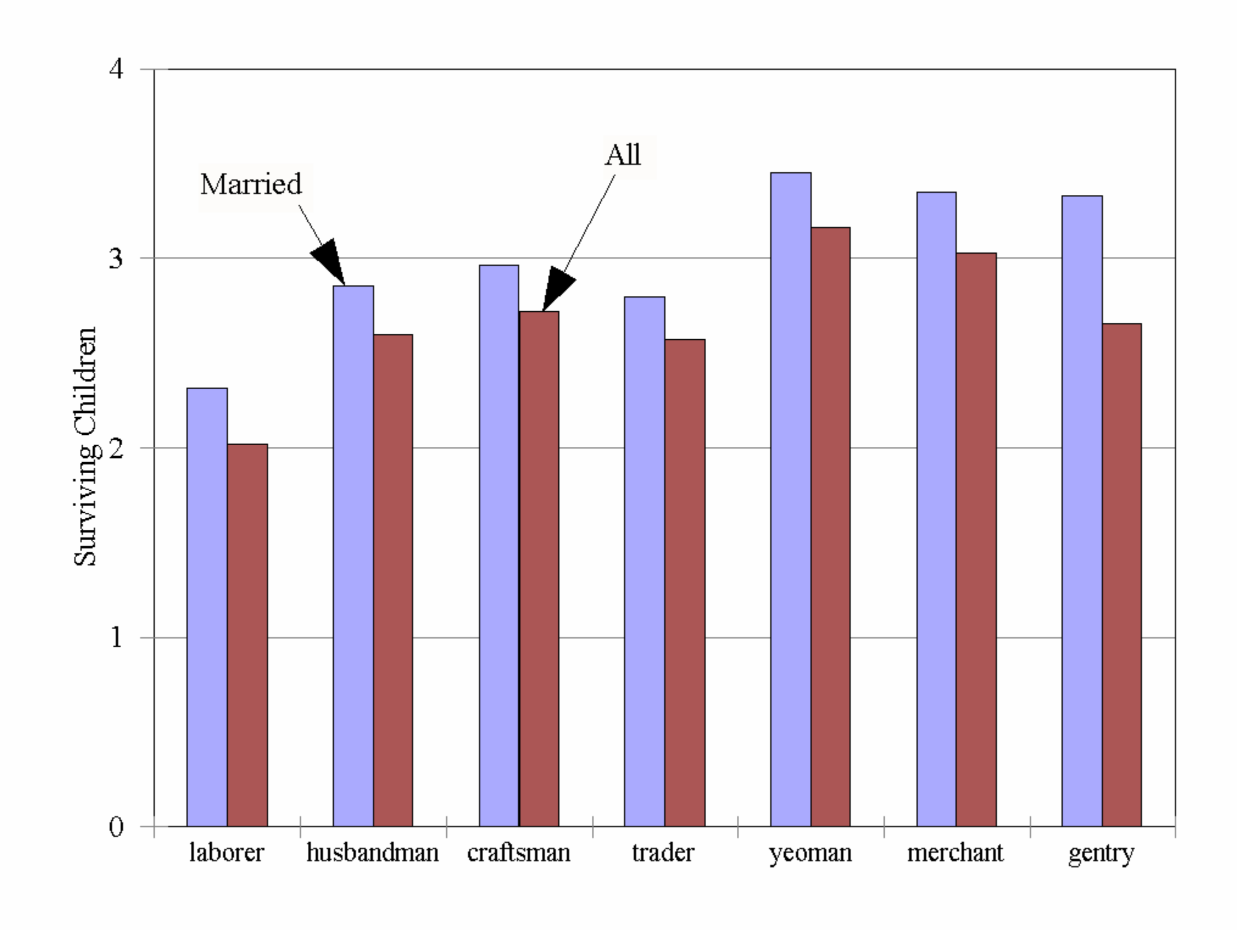


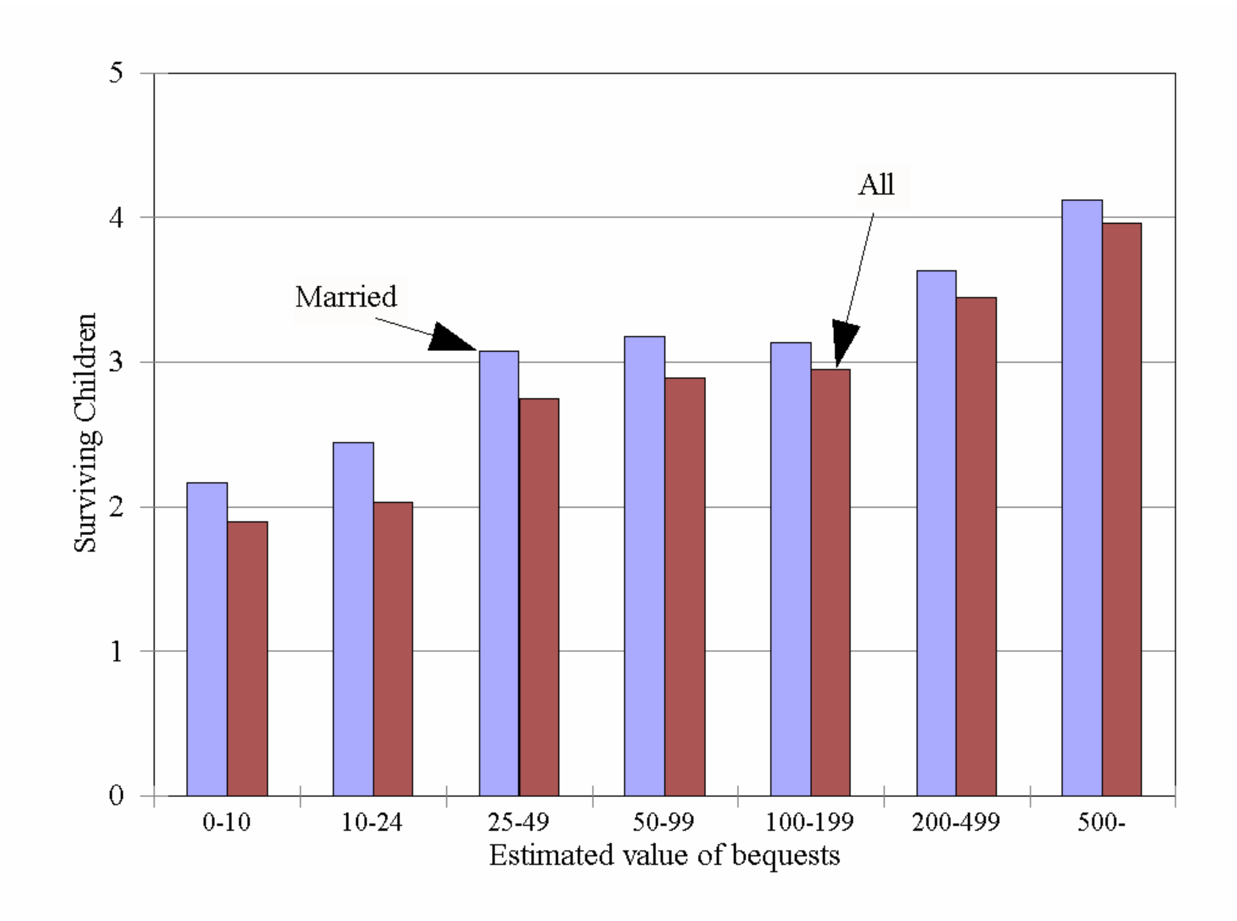
Figure 8: Labor Incomes as a Share of All Income, 1200-1869

Figure 9: Surviving Children per Married Male Deceased by Social Class



Source: Clark and Hamilton (2004).

Figure 10: Surviving Children by estimated assets of Testator



Source: Clark and Hamilton (2004).