

Malthus to Modernity: When and How did Fertility Behavior Change in the Demographic Transition in England?

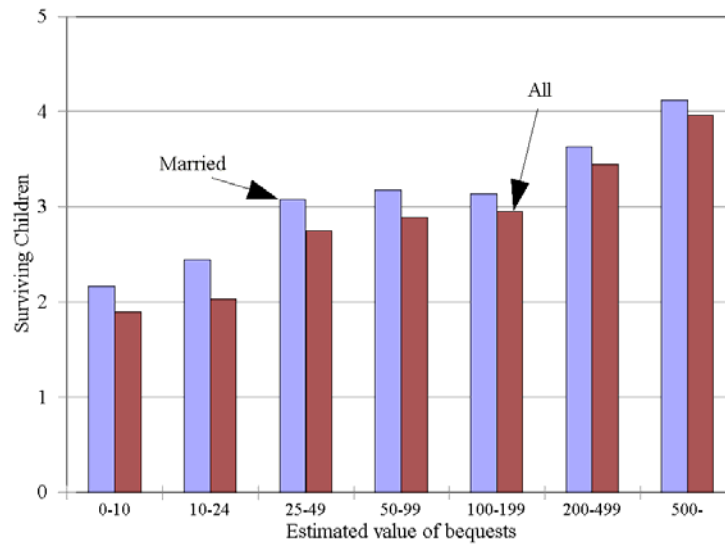
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Introduction

In the modern world a stylized fact accepted by most economists is that high incomes are associated with lower fertilities. We see this across countries, and until recently it was believed that is prevailed within countries also. This is a complete reversal of the pre-industrial pattern where net fertility was strongly positively associated with wealth, at least in England (Clark and Hamilton (2006)). This pre-industrial correlation was so strong it implied that pre-industrial England saw considerable downward mobility by the children of the rich, and the disappearance of the families of the poor over time. These demographic patterns may have been associated with the spread of “capitalist” culture in pre-industrial England, and perhaps even with the Industrial Revolution itself (Clark (2007)). Figure 1 shows this pre-industrial association.

Figure 1: Net Fertility and Wealth, 1585-1639



Source: Clark and Hamilton (2006).

By 1891 in England those in higher class occupations in England had fewer children than the poor, as has been the modern pattern up till recently. Table 1 shows this pattern.

Table 1: Children Born per Married Man, 1891-1911, England

Occupation	1891	1901	1911
Professional	4.9	4.7	3.8
Miner	6.7	6.5	5.9
Construction laborer	6.4	5.6	5.4
General laborer	6.4	6.4	5.2
Agricultural laborer	6.6	5.9	4.9

An interesting recent study in the USA of fertility from cohorts born in the 1820s onward suggests throughout these years a negative correlation between income and fertility (Jones and Tertilt (2006)).

This implies that the rich were the group that most dramatically changed their behavior in the period leading up to the demographic transition of 1870-1930. But when between 1640 and 1890 did this change in the behavior of the wealthier occur? When in England did the connection between income and fertility switch from positive to negative? And what was the reason for that change? Was it a response to a decline in child death rates that occurred first among the rich?

Using a large sample of male wills for England in the years 1500-1912 this paper examines when and how the pattern of fertility changed between the Malthusian and the modern eras. The evidence suggests that a significant change occurred in the fertility behavior of the rich in England long before the general demographic transition of the 1890s, perhaps as early as the 1810s. By the time of the 1820s birth cohort of men there is no longer an association between net fertility and income. This potentially links the demographic transition more closely with the Industrial Revolution. The paper also examines whether the earlier decline in fertility by the rich can be explained by an earlier decline for this group in child mortality. The answer seems to be that it is not induced by mortality changes.

The Wills Database

There are millions of extant wills in England for the years after 1400, and a significant fraction have been transcribed and abstracted. The wills before 1858 come mainly from local Ecclesiastical courts in Essex, Suffolk and Surrey (before 1858 church courts handled all matters of wills and testaments). Some also come from the Prerogative Court of Canterbury, which handled

estates of higher value with assets distributed across a wider area. After 1858 the wills come from the records of the Principal Probate Registry in London which has preserved all probated wills in the south of England after 1858. For wills after 1851 we are also able to link the testators to individual census records from 1851, 1861, 1871, 1881, 1891 and 1901 giving the age of the testator at death. For the earlier wills we can get the age at death for a subset of the testators from parish records giving baptisms and marriages. But we can also infer age at death from the observed features of the testator. With some experimentation the following regression was found to be the best fit for age:

$$\text{Age} = 47.6 + 0.51N + 1.33N_{21} + 8.38DCHILD_{21} + 6.33DGRANDCHILD - 4.23DSINGLE + 5.39DWIDOWER - 11.29DPARENTALIVE$$

n = 611, R² = 0.484

where N = number of surviving children

N₂₁ = number of surviving children known to be aged 21 and more

DCHILD₂₁ = indicator for at least one child known to be more than 21

DGRANDCHILD = indicator for at least one known grandchild

DSINGLE = indicator for testator never married

DWIDOWER = indicator for testator widower

DPARENTALIVE = indicator for at least one parent known to be alive

We can thus examine the fertility behavior of cohorts of testators organized by their decade of death or their decade of birth. At this stage of data collection, however, we are not yet able to form balanced cohorts for each decade in the years 1750-1850.

The assets of testators were estimated in two ways. For 1786 and later there were estate taxes, levied based on the value of the personal estate. The estimated value of the estate for tax purposes was then added to the estimated value of all real estate – houses and land – bequeathed in the will to produce an overall estimated value of the bequest. After an individual's death, those seeking to act on authority of their will needed to be granted an act of probate. Before 1898, the reported probate valuations are estimates of "the gross value of an individual's unsettled personal property", and were estimated for tax purposes (Owens, Green, Bailey and Kay 2006, 383). After 1898, unsettled property was included (Rubinstein 1977, 100). The executors or administrators of the wills submitted estimates, and because of a fine for undervaluation "the gross valuation was always likely to be an upper estimate of an individual's worth" (Owens et al. 2006, 386).

This "gross" estimate omitted any debts or credits due by or to the deceased individual. For the period after 1881, Rubenstein estimates that the difference between the gross and net value of an estate, was on average 5 to 15% (Owens et al 2006, 387). Before 1881, effects are reported as an approximation, under a certain set threshold level (e.g. under £50, under £100). As Owens et al. noted, the effect of these tax bandings is to inflate the already rough estimates of wealth (2006, 387).

The major flaws with using probate valuations as true measures of wealth are the omission of settled property and real estate, debts and credits (Owens et al 2006, 384).

For earlier years 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 bequeathed by the testator. While land was bequeathed in 975 of the wills in our sample, in only 209 cases, one in five, was the area of the land indicated. To infer the area in the other 766 cases we estimated for the observed cases area as a function of other features of the will: the number of houses bequeathed, the number of additional parishes the land was described as lying in, the total amount of cash and goods bequeathed, an indicator for the literacy of

the testator, an indicator for whether the testator lived in a town, an indicator of whether the person engaged in farming, and indicators for each occupational group. The functional form that best fit the observed cases was chosen by experiment. Thus the estimated expression was

$$\log(AREA) = a + b_1HOUSE1 + b_2HOUSE2 + b_3HOUSE3 + b_4MOREPAR + b_5BEQROOT + b_6DLIT + b_7DLITUNKNOWN + b_8DTOWN + b_9FARMER + \sum_i c_i OCCUP_i + e$$

where HOUSE1 was an indicator set to one if one house was bequeathed, HOUSE2 an indicator for two houses, HOUSE3 an indicator for three or more houses, MOREPAR an indicator for land left in more than one parish, BEQROOT the square root of the value of cash and stock bequeathed, DLIT an indicator for a literate testator, DLITUNKNOWN an indicator for someone whose literacy is unknown, DTOWN an indicator for a town dweller, DFARMER an indicator for someone engaged in farming, and OCCUP_i indicators for the six occupational groups defined above other than laborers. DFARMER was set to one if the testator left farm animals or grain in the will, or left farm implements. To normalize for changes in the price level over the years 1585 -1836 the “BEQROOT” variable in the above equation was constructed using the actual cash bequests in the will normalized by the average price level in each of the decades 1580-9, 1590-9, 1600-9, 1610-9, 1620-9 and 1630-9. To this was added the value of the stock left calculated using a standard set of values normalized to the 1630s: 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 £0.375, gold rings £1.

For a subset of 506 wills we have both estimates. In these overlapping cases the bequests estimated in the second fashion are 0.66 of the bequests estimated in the first way. For consistency

the first set of estimates was thus multiplied by 0.66. All values were deflated to a common price level of the 1630s.

The link to the census and parish records also allows us to establish for these later cohorts the marital status (never married, married, or widowed), the age at first marriage, the age of the wife, and measures of gross birth rates and child mortality rates.

Table 2 summarizes by period the data available so far in the wills database. For each testator the key variables are the numbers of children mentioned in the will, their estimated bequest size, and their actual or estimated age at death. This allows us to organize the data by death cohort, or also by birth cohort. Men only were used since women had only residual claims on their property after marriage, and left wills typically only if single or widowed. Substantial numbers of wills are available to us from the mid-fifteenth century onward, which predates the parish data on fertility that begins around 1540. However, in wills written before 1550 substantial numbers of daughters are omitted where there is a male heir (this is not a problem for later wills). Thus the average family which reported one male heir after 1550 reported 1.55 daughters, but before 1550 only 0.89 daughters. We thus have to infer the number of daughters for wills before this date. We do so by multiplying each reported daughter in a will by 1.49, to get an estimated number of actual daughters.

The switch from the ecclesiastical courts to the Principal Probate Registry is accompanied by a sharp increase in the average value of the bequest attributed to the average testator. This is in part because for the previous periods our will sources are mainly the lower ecclesiastical sources with wills leaving smaller bequests.

Table 2: Summary of the Wills Database

Death Cohort	Number	Ave. Children	Ave. Bequest (£)	Ave. Status
1500-99	425	3.00	551	3.43
1600-99	1,803	3.08	304	4.07
1700-99	310	2.84	389	4.43
1800-57	412	2.76	288	4.09
1858-1914	484	2.38	2,140	4.40

Note: Status is measured on a seven point scale, with 1 the lowest, 7 the highest.

Table 3 shows net fertility of men at death by each of four assets classes from men dying 1500 to 1914. For all periods up to 1858 there is a stable and strongly positive fertility assets relationship. Wealthier men have net fertilities well above those of men in the general population, and even of poorer testators. But for men dying after 1862 this relationship disappears. Now there is no connection between assets and fertility. Thus for the poorest men their numbers of surviving children increases, while for the richest it falls sharply. A completely new relationship between wealth and fertility emerges, much more like that of the modern world. Since will makers dying in the 1860s were on average 69 years old, their fertilities would typically have been completed by the 1840s, so the change in the relation between fertility and income seems to have predated the general decline in fertility in the fertility transition of the 1880s and 1890s.

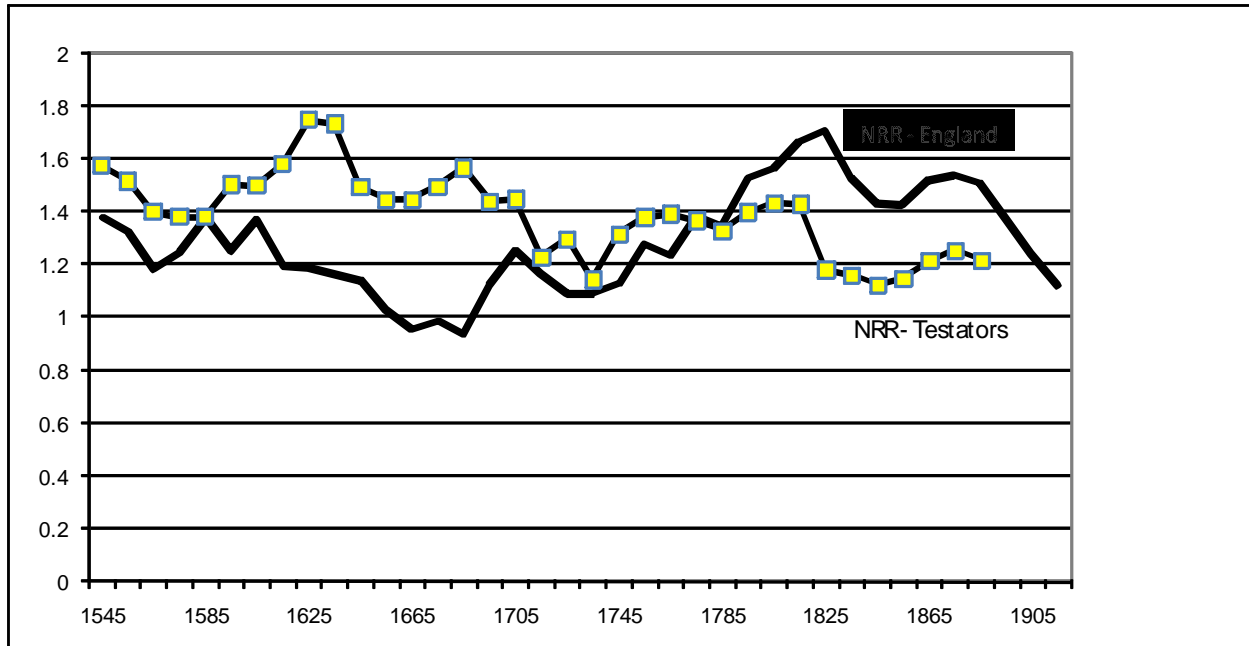
Table 3: Wealth at Death and Net Fertility, 1540-1902

Period	Wills	Assets <£50	Assets	Assets	Assets
			≥£50, <£100	≥£100, <£500	≥£500
1500-99	679	2.28	2.92	3.59	4.54
1600-99	2,251	2.09	2.81	3.27	3.98
1700-99	327	1.89	2.17	3.00	3.77
1800-58	445	1.74	1.78	3.02	4.07
1862-1914	484	2.56	2.30	2.42	2.35

Note: in 1862-1914 the proportion of wills in the bottom two wealth categories is very small.

Figure 2 shows the implied Net Reproduction Rate from the wills by death cohort compared to the net reproduction rate for England as a whole back to the 1540s. The NRR from the wills is calculated very crudely as just the number of surviving children per man divided by 2. The Net Reproduction Rate (NRR) for England as a whole in each decade is matched to the implied NRR of men dying 20-40 years after that decade. As can be seen the testators have a significantly higher net fertility than the population of England as a whole until the 1780s. Then their net fertility falls below that of the general population. Around the 1820s there is a further significant decline in net fertility of testators compared to the general population.

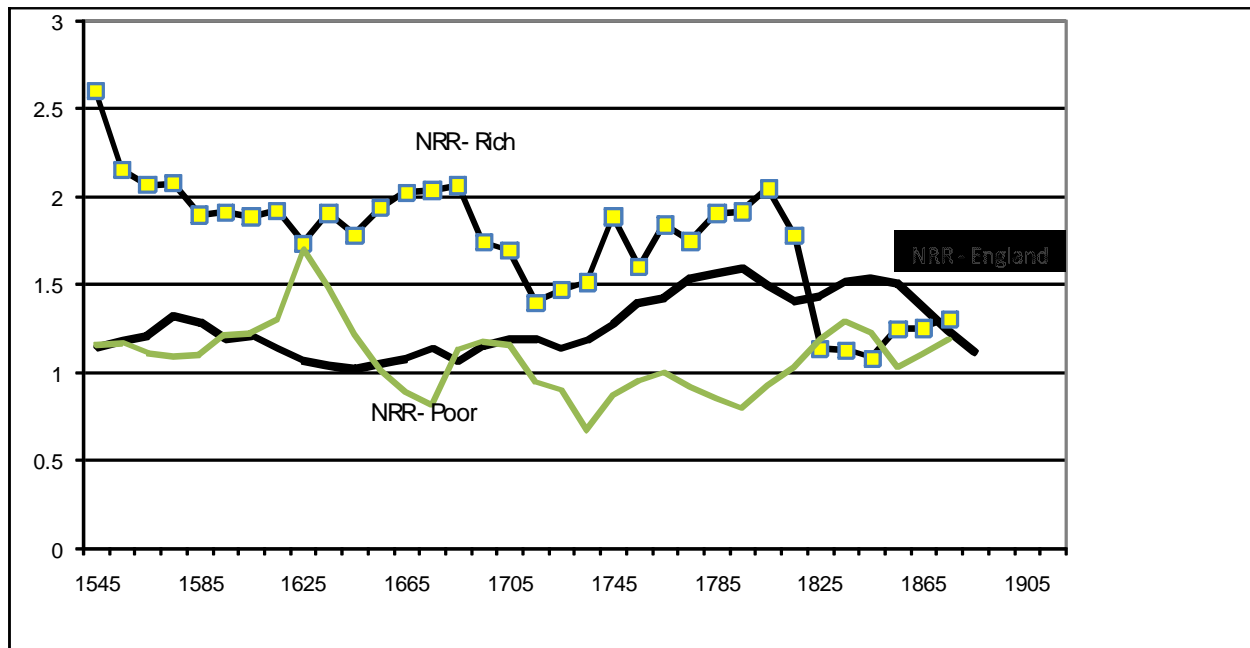
Figure 2: NRR rates, general population and male testators.



Source: NRR England from

Figure 3 shows the same data as figure 2, but now splitting testators into those leaving assets worth more than £250, and those leaving less than £100 (in 1630s prices). The reproductive advantage of richer testators is very evident in every period before the 1820s. But then suddenly their net reproduction rates fall below those of the general population. For the poorer testators there is very little change over these years (though this series is noisier). For the decades from the 1820s on there is little difference between the net reproductive success of richer or poorer testators.

Figure 3: NRR rates, general population, richer and poorer testators.



But as noted the change in reproductive behavior coincides fairly closely with the change in the sources of wills. Earlier Clark and Hamilton (2006) show what wills from before 1858 seem to be a reliable source of assets and net fertility. Table 4, for example, shows how assets and net fertility correlate with rough measures of social status. As can be seen the asset measures correlate very well with measures of social status. Fertility is modestly higher for those of higher social status (though this is obscured in part by net fertility being much higher for those with rural residence).

Table 4: Social Status, Assets and Net Fertility, 1500-1858

Social group	Numbers of wills	Average value of assets (£)	Average number of surviving children
Gentry	59	1,084	2.96
Merchants/professionals	87	268	2.46
Farmers	659	406	3.24
Traders	84	112	2.68
Craftsmen	267	85	2.57
Husbandmen	333	87	2.79
Laborers	100	42	2.22

Table 5 shows how occupational status relates to income and fertility for men dying in the 1860s and later. Occupation is still strongly associated with wealth, though the connection is weaker than before. There is also a clear association between occupation and net fertility, with the lower status occupations now having higher fertility than the higher status ones. All this suggests that the observed change in the link between fertility and income for those dying in the 1860s and later is not just an artifact of these later wills. Consistent with the data in table 1 low status occupations were

associated with higher fertility. So the disappearance of the income/fertility relationship is not just an artifact of bad measures of assets.

Table 5: Social Status, Assets and Net Fertility, 1862-1914

Social group	Numbers of wills	Average value of assets (£)	Average number of surviving children
Gentry	36	3,265	2.17
Merchants/professionals	107	3,103	1.93
Farmers	87	1,353	1.94
Traders	91	2,560	2.59
Craftsmen	74	953	2.99
Husbandmen	15	260	3.20
Laborers	15	614	3.00

The occupation data in table 5 also suggests that controlling for occupation there was still a positive association between assets and net fertility. To get the overall flatness of net fertility with assets, given that fertility declined with occupation status that was associated with assets, it must be the case that assets were positively associated still with income within occupational groups.

This is confirmed by the following regression, though the t-stats are poor because there are only 446 observations and the dependent variable, the numbers of surviving children is very noisy.

$$\begin{aligned}
 \mathbf{N} = & 2.54 + 0.21\mathbf{S2} + 0.01\mathbf{S3} - 0.48\mathbf{S4} - 1.18\mathbf{S5} - 1.18\mathbf{S6} - 0.92\mathbf{S7} + 0.094 \ln(\mathbf{ASSETS}) \\
 & (0.85) \quad (0.01) \quad (0.66) \quad (0.67) \quad (0.66) \quad (0.73) \quad (0.072)
 \end{aligned}$$

The variables S2, ... S7 are the occupations arranged in terms of increasing status, Assets is the size of the bequest, and N the number of children. Laborers were the omitted occupational category.

The numbers in parentheses are the standard errors. None of the individual coefficients is significant at conventional levels, but the interesting suggestion of this exercise is that occupation difference in fertility were important, but were being counterbalanced by a still positive association between assets and fertility. Thus controlling for assets farmers (S5) and merchants/professional (S6) had only half the number of children of laborers. But as table 5 shows this difference was narrowed by wealth effects on fertility within in occupational grouping.

Another thing suggesting that the post 1850s fertility data from wills is likely correct is the relation between fertility and age. This increases with age until a testator is in their 50s. Thereafter net fertility is flat and then declining with age. The reason for this is that testators get older some of their adult children will pre-decease them without leaving any children, so being omitted from the will. Exactly the same pattern, just at a higher level is observed for wills before 1858. Table 6 shows this data. So the evidence suggests that the change in the relation observed between assets and fertility for cohorts dying after the 1850s is a real effect, not just an artifact of the sources.

Table 6: Net Fertility and Age at Death

Age	number post 1858	children post 1858	number pre 1858	children pre 1858
20-39	10	0.90	129	1.30
40-49	18	1.44	135	2.47
50-59	52	2.69	219	3.26
60-69	112	2.45	302	3.32
70-79	160	2.44	296	3.18
80-89	89	2.13	130	2.59
90-	7	1.57	10	2.20

Why Did Net Fertility Become Independent of Income?

One potential explanation of a decline in net fertility among high income groups is a decline in child mortality. For the testators where we observe ages we see a fairly steady increase between 1580 and 1914 in the average age of death. Figure 4 shows that trend. However this trend is gradual while the change in net fertility is more sudden. Nevertheless one idea is that in pre-industrial society men had to have as many children as possible in order to maximize the chance of a male heir. The hazards of survival meant that even with relatively high net fertility rates a substantial fraction of men would die with no son to inherit. As infant and child mortality declined, eventually families could ensure an heir with many fewer children. There was more certainty that if a son was born he would survive to adulthood. Consequently their net fertility declined.

The empirical content of this idea would be that declining net fertility for the rich in the later nineteenth century would be associated with a larger fraction leaving at least one surviving son.

Table 7 contains a simple test of this idea. It records the fraction of men leaving a male survival at

different epochs and asset levels. Before 1858 rich men were left without a male heir far less often than poor men. However, after the 1850s the proportion of richer men leaving a male heir declined significantly from around 0.77 to 0.55. Thus the interpretation that the changed behavior of the rich was a response to declining mortality rates cannot be sustained.

Figure 4: Average Age of Testators, 1580s to 1900s

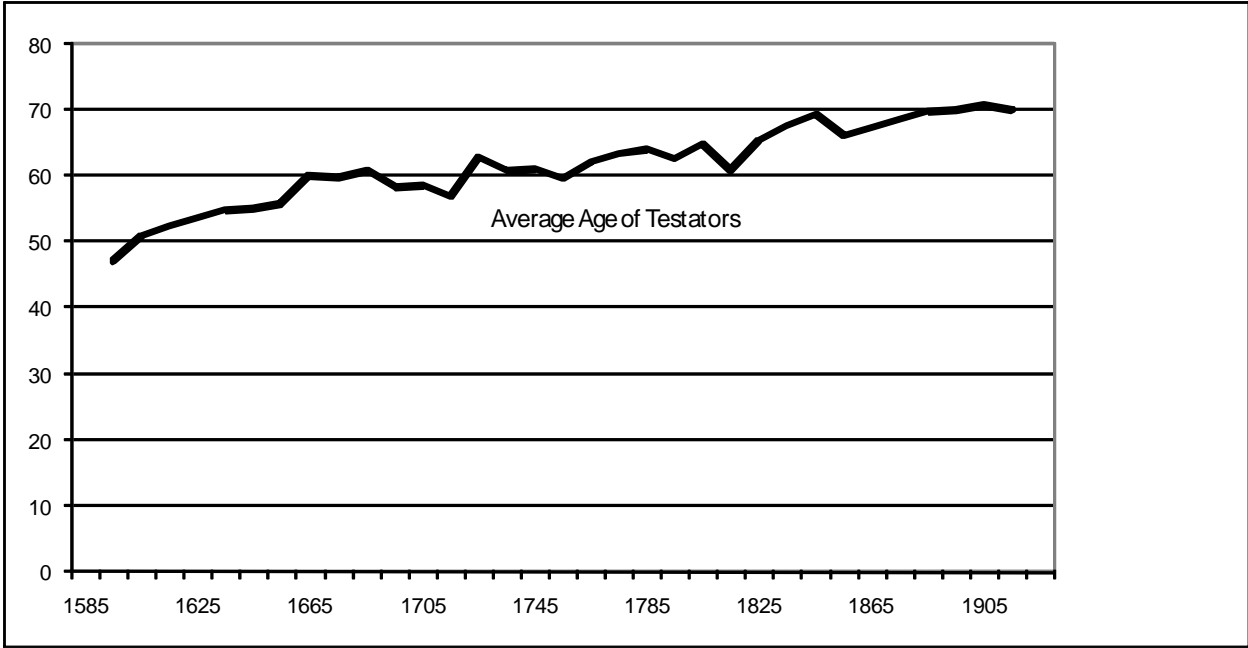


Table 7: Wealth at Death and Chances of Male Heir, 1540-1902

Period	Wills	Assets <£50	Assets ≥£50, <£100	Assets ≥£100, <£500	Assets ≥£500
1500-99	679	0.57	0.67	0.75	0.77
1600-99	2,251	0.54	0.68	0.71	0.77
1700-99	327	0.52	0.54	0.66	0.73
1800-58	445	0.46	0.44	0.62	0.75
1862-1914	484	0.56	0.59	0.58	0.55

Future Research

Construction of this database is still in its infancy. In particular we are working hard to increase the numbers of observations of in the years of interest in 1800-1914 to try and estimate better when behavior of the rich actually changed. With this larger data set we will also hope to be able to consider the gross fertility of rich and poor, by linking the testators to the censuses of 1851-1901, and to earlier parish records. But one strong implication of our data already is that there must

have been for the class of the rich in England a period of substantial and perhaps even dramatic change in their demographic behavior that occurred much earlier than the conventionally dated demographic transition of the late nineteenth century.

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