What is the True Rate of Social Mobility? Evidence from the Information Content of Surnames

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What is the true rate of social mobility? Modern one-generation studies of individual families suggest considerable regression to the mean for all measures of status – wealth, income, occupation, and education - across a variety of societies. The b that links status across generations is in the order of 0.2-0.5. In that case inherited surnames will quickly lose any information about social status. This paper reports results of studies of social mobility rates using surnames for England 1086-2011, Sweden, 1700-2011, the USA 1850-2011, India, 1860-2011, Japan, 1870-2011, and China and Taiwan 1700-2011. In all cases surnames lose information about social status at rates much slower than implied by modern studies, even in the most recent generations. Surnames imply an underlying b for social mobility in the range 0.7-0.8 in most societies. This paper seeks to explain why these two types of measure are so different.

Introduction

This paper summarizes the results of Clark and Cummins (2012, 2013), Clark (2012a, 2012b), Hao and Clark (2012), Clark and Landes (2012) which examine social mobility rates over many generations, across countries, and across different measures of social status. The framework adopted is very simple. We assume that we have measures of status that are cardinal, or can be approximated as cardinals: earnings, income, wealth, years of education, level of education, occupational status, or longevity. Then if y_t is this status measure (or in the case of income or wealth its logarithm), and is normalized to have a constant standard deviation and a mean of 0, the intergenerational correlation of y, b, , is inferred just as the regression coefficient from

$$y_{t+1} = \mathrm{b}y_t + u_t$$

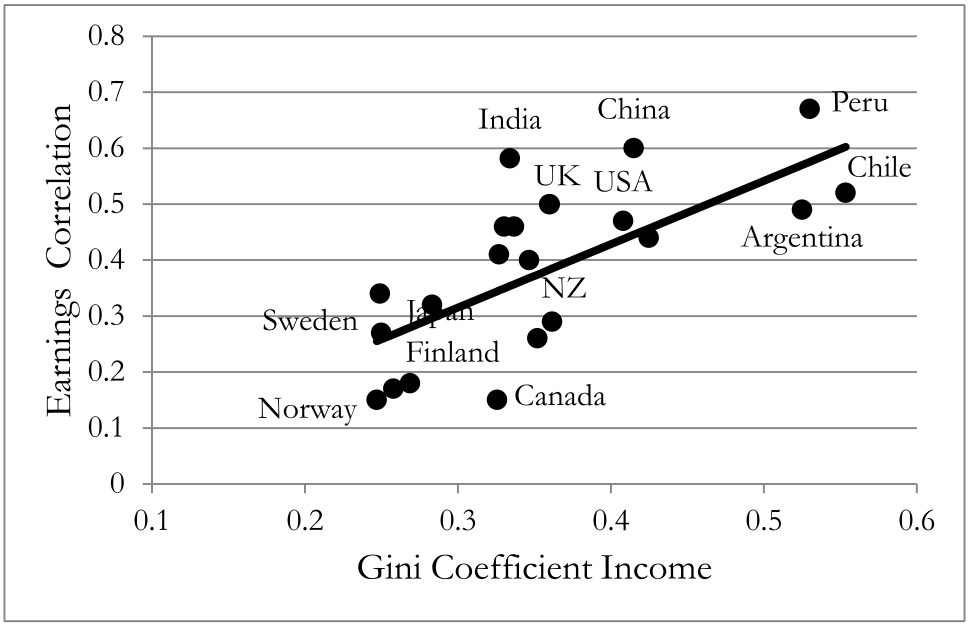
1-b is the rate of regression to mean. b^2 is share of social position variance derived by inheritance. If the process of transmission of status is Markov, then b^n is the intergenerational elasticity of status over n generations.

There have been over the last 40 years many measures of the intergenerational correlation of various measures of status within this framework, looking just at two generations. Figure 1, for example, shows estimates of the intergenerational elasticity of earnings for a variety of countries summarized by Corak, 2011. Figure 2 shows equivalent intergenerational correlation for years of education by Hertz et al., 2011.

These studies suggest the following conclusions.

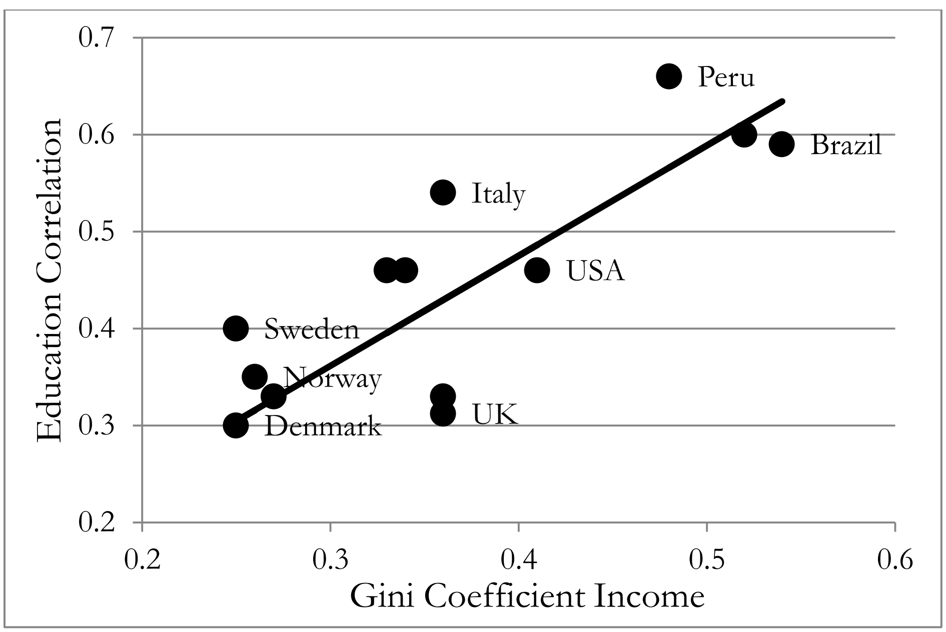
- Intergenerational correlations are typically of the order of 0.2-0.5 for income, years of education, occupational status, and even for wealth.
- Social mobility rates vary substantially across countries. In particular the more unequal is a society in income the lower are mobility rates.
- Social mobility rates vary substantially across different measures of status such as earnings and education within the same country. The intergenerational elasticity for earnings in Scandinavia is consistently lower, for example, than that for education.
- Thus mobility rates are "too low" in some societies. With better opportunities for the children of low income or status families, more mobility would be possible.
- If status transmission is Markov, earnings, occupational, and social mobility are all largely complete within 2-5 generations. The descendants of a person with an income 20 times above the average, or 1/20 of the average, 5 generations later will have expected incomes within 10% of the average.

Figure 1: Intergenerational Earnings Correlations and Inequality



Source: Corak, 2012, Figure 2. Canada, personal communication from Corak.

Figure 2: Intergenerational Education Correlation and Inequality



<u>Sources</u>: Hertz et al., 2011, table 2. Gini for Income, World Bank.

- If the process is Markov, and the variance of status across generations is constant, then the fraction of variance of social position explained by inheritance is low. The above figures suggests this is 4% in Scandinavia, and 22% in the USA. Most of social status is not predictable at birth.
- Recent studies of multiple generations consistently suggest, however, that the process is not Markov. If we estimate

$$y_{t+1} = b_1 y_t + b_2 y_{t-1} + b_3 y_{t-2} + u_t$$

then $b_2 > 0$, $b_3 > 0$ and so on. Even controlling for parents, the status of grandparents, and even great-grandparents is predictive of this generation's status (Long, 2012, Lindahl et al., 2012).

However, when we switch to measuring b though the rate of regression to the mean of social groupings identified by surnames we find the following:

- Persistence, b, is much higher than conventionally measured for all aspects of status. Table 1 shows for various periods and countries estimates of persistence through surname studies. The typical value is 0.7-0.8. Complete regression to the mean typically takes 10-16 generations, 300-500 years.
- The rate of persistence is similar for education, occupation and wealth. It is similar across the entire distribution of status, being the same for the upper tail as for the lower tale.
- The rate of persistence varies little between societies and epochs. There is little sign that rates of social mobility are "too low" in some societies.
- Regression to the mean measured in this way is indeed Markov. The social status of the next generation is predicted only by the status of the current generation.
- Since $b^2 = 0.5\text{-}0.6$ the majority of social status is determined at conception.
- We observe persistent elites and underclasses only in two cases. The first is an isolated elite with marital endogamy (as with Hindu castes in India, Muslims in India, or the Copts in Egypt). The second is where an elite or an underclass is maintained by selective retention of members with the elite or underclass characteristics, and recruitment of outsiders with the characteristic.
- Assortative mating is what makes b so high. Mating has become more assortative in the modern world, so mobility rates may decline further (Herrnstein-Murray claim).

Table 1: Estimates of b from Surnames

Country	Measure	Period	B
USA	Attorneys	1950-2011	0.67-0.77
USA	Doctors	1950-2011	0.73-0.74
England	Attorneys, Doctors	1950-2012	0.69-1.00
England	Wealth	1950-2012	0.70
England	Education	1950-2012	0.77
England	Education	1300-1500	0.75
Chile	Occupations	1940-2010	0.74
China	Education	1905-2011	0.71
Japan	Education	1940-2012	0.84
India	Doctors	1860-2009	0.89

Sources: England, Clark and Cummins, 2012**,** China, Hua and Clark, 2012, India, Clark and Landes, 2012, Japan, Clark and Ishii, 2012, USA, Clark et al., 2012. Chile communication from Daniel Diaz.

Why are these results so different from the conventional studies? One suggestion is that by looking at surname groupings we are implicitly controlling for errors in the measurement of current status that will reduce the estimated elasticity, so estimating higher values of b. But the correlation estimates in figure 1 are those corrected for measurement error. And in the case of education in figure 2 measurement errors are believed to a relatively insignificant. The different bs estimated in these ways are not about different degrees of control for measurement errors.

The preferred interpretation of these differences is the following. Current one generation studies suffer a key limitation. Suppose in particular we assume that the various aspects of social status in generation t, y_t – income, wealth, education, occupation – are all linked to some fundamental social competence or status of families, x_t, such that $y_t = \theta x_t + e_t$, where e_t is some random component. The random component exists for two reasons. First there is an element of luck in the status attained by individuals given their underlying aptitudes. People happen to choose a successful field to work in, or firm to work for. They just succeed in being admitted to Harvard, as opposed to just failing. But second people trade off income and other aspects of status. They choose to be philosophy professors as opposed to finance executives.

The one generation studies, as long as y is correctly measured, will indeed report what the b is across one generation, for any particular aspect of status. However the regression to the mean exhibited by each partial measure of underlying status, y, will overestimate the regression to the mean of the underlying status x. For the $\hat{b}$ estimated from the partial measures will be related to the b for the underlying status through

$$\hat{b} = b \frac{1}{1 + \left(\frac{\sigma_e^2}{\theta^2 \sigma_x^2}\right)}$$

where σ_x^2 is the variance of the underlying social status, and σ_e^2 is the variance of the random components linking the underlying status to the measured aspect.

But it is this underlying b that governs long run social mobility, and that also governs mobility on more comprehensive measures of status. Suppose the bs across generations for income, education, occupational status, and wealth were all 0.3. It does not follow that the regression to the mean across two generations will be b^2, so that initial differences in social status quickly disappear. It also does not follow that the b for a more general measure of status that averages income, wealth, education and occupational status would be 0.3, or even anywhere close to 0.3. When we classify people by religion, race, or ethnic or national origin, the b that applies to such groupings will also not be 0.3.

The conventional studies have been often misinterpreted as speaking more generally about the mobility of society than they can, as we see in figure 1 above. When we classify families as high or low status based on partial measures such as income, wealth, education or occupation there will appear to be substantial regression to the mean. But if we took a more aggregate measure of status, which averaged the various partial y measures the regression will be substantially lower. These partial measures are correlated, so that with such an aggregate measure the variance of the error term will decline relative the variance of *x*.[1] So the measured intergenerational correlation will be greater.

With conventional measures, the intergenerational correlation of status, even for broad measures of status, will not predict long run social mobility across many generations. And its relationship to long run mobility will depend on the relative importance of the error components in the first generation. This is because when we classify families as high or low status originally based on their status in an original generation, the measures incorporate random errors of measurement and luck. The

[1] Indeed, if people are trading off aspects of status the individual error elements will be negatively correlated, so reducing even further the aggregate error.

regression to the mean observed in the first generation incorporates this error correction, and that component will not occur across subsequent generations. So even the regression of an aggregate status for a first generation t to t+1 will be greater than that for the same families from generation t+1 to t+2, and so on.

The greater are the random components in determining measures of status such as income, relative to the systematic elements stemming from underlying status, the greater will be the degree of mismatch between such partial one generation estimates of regression to the mean, and the underlying regression of fundamental social status. The USA, for example, has much greater inequality in earnings than does Sweden. Figure 3 shows, for example, the salaries in $2010 for some comparable high and low status occupations in Sweden and the USA. A US doctor earns 6 times the wage of a bus driver, while in Sweden the ratio is only 2.3 times. A US professor earns 60% more than a bus driver, in Sweden it is only 40% more.

This can be interpreted as meaning that the θ in the expression

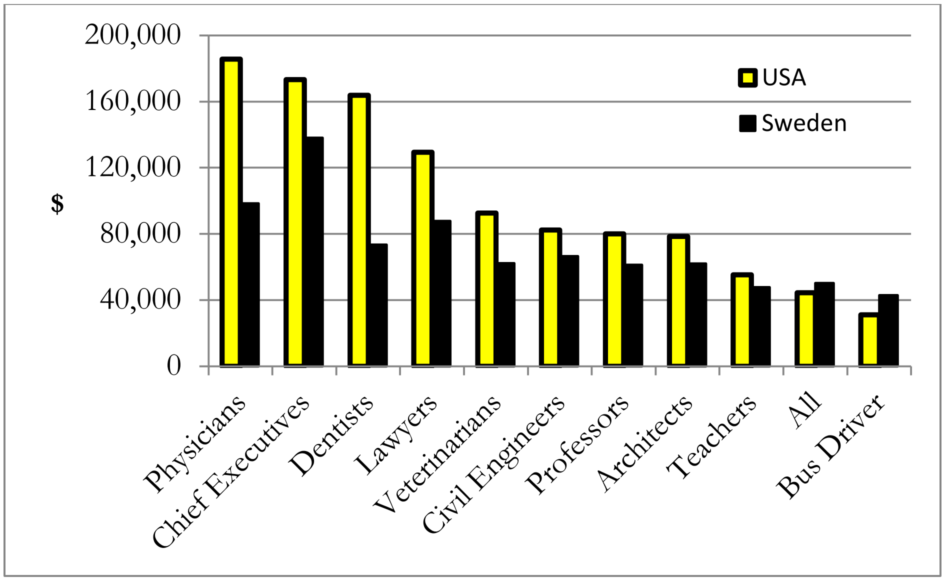
$$y_t = \theta x_t + e_t$$

linking social status to earnings is higher in the US than in Sweden. That in turn implies that the measured b for earnings will be lower in Sweden than in the US even though the underlying rate of regression to the mean of status seems the same, because the share of earnings variation contributed by random elements is greater in Sweden.

There is no support in the surname studies for three propositions that have gained currency in recent discussions of mobility. The first is that the USA has low rates of social mobility compared to other high income societies (Corak, 2006, Jäntti, 2006). Generalized mobility rates are no lower in the US than elsewhere. The second is that rates of social mobility have declined recently in the USA.[2] And the third is that there is a link between income and wealth inequality and social mobility rates (Corak, 2012). Instead the rate of generalized social mobility seems to be closer to a universal constant across societies, changing little across social systems and epochs.

[2] Though this notion has gained popular currency (see, for example, Foroohar, 2011) there seem to be no academic studies suggesting it.

Figure 3: Average Earnings by Occupation, Sweden and the USA, 2008



Sources: USA – Bureau of Labor Statistics, National Occupational Employment and Wage Estimates, May 2010. Sweden – Statistics Sweden, Wage and salary structures, private sector (SLP), 2011.

Even though we measure social mobility here using surname frequencies among social elites, the slowness of mobility cannot be explained as being a peculiar property just of the upper end of the status distribution. For then we would see a mismatch in status for groups between the upper percentiles of the distribution and the lower percentiles. Yet we see in cases such as the USA or Sweden that the high representation of elite surnames, such as Jewish surnames in the USA, at the top of the status distribution is coupled with a reverse underrepresentation at the bottom of the distribution.

The fact that mobility rates for social groups, such as Jews or Blacks will be measured by the underlying b, rather than the conventionally measured b, means that if indicators for such groups are included in conventional intergenerational mobility estimates then it will appear that these groups are not regressing to the social mean. This is exactly what Hertz (2005) finds with reference to both the Black and Jewish sub-groups in the NYLS when he measures intergeneration income mobility, in this case using the log of family income. Table 2 shows his estimated regression

Table 2: Regression to the mean controlling for race and religion, USA

Independent Variable	No controls	Only Race	All Observable Parental Characteristics
Ln Family Income of Parents	0.52**	0.43**	0.20**
Black	-	-0.33**	-0.28**
Latino	-	-0.27**	-0.15
Jewish	-	-	0.33**

Notes: ** = significant at the 1 percent level. Only 3 percent of the sample was Latino.
Source: Hertz, 2005, table 6.

coefficients, with and without dummies for race and religion, for a sample of 3,568 parental incomes in 1967-71, and the income of adult children in 1994-2000.

The regression estimates imply that, even when we control for all other measured attributes of parents in 1967-71 such as education, occupation, and household cleanliness, we can predict that Black, Latino and Jewish families are all regressing more slowly to the mean than is found for the population as a whole.[3] The Hertz interpretation is that this is because of special characteristics of these groups. Our interpretation, however, is that if we included a dummy for membership in any high or low income group, such as the descendants of the 1923-4 rich, then it would have a significant coefficient also. This is because the underlying rate of regression to the mean for all families is much lower than the conventional regression estimates imply. Thus once we can identify families as collectively

[3] Hertz, 2005.

belonging to groups of on average high or low incomes, we can predict much better the expected income in the next generation.

This same effect of group background was found by George Borjas in his study of immigrants where he regressed

$$y_{ijt+1} = b_0 y_{ijt} + b_1 \bar{y}_{jt}$$

where y was log wage or years of education, i indexed families, j the country of origin of fathers, and t the generation (Borjas, 1995). $\bar{y}_{jt}$ was the average log wage or years of education of all men from that country, estimated from the 1980 census reports of education and occupation. In both the case of education and earnings the average status of people from the country of origin was predictive of the outcome for sons (b_0+b_1 equalled 0.44 for education and 0.70 for earnings) (Borjas, 1995, table 8).

Borjas interprets this as the result of "ethnic capital" externalities. Sons from ethnic groups with high average education levels do better than would be predicted from the education of the father alone, because of spillovers from the education of others in the community. But again our interpretation would be that there is likely little or no externality. It is just that information on the country of origin allows a better prediction of the likely "true" underlying status of families, and so a better prediction of the son's outcomes. That is why the same effect appears below for the wealthy of 1923-4 in the USA, who span many ethnic communities.

A prediction of the model outlined above, where the $\hat{b}_1$ measured between adjacent generations is just the underlying b pushed down by the presence of measurement error is that if we estimate

$$y_{t+n} = b_n y_t + e_{t+n}$$

then $\hat{b}_n = b^{n-1}\hat{b}_1 = \varphi b^n$, where φ is the attenuation factor caused by the random components linking observed status on any one dimension with underlying status. In Sweden, using the nice data set assembled by Lindahl et al. (2012) on four generations of Swedish families we can test this prediction. The Lindahl et al. data,

Table 3: Persistence in Education Across Multiple Generations in Sweden

Last Generation	Great-Grandparents	Grandparents	Parents
OBSERVED			
Grandparents	0.334		
Parents	0.229	0.312	
Children	0.123	0.202	0.412
PREDICTED, b = 0.7			
Grandparents	0.334		
Parents	**0.226**	0.312	
Children	**0.173**	**0.253**	0.412

Source: Lindahl et al., 2012, table 2.

for example, has years of education for a first generation born 1865-1912, and then years of education for the three succeeding generations. The upper panel of table 3 shows their estimates of $\hat{b}_n$ for years of education, standardizing the variance in each generation to be the same. They find much more persistence across generations than would be predicted generation b estimates. Table 3 also shows what the estimated $\hat{b}_n$ s would be if the underlying rate of persistence for status is 0.7 as indicated by my results above. This estimates slightly too high correlations for the link to grandchildren and great-grandchildren, but the difference is not statistically significant. The underlying b that would best fit this pattern of intergenerational correlations would be b = 0.61. Note that Lindahl at al. also see no decline in the one generation b for education in Sweden over the last 3 generations.

For earnings Lindahl et al. have results only for 3 generations. Their correlation between grandparents and grandchildren, compared to grandparents and parents, and parents and children, would imply an underlying b of 0.49 (Lindahl et al., 2012, table 5). But the standard error on their estimated grandparent/grandchild earnings correlation is large enough that an underlying b of even 0.7 would not be rejected at the 5% level of confidence. Thus the Lindahl et al. study is consistent with the existence of an underlying persistence coefficient b for status that is much greater in magnitude than the persistence observed in conventional one generation studies.

Surnames

To investigate the rate of regression to the mean of this deeper underlying social status (and by implication the long run rate of regression to the mean of income, wealth, occupational status and education) this study traces people not through individual family linkages, but through surnames over multiple generations.

In many societies surnames are inherited unchanged from one generation to the next, typically through the patriline. If at some generation surnames differ in social status, we can then trace through surnames the descendants of the current generation for many generations. As long as there is nothing peculiar about the path of descent of surnames, the surnames link the status of groups of families many generations in the past with their descendants in the present.

When initially formed, surnames in many societies were associated with social status. For example, in England some high status land owners already possessed surnames at the time of the Domesday Book of 1086, which listed the major landholders of England. Most of these people were the Norman, Breton and Flemish followers of Duke William of Normandy, who seized the throne of England in 1066. These surnames thus constitute a distinctive subset of modern English surnames: Baskerville, Beaumont, D'Arcy, de Vere, Mandeville, Montgomery, Vernon, and Villiers, for example. In England also about 10 percent of surnames derive from the occupations of the original holder, and these occupations had a range of social statuses: Smith, Baker, Shepherd, Clark, Chamberlain, Butler.

In Sweden, surnames started as patronyms which changed with each generation. Sven, son of Lars, was Sven Larsson. But his son Gunnar would be Gunnar Svensson. For the ordinary people patronyms did not become fixed across generations until the late nineteenth century. However, from at least the 17th century two groups of high status individuals were acquiring permanent and distinctive surnames. The first were those who attended universities, who adopted latinized or grecified surnames such as Celsius, Linnaeus, and Melander. The second was the aristocracy, often imported mercenary commanders, who imported surnames from Germany, Scotland and elsewhere or created their own distinctive family names when inducted into the house of nobles such as Leijonhufvud.

Even in societies such as England where the early introduction of universal surnames by 1300 meant that by 1800 common surnames all had the same average social status, we can study modern long run social mobility through the use of rare surnames. Through processes of chance in each generation some such rare surnames will be on average of high status, others of low status. If in some initial generation, surnames are predictive of social status, then over time, as long as b is less than 1, surnames should lose this information. And the rate at which they lose it is a measure of the rate of social mobility. If the high rates of mobility typically found in one generation studies are predictive of long-run rates of social mobility, then within a few generations surnames should contain no systematic information on social status.

The crucial advantage the surname linkages give is that we can identify high and low status groups in some initial period, and then track them over multiple generations using their initial classification of status into high and low groups. This means that after the first generation the average error from the underlying status associated with each surname group in each generation is 0, so that for the surname cohorts

$$b_y = b_x$$

where x is the underlying broader social status of families or groups.

The b_x estimated for surnames, however, is not identical to that within families, if we could estimate that. This is because in surname cohorts, when we estimate

$$\bar{y}_{kt+1} = a + b\bar{y}_{kt} + u_{kt+1} \qquad (1)$$

$\bar{y}_{kt}$ measures, for example, the average log wealth across a group of people with the surname k in the initial generation. But some of these people will not have any children, and would not be included in the within family regression. And those with 1 child from generation t get weighted as much as those with 10 children. Thus surname cohorts themselves introduce some measurement error in y_t, which will reduce the observed value of *b*. The magnitude of this downwards bias will decline, however, the larger the size of the surname groupings unless there is some systematic connection between social status and child numbers.

In looking at social mobility through surnames in some cases we have direct measures such as wealth in England 1858-2012 (Clark and Cummins, 2012). Then it is easy to estimate b from the equation

$$\bar{y}_{Rt+1} - \bar{y}_{At+1} = \mathrm{b}(\bar{y}_{Rt} - \bar{y}_{At})$$

where $\bar{y}_{R,t}$ is the average log wealth at death of surname group R, and $\bar{y}_{A,t}$ is the average wealth at death of England as a whole. Figure 5 shows this information for England for three initial rare surname groups: wealthy surnames at death 1858-87, prosperous surnames at death 1858-87, and poor surnames at death 1858-87 (which is here defined as surnames for which no-one dying in this interval was probated).

Table 4 shows the average implied estimate of b for each period, and across the 5 generations as a whole. Since the poor group is much closer to average wealth than the two richer groups, the b estimate here is much noisier, as can be seen in the variance of the estimates in the last row of table 4. Looking at the top two wealth groups we see quite stable average estimates of b across the 5 generations - 0.71, 0.78, 0.71, and 0.69 – for an overall average of 0.72.

However, in most cases we have instead measures of the fraction of people bearing a surname who are in high or low status occupations over many generations compared to the fraction of those surnames in the general population: university graduates, doctor, attorney, member of Parliament, professor, author, or criminal.

To extract implied bs for these cases we proceed as follows. Define the *relative representation* of each surname or surname type, z, in an elite group as

$$relative\ representation\ of\ z = \frac{Share\ of\ z\ in\ elite\ group}{Share\ of\ z\ in\ general\ population}$$

With social mobility any surname which in an initial period has a relative representation differing from 1 should tend towards 1, and the rate at which it tends to 1 is determined by the rate of social mobility.

Figure 5: Log Average Wealth relative to the Average, 1858-2011

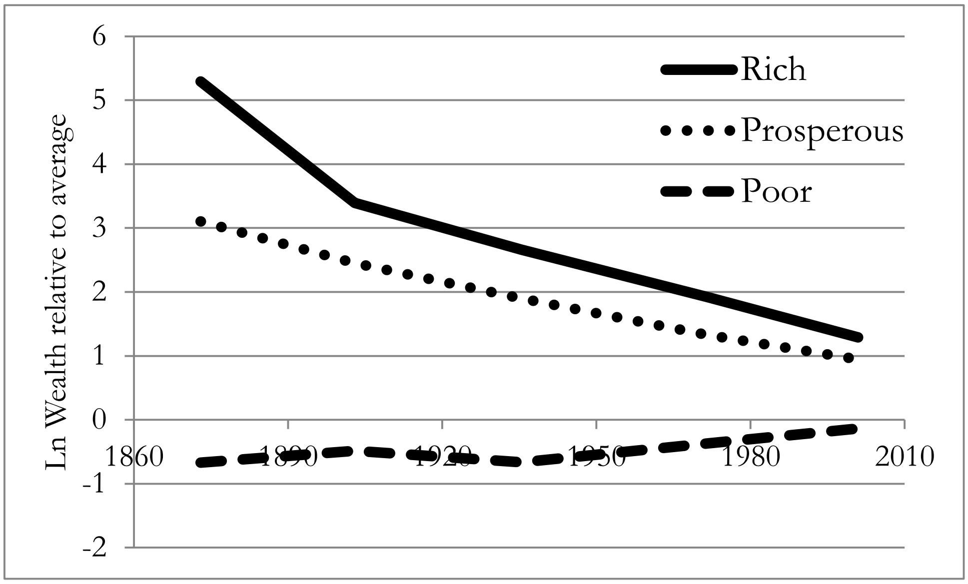


Table 4: Estimating b from average wealth at death

	Gen 0 to Gen 4 Average	**Gen 0 to Gen 1**	**Gen 1 to Gen 2**	**Gen 2 to Gen 3**	**Gen 3 to Gen 4**
Rich	0.70	0.64	0.78	0.72	0.67
Prosperous	0.74	0.79	0.78	0.70	0.71
Poor	0.76	0.72	1.38	0.56	0.37

***Notes**:* These b values are calculated by comparing the log of average normalized wealth for the surname groups with that of the average of England and Wales via the formula; $\bar{y}_{Rt+1} - \bar{y}_{At+1} = \mathbf{b}(\bar{y}_{Rt} - \bar{y}_{At})$ where $\bar{y}_R$corresponds to the log of average normalized wealth for the rare surname groups and $\bar{y}_A$ is the log of average normalized wealth at death.

To extract implied bs from information on the distribution of surnames among elites we proceed as follows. Assume that social status, y, follows a normal distribution, with mean 0 and variance σ^2. Suppose that a surname, z, has a relative representation greater than 1 among elite groups. The situation looks as in figure 6, which shows the general probability distribution function for status (assumed normally distributed) as well as the pdf for the elite group.

The overrepresentation of the surname in this elite could be produced by a range of values for the mean status, $\bar{y}_{z0}$, and the variance of status, σ_{z0}^2, for this surname. But for any assumption about ($\bar{y}_{z0}$, σ_{z0}^2) there will be an implied path of relative representation of the surname over generations for each possible *b*. This is because

$$\bar{y}_{zt} = \bar{y}_{z0} b^t$$

Also since $var(y_{Zt}) = b^2 var(y_{Zt-1}) + (1-b^2)\sigma^2$,

$$var(y_{zt}) = b^{2t}\sigma_{z0}^2 + (1-b^{2t})\sigma^2$$

With each generation, depending on *b,* the mean status of the elite surname will regress towards the population mean, and its variance increase to the population variance (assuming that $\sigma_{z0}^2 < \sigma^2$). Its relative representation in the elite will decline in a particular pattern.

Thus even though we cannot initially fix $\bar{y}_{z0}$ and σ_{z0}^2 for the elite surname just by observing its overrepresentation among an elite in the first period, we can fix these by choosing them along with *b* to best fit the relative representation of the elite surname z in the social elite in each subsequent generation. While we can in general expect that

$$0 < \sigma_{z0}^2 < \sigma^2$$

it turns out to matter little to the estimated size of b in later generations what specific initial variance is assumed. Below we assume that the initial variance of the elite surname status is the same as the overall variance, since this assumption fits the observed time path of relative representation well in most cases.

Figure 6: Initial Position of an Elite

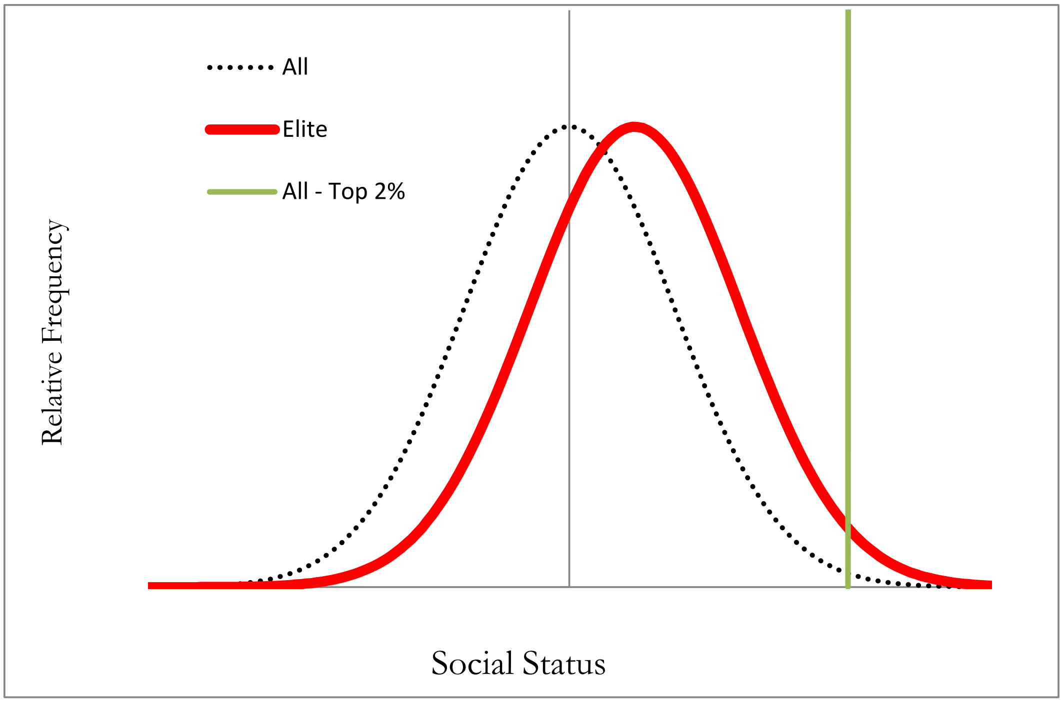


Table 6: Share Probated by Generation

Period	All Deaths 21+	Rich 1858-87	Prosperous 1858-87	Poor 1858-87
1858-87	0.15	0.84	0.57	0.00
1888-1917	0.22	0.68	0.54	0.10
1918-52	0.38	0.73	0.63	0.21
1953-89	0.46	0.70	0.65	0.34
1990-2011	0.43	0.61	0.59	0.37

For England in 1858-2012 average wealth at death is determined by the average estate value of those probated as well as the fraction of people probated. Table 6 shows this fraction for all adults (21 and over at time of death) by generation in England 1858-2012, as well as for those in the three rare surname groups of 1858-87. As can be seen the rich surnames continue to be probated at higher rates than the general population even into the last generation, 1990-2012. The poor group of surnames in 1858-87 is always probated at lower rates than the general population.

By dividing the probate rate of each group in each period by the general probate rate we can calculate the relative representation of each surname group among the probated. This is shown in table 7. Thus in 1858-87 the rich surnames were 5.5 times as likely to be probated as the average person at death. Assuming wealth variance for each surname equal to the social average we then get an implied persistence rates across generations, b, shown in table 8.[4]

The estimated intergenerational correlation of wealth from just the fractions of people in each surname group probated is very similar to that estimated directly by calculating average log wealth, as is also shown in table 8. Thus though in most cases we only observe the status of social groups by observing their relative representation in some top x% of the population, the estimates derived in this way will be completely comparable with the standard estimates.

[4] For the poor surnames we cannot derive this for the first period since by construction no-one in this surname group was probated in this period. With a normal distribution of wealth in each period it would not be possible to have a 0 percent of any group probated.

Table 7: Relative Representation by Generation

Period	All Deaths 21+	Rich 1858-87	Prosperous 1858-87	Poor 1858-87
1858-87	1.00	5.48	3.71	0.00
1888-1917	1.00	3.10	2.46	0.48
1918-52	1.00	1.92	1.65	0.56
1953-89	1.00	1.51	1.39	0.73
1990-2011	1.00	1.42	1.37	0.87

Table 8: Estimated b by Surname Group and Period

Period	Rich 1858-87	Prosperous 1858-87	Poor 1858-87
1888-1917	0.61	0.72	-
1918-52	0.75	0.72	1.04
1953-89	0.68	0.74	0.64
1990-2011	0.70	0.84	0.40
Average	0.68	0.76	0.70
Direct Estimate	0.70	0.74	0.76

Intergenerational Correlations by Country and Status Type

The tables below report the various intergenerational correlations found in the studies of the various countries. Table 9, for example, shows the various estimated of b for England, running from 1300 to 2012, and covering wealth, education, occupations, and membership in the political elite. These estimates all suggest high intergenerational correlations of status, on all measures. There is no clear sign of an increase in social mobility over time.

The other thing that stands out is that the assumption that all mobility is governed by a simple Markov underlying equation of mobility

$$x_{t+1} = bx_t + e_t$$

is strongly confirmed. Figure 7, for example shows the relative representation at Oxford and Cambridge, representing a 0.7% elite of educational achievement in England all the way from 1500-2012, of two sets of rare surnames: rare surnames of men born 1780-1809 dying wealthy 1858-87, and rare surnames of someone attending Oxford or Cambridge 1800-29. For these surnames we calculate the *relative representation* at the universities for the succeeding generations, 1830-59,…2010-2. We can also calculate their *relative representation* in the preceding generations, going all the way back to 1530-59.

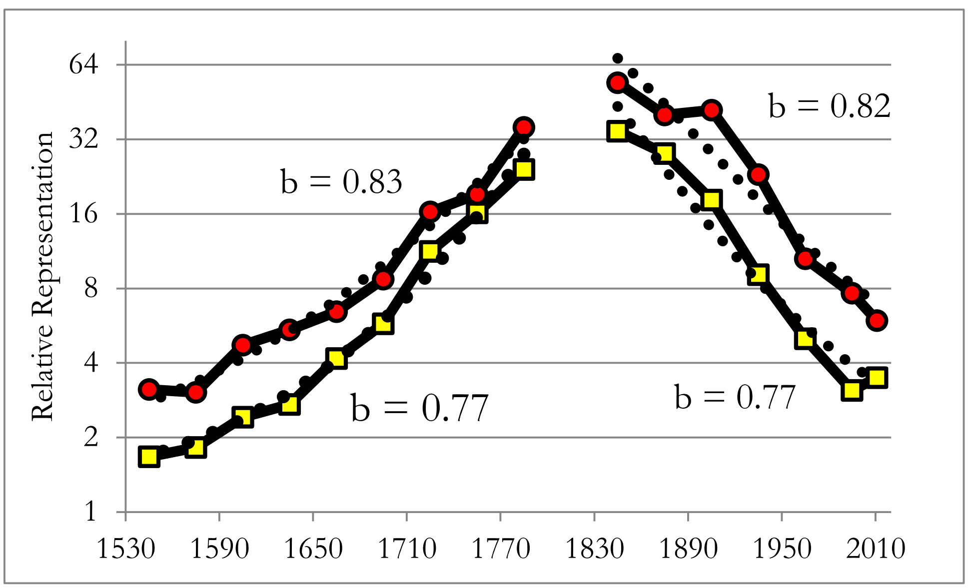
The patterns in figure 7 are striking. Surnames associated with the rich are always more overrepresented at Oxford and Cambridge than those associated with people who happened to attend the universities 1800-29, in all subsequent or prior generations. In 1830-59, for example, the rich surnames were 54 times as frequent in Oxford and Cambridge as in the general population, and the earlier Oxbridge surnames 34 times as frequent. But the rate of decline of the overrepresentation of these surnames at the universities is similarly slow. It is so slow that even now in 2010-2, just knowing that a rare surname was on average wealthy at death 1858-87 tells us that it will be 6 times more likely to show up on the Oxbridge rolls than the average English surname. Just knowing that a rare surname had at least one enrollee at Oxbridge 1800-29 allows us to predict that it will still be 3 times as likely to appear at the universities now as the average surname.

But the rate of decline for each group is constant. One b fits all generations. The implied b measure of persistence for the rich surnames 1830-2012 is 0.82, while for the 1800-29 universities cohort it is 0.77.

Table 9: b Estimates for England

Period	Wealth	Education	Occupations	Political Elite
1300-1500	-	0.75-0.78	-	-
1500-1700	-	0.77-0.83	-	-
1700-1850	0.71-0.85	0.77-0.83	-	-
1850-1900	0.67-0.71	0.77-0.83	-	0.81
1900-1950	0.74-0.78	0.77-0.83	-	0.81
1950-2012	0.70-0.74	0.77-0.83	0.65-1.00	-

Figure 7: Relative Respresentation



The model posited above that underlying status is linked across generations by the formula

$$x_{t+1} = bx_t + e_t$$

also has implications about what the path of relative representation will be for surnames observed to be elite in any specific generation in the periods before that observation. The OLS estimator of b in this expression is

$$\hat{b} \;=\; \frac{\sum x_{t+1}x_t}{\sum x_t^2}$$

Suppose we were instead to posit that

$$x_t = \beta x_{t+1} + \varepsilon_{t+1}$$

The OLS estimator of β would then be

$$\hat{\beta} \;=\; \frac{\sum x_{t+1}x_t}{\sum x_{t+1}^2}$$

If the variance of x_t is the same as that of x_{t+1} , then it will also be the case that $E(b) = E(\beta)$. Since we have normalized variance to be the same in each generation we have met this condition. Thus the rate of rise of surnames to be an observed elite in any generation should mirror their rate of decline back to mediocrity.

This is exactly what we observe in figure 7. These rare surnames seem to rise steadily from a relative representation close to 1 back in 1530-59 to the high levels observed circa 1800. The estimated b underlying that rise is 0.83 for the rich surnames, and 0.77 for the one that happen to appear at Oxford and Cambridge 1800-29.

There is plenty of other evidence that this simple underlying model of a constant b, operating through a simple Markov process, applies to England in all periods. One elite group we observe all the way from 1700 to 1858, for example, are the people whose estates were probated in the highest probate court in the land, the Prerogatory Court of the Archbishop of Canterbury (PCC). This was the court where the elites of English society, by wealth and occupation, had their wills proved at death. The share of men dying in England with wills proved in this court was fairly stable over these years, averaging 5.3% of all adult male deaths. Thus we can take those testators proved in this court as representing the top 5.3% of wealth holding in English society. By 1700 about a quarter of the wills probated in this court were from women, typically from women who were widows or spinsters. So while this measure will mainly show the inheritance of wealth by men, the inclusion of these women means that it is a bit broader, and is about the general inheritance of wealth within families.

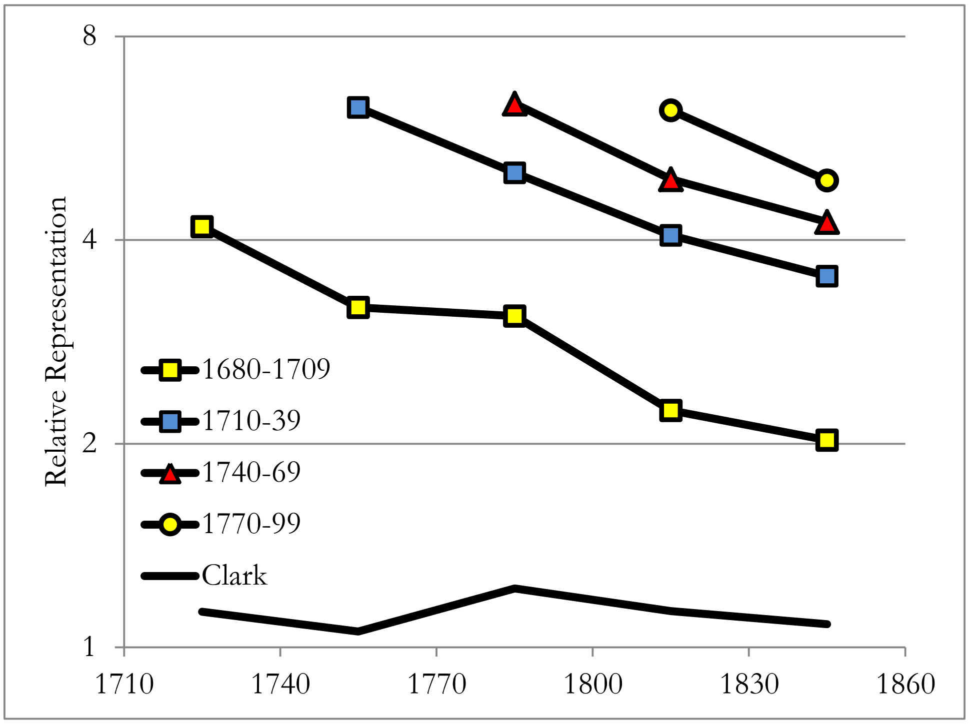
Using the PCC we can form sets of rare surnames that showed up in these probates 1680-1709, 1710-39, 1740-69, 1770-1799, corresponding to generations of 30 years.[5] We can then examine what the relative representation of these same surnames was in subsequent generations, and how quickly that representation was returning to 1.

Figure 8 shows the results. It shows the relative representation of these various groups of rare surnames across adjacent generations. They also show for comparison the relative representation of the surnames Clark(e) in these records. As a common surname Clark(e) shows up in the PCC records just slightly more than its proportion among marriage records all through these years. But the rare surnames all show up in the PCC records as heavily overrepresented in the period in which they are identified.

The 1680-1709 rare surnames, for example, had a relative representation in 1710-39 of 4.2. More than 4 times as many people with these rare surnames were probated in the Canterbury Courts as were people with the common surnames of England. These rare surnames became more average by generation. It is immediately clear from figure 8 is that the rate of decline of the relative representation of these surnames does not increase in the Industrial Revolution era. There is no sign that the Industrial Revolution increased rates of social mobility, or led to a rapid decline in the position of old elites from the pre-industrial era.

[5]We can tell which surnames appearing in the PCC are rare in each period from their frequency in the parish records of marriages. Large numbers of these records have been transcribed and are available on the Family Search website, https://familysearch.org/.

Figure 8: Relative Representation of Cohorts of Elite Surnames in the PCC, England, 1710-1858



Note: The vertical axes is on a logarithmic scale, so that a constant rate of decline of relative representation would appear as a straight line.

Instead the b represented by these curves stays close to 0.83 throughout these years. Second there is no sign of any increase in social mobility rates as the Industrial Revolution proceeds. The average b for those dying 1830-58, who would have lived through the heart of the Industrial Revolution is 0.86, higher than for the period as a whole. For the elites of 1710-39 or 1740-69 the Industrial Revolution had little impact on the rate of downwards social mobility.

As well as following what happens to those with rare surnames overrepresented among those probated in the Canterbury Court 1680-1709 over subsequent generations, we can also follow those overrepresented in 1830-58 over previous generations from 1680-1709 to 1800-29. If upwards social mobility rates are the same as downwards, then the slope of the curves showing relative representation against generation should be the same upwards as they are downwards.

Figure 9: Relative Representation of Rare Elite Surnames in earlier Generations, England, 1680-1829

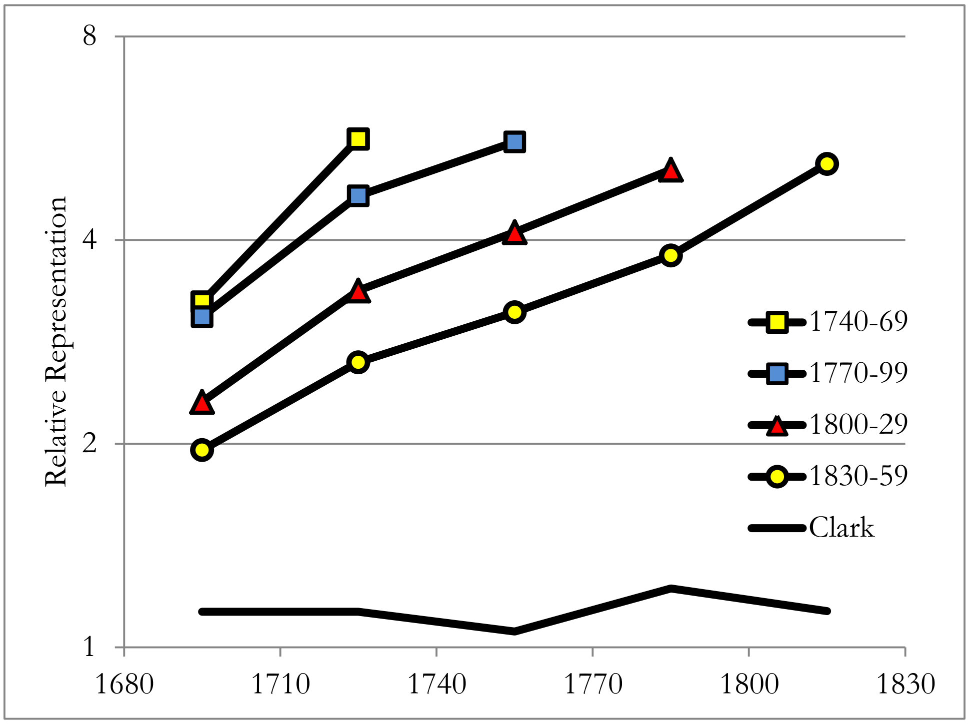


Figure 9 shows this pattern for rare surname wealth elites identified for 1830-58, 1800-29, 1770-99, and 1740-69. As can be seen the wealthy rare surnames of 1830-58 become more average the further back in time we go. They rise across the generations in their relative representation, though this process is again very slow. The elite surname group of 1830-58 which was 6 times as common among probates in the Canterbury Court than in the general population, was already 2 times as common in the Court than in the general population for deaths 1680-1709. The implied b from the curves in figure 9 averages 0.77.

Sweden

Table 10 summarizes the surname estimates of social mobility rates for Sweden 1700-2012 from Clark (2012). Three features are notable. First these mobility rates are very similar to those reported for England 1300-2012. Second the rates do not seem to show any clear downwards trend in the modern era. Third, the mobility rates for education and occupation seem similarly slow.

Figure 10 shows the details of relative representation of surnames in some of the Swedish Royal Academies, the most elite fraction of the academic establishment. Comprehensive membership lists are available for the Swedish Academy of Sciences (founded 1739), the Swedish Academy of Music (1771), and the Royal Academy (1786). Together these three academies have had 2,834 domestic members. Figure 10 shows the relative representation of the surnames of the eighteenth century elite – Latinized surname and the surnames of nobles - in these three academies by 30 year generations starting in 1739-1769, and ending in 1980-2012. In the earliest period such surnames made up half of the members of the academy. By 1980-2012 this had declined 4.1% of the Academies. But these surnames in 2011 were only 0.71% of the Swedish population, so they were still strongly overrepresented in the Academies.

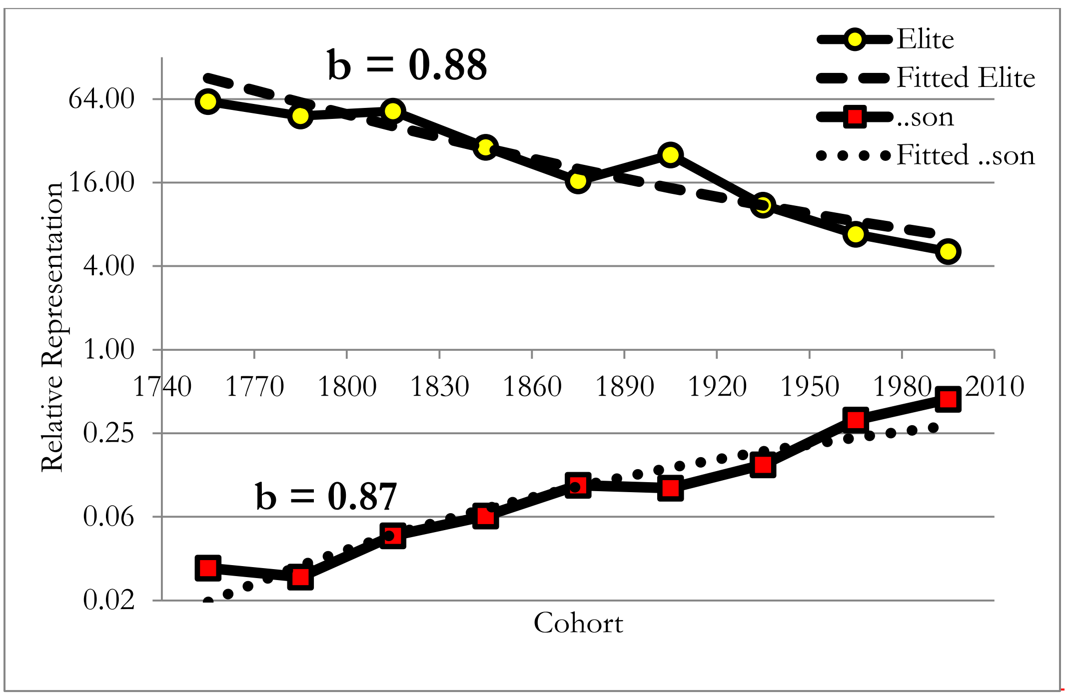
The small number of members compared to other groups we have looked at means that in the latter years there is a lot of sampling error in terms of the frequency of elite surnames. Taking these academies to represent the top 0.1% of Swedish society the implied persistence b over these 273 years is 0.88. There is also little sign of an increased rate of regression to the mean for the entrants to the academies 1980-2012 compared to 1950-79. The estimated b for elite surnames is still 0.84.

Figure 10 also shows the relative representation of Patronyms, lower class Swedish surnames, in the Academies. Such surnames are of course still strongly underrepresented, but they have shown a slow but steady convergence towards proportional representation. However, the implied b is 0.87, close to that for the elite surnames. Again we see the predicted symmetry in terms of rates of upwards and downwards mobility. However, there is a caveat that many people in Sweden whose father had a patronym did not take their father's name as an adult, and this switching was likely selective. This would reduce the rate of measured upward mobility.

Table 10: **Summary b Estimates by Period, Sweden**

Group	1700-1900	1890-1979	1950-2012
Attorneys	-	-	0.71
Physicians	-	0.67	0.88
University Students	0.78	0.85	0.66
Academicians	0.89	0.75	0.84

Figure 10: Elite and Lower Class Surnames in the Swedish Royal Academies



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