Grandfathers Matter(ed): Occupational Mobility Across Three Generations in the U.S. and Britain, 1850-1910

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Intergenerational mobility has been a topic of persistent interest in sociology and, increasingly, in economics. Nearly all of these studies focus on fathers and sons. The possibility that intergenerational mobility is more than a simple two-generational AR(1) process has been difficult to assess because of the lack of the necessary multi-generational data. We remedy this shortcoming with new data that links grandfathers, fathers, and sons in Britain and the U.S. between 1850 and 1910. This permits an analysis of mobility across three generations in each country and a characterization of the differences in those patterns across two countries for which we have found substantial differences in two-generation mobility in previous work. We find that, in both countries, grandfathers mattered: even controlling for father's occupation, grandfather's occupation significantly influenced the occupation of the grandson. For both Britain and the U.S. in the second half of the nineteenth century, therefore, assessments of mobility based on two-generation estimates significantly overstate the true amount of mobility.

The transmission of economic and social outcomes such as earnings, occupation, and education across generations has long interested a wide range of social scientists. Intergenerational social mobility has been a central topic of empirical sociology for many years. More recently, measuring the intergenerational elasticity of earnings has received a great deal of attention in economics, particularly following the publication twenty years ago of influential papers by Gary Solon (1992) and David Zimmerman (1992). One commonality across this large and diverse literature is the dominance of studies that analyze only two generations. Solon (1999) and Black and Devereux (2011) provide extensive surveys of the empirical economics studies, which focus almost exclusively on the transmission of outcomes from parent to child and ignore any potential influence of grandparent and further-removed generations.[1] The theoretical work that informs the empirical studies, particularly the Becker-Tomes model on which so many of the studies rely, is a two-generation model in which the child's outcome is a function of investments made by and an endowment received from the parents (Becker and Tomes, 1979).[2]

This focus on the impact of parents on children is not so much one of choice as of necessity. Typically, the available information covers only two generations, whether the data source follows individuals over time or has retrospective questions on an individual's early-life household. In fact, the overarching goal of economic and social mobility studies is to determine how family background – in the sense of a broad-ranging familial endowment of genes, investments in human capital, social networks and the like – influences individuals' educational and labor market prospects. In theory, there is no reason why this should be a simple two-generation AR(1) process. It is entirely plausible that the impact of family background characteristics goes back farther than just the father/mother generation. Whether it does is an empirical question, and if it does, then the large literature that measures and compares intergenerational mobility across many countries and time periods systematically overestimates true mobility rates by assuming that only the previous generation matters for the prospects of the current one.

Sociologists have explored the possible effect of multiple generations more than have economists. A relatively recent study by Warren and Hauser (1997) provides a useful survey of sociological work on mobility over multiple generations, some of which has found evidence for multigenerational effects and some of which has not. They analyze the Wisconsin Longitudinal Study, which includes information over a long time period on a sample of 1957 Wisconsin high school graduates. Approximately 4,000 individuals from the sample report occupational information for their parents and at least one of their children over the course of their study. The authors find that the occupation of the grandfather does not influence the occupation of the grandson if the occupation of the father is controlled for. An obvious limitation of this study is its reliance on data from only one state; whether this finding applies to the U.S. as a whole cannot be determined.

[1] Though some studies consider mothers and daughters, the analysis of men is far more typical. In what follows, we will refer to grandfathers, fathers, and sons in the interest of brevity and clarity, though all of the analytical framework could just as well refer to females in any of the generations considered.
[2] This basic structure is also followed by Solon (2004).

Research by economists on the multigenerational transmission of occupation, earnings, or education is more limited. In an early study of the intergenerational elasticity of earnings between fathers and sons, Peters (1992) includes grandfather's education as a control variable in her estimation equation, and finds no significant effect. However, her data does not reveal grandfathers' earnings, nor is the analysis of multigenerational effects an explicit aim of her study. More recently, a team of Swedish researchers has conducted a detailed analysis of the persistence of human capital over four generations of individuals originating with the 1938 Malmö Study (Lindahl et al., 2012). The original study surveyed 1,542 third graders in the Malmö metropolitan area in 1938. Since that time, subsequent generations have been added to the dataset so that at present the authors are able to observe earnings for three generations and education for a fourth for a total of 901 complete families. They find that simple two-generational estimates of the elasticity of earnings and education between parent and child significantly underpredict the true persistence across three generations. This finding runs counter to the finding of Warren and Hauser for Wisconsin and indicates that multigenerational effects matter for this particular sample. Like the Warren and Hauser study, and like many of the studies they survey from the sociology literature, the dataset used contains relatively few observations across all three generations and is not clearly nationally representative.

Several recent studies have considered mobility and the persistence of inequality over very long runs of family and dynastic history using methodology quite different from the standard intergenerational regression framework. Clark and Cummins link seven generations of families with rare surnames in England from 1800 to the present. Rather than comparing income and education between individual parents and their children, they compare average wealth of surname-sharing families across generations. With this methodology, they are able to include up to five generations in the wealth estimation equation for their most recent generation. Their results indicate that, while the impact of each successive generation diminishes, all five generations do exert a significant influence, leading the authors to conclude that existing studies significantly overestimate the true rate of mobility. In a somewhat similar vein, studies based on archival data on the descendants of Qing Dynasty emperors in China also indicate a farreaching effect of ancestry on the occupational status of subsequent generations (Campbell and Lee, 2011, Mare and Song, 2012).

Whether multiple generations do in fact influence the occupational attainment of individuals is an empirical question, but there are good reasons to expect, *a priori*, that they could. Mare (2011) describes several mechanisms by which multigenerational influence could operate. The accumulation within a family of sufficient wealth in the form of financial or physical capital would be one channel by which generations prior to the parent could influence the outcomes of children. The availability and quality of a wider kin network that could assist with child rearing, job acquisition, et cetera is another. One might extend this concept to include the relevant social capital available to individuals, the accumulation of which could be influenced by generations prior to the parents. Finally, various biological mechanisms could determine the inheritance of salient traits across more than two generations.

In this paper, we use new data on grandfathers, fathers, and sons linked across nineteenth century censuses in the U.S. and Britain to assess the degree of mobility across three generations. The data are constructed from nationally-representative sources in a base year (the 1881 British Census and the 1880 U.S. Census) which are then linked to (1) the appearance of the fathers from those sources (when they were children residing with own fathers) in the census three decades prior; and (2) the appearance of the sons from those sources (when they were adults) in the census two decades subsequent. This permits an analysis of mobility across three generations in each country and a characterization of the differences in those patterns across two countries for which we have found substantial differences in two generation mobility in previous work (Long and Ferrie, forthcoming).

Linking Generations Across Censuses

Previous work on intergenerational mobility has, for the most part, relied on simple comparisons of fathers and sons out of necessity – there were no suitable, nationally representative datasets that provided information on three or more generations. The recent completion of indexes to the British (through 1911) & U.S. (through 1940) population censuses now provides the opportunity to generate such samples. We have completed three-generation samples for both Britain and the U.S. and, in the next few months, will add a fourth generation to the British data and both a fourth and fifth generation to the U.S. data. The British and U.S. datasets were generated in slightly different ways from each other, so readers should draw no cross-national comparisons in what follows.

British Data

We used three sources to construct the data for Britain[3]: (1) a computerized two percent sample of the 1851 census, (2) a computerized version of the complete count 1881 census, and (3) the complete count 1901 census, accessible through Ancestry.com, a Web-based genealogical research service.[4] The first stage of the data creation process was the nominal linkage of 12,647 sons living with their father from the 1851 census sample to the 1881 complete-count census. This is generation two (G2). Complete details of the linkage procedure and data construction process, including the matching algorithm, potential sources of bias, and expected versus actual linkage success rate, have been reported elsewhere and will not be repeated here.[5] Briefly, individuals were linked based on first and last name and county, parish and year of birth – information that should, barring error, remain constant across censuses. Some leeway in the matching algorithm was allowed for small discrepancies in reporting personal information across censuses thirty years apart. Names were allowed to vary slightly, as long as they matched phonetically, and reported age in 1881 was allowed to deviate by up to five years from the expected value based on reported age in 1851.[6] This linkage procedure produced a sample that is well representative of the young male population of England and Wales.

[3] Throughout the paper, we use the term "Britain" as a matter of convenience. In fact, the data include only information on individuals residing in England and Wales. When the project was begun, Scotland was not included in the 1881 data source. The Scottish data are now available, and will eventually be incorporated into the analysis.
[4] The 1851 and 1881 data sets are available from the UK Data Archive, as studies number 1316 and 4177, respectively.
[5] See Long and Ferrie (forthcoming) and especially Long (2005).
[6] To test the robustness of the matching procedure, the intergenerational mobility analysis was repeated using only the individuals who were matched exactly between 1851 and 1881 – in other words, those individuals who reported precisely the same name in both censuses and whose reported age in 1881 was exactly 30 years greater than their reported age in 1851. The mobility pattern for this group is essentially the same as the results reported for the data as a whole. The Altham G2 test statistic, described in a following section, shows no statistically significant difference in mobility between the exact-match subset and the whole data set.

The sample is younger than the population as a whole for the simple reason that men had to have survived 30 years in order to be found in the 1881 census. Table I illustrates the representativeness of the data by comparing the linked individuals from the two percent sample of the 1851 census to the entire sample. Observable characteristics are compared for sons under the age of 20 (the group of interest for intergenerational mobility) and males between the ages of 20 and 35.

Because the census records households together and because the 1851 sample preserves this household structure, it is simple to connect the young linked males who were sons living with their family in 1851 with their fathers, who constitute generation one (G1) in this study. This provides the basic structure necessary to observe intergenerational mobility from 1851 to 1881, and it does so in such a way that both father and son are observed as mature adults, with approximately equal ages, at approximately the same point in the life cycle. For the 12,647 father/son pairs in which the son is aged 0 – 19 years and living with his father in 1851, the average age of the father in 1851 is 41.5 years, and the average age of the son thirty years later in 1881 is 38.0 years. An average age difference of only 3.5 years should have a negligible impact on observed mobility considering the advanced age of both father and son at the time of observation.[7]

The final stage of the linkage process adds a third generation to the data. 20,269 sons were extracted from the households of the linked males in 1881, and 8,677 were linked into the 1901 complete-count census using Ancestry.com's Web-based genealogical research service. This is generation three (G3). These individuals are used to measure intergenerational mobility from 1881 to 1901. Table II summarizes the three data sets used to construct these mobility measures, and Table III uses the households of three successive generations of males from 1851, 1881, and 1901 to illustrate the nature of the linked census data.

We use both observed occupation and earnings imputed by occupational class to assess mobility. The censuses only directly reveal occupation. Although earnings is the measure most commonly used in the economics literature on mobility, there are

[7] The age structure of the linked census data makes it particularly well suited to measuring intergenerational mobility in nineteenth century England relative to the sources that have typically been used in the past. For more, see Long (forthcoming).

advantages to using occupation (as is the norm in the sociology literature). One of the principal empirical difficulties in the study of earnings mobility is obtaining a true measure of permanent income in the face of frequent transitory income shocks. As shocks often occur without job changes, occupation should be less affected by such disturbances. Further, compared to a simple earnings measure, occupation and social class capture more dimensions of an individual's experience that may be related to interpretations of social mobility, such as prestige in the community, autonomy in the workplace, manual versus non-manual labor, place of work, and so on.

We code the British occupations according to W. A. Armstrong's classification system, which is based on the Registrar General's 1921 and 1951 classification schemes (Armstrong, 1972). Every individual is assigned to one of five ranked social classes according to his occupation as recorded in the census enumerator's book: I – Professional, II – Intermediate, III – Skilled, IV – Semiskilled, and V – Unskilled.[8] This is a classification system based solely on occupation, and while there surely are additional components of social class, occupation is nearly always considered to be of central importance in determining an individual's class. Armstrong's aim for the classification system is to "ensure that each category is homogeneous in relation to the basic criterion of the general standing within the community of the occupations concerned."

Under Armstrong's system, each occupation is coded according to the Registrar General's classification scheme, with several modifications made to minimize anachronism. The most important modification is that, regardless of job title, all employers of 25 or more are included in Class I, and all individuals with Class III or IV occupations employing at least one person other than a family member are included in Class II. Empirically, this scheme correlates well with other indicators of social class. In this sense, what is referred to here as "social class" is essentially synonymous with what is often referred to in the social sciences as socioeconomic status. According to occupational/industrial pay estimates compiled by Jeffrey Williamson (1980, 1982), the average wage premium in 1851 for each class relative to the next lowest class was 7

[8] Some typical occupations are Class I – solicitor, accountant; Class II – farmer, carpenter (employer); Class III – carpenter (not employer), butcher (not employer), skilled in manufacturing; Class IV – agricultural laborer, wool comber; Class V – general laborer, porter.

percent for Class IV, 33 percent for Class III, 81 percent for Class II, and 45 percent for Class I. Furthermore, Armstrong (1972, p. 212) demonstrates that job class, defined according to this system, is positively correlated with the employment of servants and negatively correlated with the incidence of shared accommodation.

While earnings is not revealed in the census, it can be imputed to individuals based on their reported occupations. While no source is ideally suited to the task, Williamson's pay estimates will suffice. There are well-known problems with these estimates, primarily having to do with a handful of professional occupations, especially solicitors and barristers, surgeons and doctors, and engineers. The wage information for these occupations is derived from a small number of sources and demonstrates extreme variation across time periods (Jackson, 1987, Feinstein, 1988). For the limited purposes of this study, these problems can be dealt with simply enough by omitting these occupations in the construction of the average wage for each class and year. This method preserves some of the important advantages of the Williamson wage data relative to other sources, particularly its consistent construction across the decades from 1851 to 1901.[9] The occupations used for each class along with the average wage for each relevant year are shown in Table IV. Wages are imputed to individuals by occupation when possible; otherwise, individuals are assigned the average wage for their occupational class.

U.S.Data

The U.S. data reports the occupation of a male household head in 1850 (Generation 1), the occupation of his son in 1880 (Generation 2), and the occupation of the son of the Generation 2 male in 1910 (Generation 3). The linkages across three U.S. population censuses proceeded in three steps:

1. All males present in the Full-Count File of the 1850 U.S. Population Census who met the following criteria were extracted: (1) they were age 3-21 in 1850; and (2) they were co-resident with both parents in 1850. A total of 3,057,484 individuals satisfied both criteria. The age requirement was imposed so they would be independent household

[9] Another advantage is the inclusion of some wage information for white-collar workers. While the previously mentioned professional occupations are problematic, there are a handful of occupations included with which to derive an average wage for classes I and II. Other viable sources for occupational wages from one specific time period, such as Leone Levi's 1885 report, lack any wage information for the professional occupations (Levi, 1885).

heads thirty years later in 1880. The co-residence requirement was imposed to determine the birthplaces of both parents (which was necessary in the next step) and, in the case of fathers, to determine the father's occupation. Requirement (2) necessarily creates a bias toward intact households which, for a variety of reasons, will be unrepresentative of the total population of males age 3-21 in 1850 (see Xie & Killewald (forthcoming) for a discussion of this issue). As the same requirement will be imposed in subsequent stages of the linkage process, however, this bias will be consistent throughout the linked sample.

2. The individuals extracted from the 1850 census in Step (1) were then sought in the Full-Count File of the 1880 U.S. Population Census (Ruggles et al, 2010a), based on their anticipated age in 1880 (± 3 years), the phonetic proximity of their surname and given name (a value for the SPEDIS function in SAS ≤ 15; see Gershteyn (2000) for a description of the function)[10], exact matches on the individual's own birthplaces and the birthplaces of both parents, and only one person in both censuses meeting the preceding criteria. In order to reduce the probability of "false positives," the linked dataset was further limited to individuals who either had a full given name (i.e. not just an initial) reported in both censuses and for whom no individual matching the other non-given name criteria was present in either census without a full given name.[11] This process produced 398,181 matches from 1850 to 1880, a match rate of 13.0%.[12]

3. The sons of individuals matched 1850-1880 were then matched to the 1910 IPUMS 1% Sample (Ruggles et al., 2010b) using the same criteria as in Step (2). This

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[10] The SPEDIS function is not symmetric in comparing two names a and b, so the value used was actually the average of SPEDIS(a,b) & SPEDIS(b,a). For example, for the surnames a="Ferrie" and b="Ferry," SPEDIS(a,b)=22 and SPEDIS(b,a)=30, the average is 26 and the observation is rejected; for given names a="Joseph" and b="Joesph," SPEDIS(a,b)=8 and SPEDIS(b,a)=8, the average is 8 and the observation is accepted if the other criteria are met.

[11] For example, even if "Joseph Ferrie" in 1850 and "Joseph Ferrie" in 1880 were matched on age, own birthplace, and parents' birthplaces, but there was also a "J. Ferrie" present in 1880 who matched on these criteria, the "Joseph Ferrie" match was rejected, on the basis of the possibility that the 1880 "J. Ferrie" was actually the correct "Joseph Ferrie" (because either the correct 1850 match for the "Joseph Ferrie" observed in 1880 was not successfully enumerated in 1850, or because the correct 1850 match for the "Joseph Ferrie" observed in 1880 was actually reported in 1850 as "J. Ferrie."

[12] There are several sources of loss in this linkage: the most likely are mis-enumeration (15%) or non-enumeration in either census (15%), age or name mis-reporting/changing (15% each), death between 1850 and 1880 (22.1% based on survival of this cohort inferred from the 1850 and 1880 population totals for males age 3-21 in 1850 and age 33-51 in 1880). If we assume these factors are independent, the predicted match rate is 40.7%. Of these, half had at least one person sharing the same surname, given name, year of birth, birthplace, and parents' birthplaces. The additional deletion of individuals with a potential match on criteria other than given name but an initial rather than a full given name reported in either census lowers this rate to 15%, just over the observed rate.

yielded 1,886 unique matches. A random sample of 10,000 of the sons of 1850-1880 matches not found at this stage were then sought directly in the on-line 1910 U.S. Census index, of whom 5,019 were located in the 1910 census. We have transcribed a random subset consisting of 255 of these 5,019 matches and are in the process of transcribing the remainder.

The currently-transcribed data used here, then consists of 2,141 observations consisting of an occupation in 1850 for Generation 1 (grandfathers), an occupation in 1880 for Generation 2 (fathers), and a 1910 occupation for Generation 3 (sons). With the thirty-year gap between censuses, all observations occur at roughly the same point in each adult's life cycle. Occupations have been grouped into four broad comparisons (white collar, farmer, skilled & semi-skilled, and unskilled) that are defined consistently across censuses. There is no comprehensive measure of income by occupation for the total U.S. until the 1940 census, so occupations have instead been scaled by the average wealth (real estate & personal wealth) reported by white males age 24-55 in 1860 and 1870 for 106 distinct occupational titles. This will be referred to below as "occupational wealth."

Analysis and Results

The implicit assumption in much of the work on intergenerational mobility is that the transition from fathers to sons is independent of the history of previous father-son transitions in the same family line. In terms of income or wealth,

$$\ln\left(Y_{it}\right) = \alpha + \beta_1 \ln\left(Y_{i,t-1}\right) + \varepsilon_{it}$$

where Y_{it} is the outcome for an individual in family line i in generation t, Y_{it-1} is the corresponding outcome for another individual in family line i in generation t-1, and ε_{it} is an error term with the usual properties. Y is thus the outcome of a simple AR(1) process, so if the term Y_{it-1} is replaced with Y_{it-2}:

$$\ln\left(Y_{it}\right) = \alpha + \beta_2 \ln\left(Y_{i,t-2}\right) + \varepsilon_{it}$$

the resulting regression coefficient $\beta_2 = (\beta_1)^2$. In terms of occupational categories,

$$\left[\text{Occupations}_t\right] = \left[\text{Occupations}_{t-1}\right]' \mathbf{M}$$

where the first term is a vector of 1,...,*m* occupational counts in generation *t*, the second is the corresponding vector in generation *t*-1, and **M** is an $m \times m$ matrix of transition probabilities. Here, an individual's occupational category in generation *t* is the outcome of a Markov process, so outcomes for generation *t* are related to those in generation *t*-2 by the square of the Markov matrix **M**.

The simplest way to assess whether intergenerational mobility is described by a process that ignores any history prior to generation *t*-1 is to see whether $\beta_2 = (\beta_1)^2$ for income or wealth or whether $[\text{Occupations}_{t\text{-}2}]'\mathbf{MM}' = [\text{Occupations}_{t\text{-}1}]'\mathbf{M}$. We will take the former approach here. As in Lindahl et al. (2012), we simply regress father's outcome on son's outcome (yielding β_1), grandfather's outcome on son's outcome (yielding β_2) , and then compare $(\beta_1)^2$ to β_2. Table IV presents these results for Britain (Columns 1-3) and the U.S. (Columns 4-6).

For both Britain and the U.S., the effect of both fathers and grandfathers on sons is statistically significant when each regression is estimated separately. When both fathers and grandfathers are included, in the same regression, both are statistically significant. In both Britain and the U.S., it is clear that $\beta_2 > (\beta_1)^2$, in Britain by nearly a factor of two and in the U.S. by a factor of more than four. Using the delta method, we can formally test the null nonlinear hypothesis $\beta_2 > (\beta_1)^2$ after obtaining bounds on the standard errors of β_2 and β_1^2. Doing so yields 95% confidence intervals for the difference $\beta_2 - (\beta_1)^2$ of [0.060, 0.172] for the U.S. and [0.025, 0.092] for Britain, clearly excluding not just zero but also all negative values. In the regressions that include both fathers and grandfathers (Columns 3 and 6), the fathers' outcomes are endogenous (determined solely by the grandfathers' outcomes) if the underlying process is simply AR(1). When we have completed the construction of the four-generation data for Britain and the U.S., we can account for this possibility by using the outcomes for great-grandfathers as an instrument for the outcomes of fathers.

Although earnings and wealth information are not generally included in the censuses, the 1850 U.S. census does report the value of real estate holdings for household heads. With this information, we can begin to explore, for the U.S. at least, the mechanisms through which (dis)advantage is transmitted across multiple father-son transitions. If the regression in Column (6) of Table IV is re-estimated, with the use of grandfather's actual 1850 real estate wealth (average value in the sample of $1799.33) in place of the grandfather's wealth imputed on the basis of occupation, similar results are obtained: when a dummy for real estate > 0 is used, $\beta_2 = 0.119$ (p = 0.045); when ln(real estate + $1) is used, $\beta_2 = 0.0189$ (p = 0.018).

Tables VI–VIII show occupational class mobility (transition probabilities) across three generations for Britain, and Tables IX–XI show the same for the U.S. For both countries, three transitions are shown: G1 → G2, G2 → G3, and G1 → G3. The British occupational classes are ranked from 1: Professional (highest) to 5: Unskilled (lowest). The U.S. occupational categories are not formally ranked, although moves from the unskilled category into any of the other three may unambiguously be considered upward moves while moves into the unskilled category may be considered downward moves.[13] In the British case, the most common upward and downward moves were into category 3 (skilled), though this is driven mechanically by the sheer number of these occupations. If the transition matrices are scaled so that the marginal probabilities of each category are equal (not shown), the most common upward and downward moves are one-category moves in either direction. Though it does not directly bear upon the question at hand, it is worth mentioning that the total and upward mobility rates shown here are indicative of significantly greater two-generation mobility for nineteenth century England than has previously been realized (for more, see Long, forthcoming).

A striking feature of the U.S. mobility tables are the high rates of total mobility and of upward mobility out of unskilled occupations. Although the differing classification schemes used here for the British and U.S. data preclude direct cross-country comparisons, we have made those comparisons elsewhere, confirming higher mobility in the U.S. (Long and Ferrie, forthcoming). The exception is the particularly high rate of persistence in farming between the first and second generation in the U.S. One particularly striking type of transition in the U.S. is the move into farming from other occupational backgrounds, which is far more common than in Britain. It is not the case, however, that farming accounts for all of the mobility out of skilled, semiskilled, and

[13] The prevalence of farmers in the U.S. and the significant variance in their earnings and status make it more difficult to rank occupational categories in the U.S. than in Britain, where farming was a far less common and on average relatively high-status occupation. In the future, we intend to explore possible ranking schemes for U.S. occupations.

unskilled occupations. There is also a great deal of mobility into white-collar occupations from these groups, and from unskilled into skilled/semiskilled.

To summarize the differences in mobility between the three British tables and between the three U.S. tables, we calculate the Altham statistic for each comparison. These are reported in Table XII, along with a comparison of each table to a matrix **J** of ones, representing perfect mobility; i.e. complete independence of rows and columns. The Altham statistic is

$$d(\mathbf{P},\mathbf{Q}) = \left[\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{l=1}^{r}\sum_{m=1}^{s} \left| \log\left(\frac{p_{ij}p_{lm}q_{im}q_{lj}}{p_{im}p_{lj}q_{ij}q_{lm}} \right)^2 \right| \right]^{1/2}$$

It is an aggregation of the differences between each cross-product ratio in tables **P** and **Q**, both with *r* rows and *s* columns, where *p* and *q* denote the individual elements of each table. It measures how far the association between rows and columns in table **P** departs from the association between rows and columns in table **Q**. A simple likelihood-ratio χ^2 statistic G^2 (Agresti, 2002, p. 140) with $(r - 1)(s - 1)$ degrees of freedom can then be used to test whether the matrix $\mathbf{\Theta}$ with elements $\theta_{ij} = \log(p_{ij}/q_{ij})$ is independent; if we can reject the null hypothesis that $\mathbf{\Theta}$ is independent, we essentially accept the hypothesis that $d(\mathbf{P},\mathbf{Q}) \neq 0$ so the degree of association between rows and columns differs between table **P** and table **Q**. The metrics $d(\mathbf{P},\mathbf{J})$ and $d(\mathbf{Q},\mathbf{J})$ reveal which of tables **P** and **Q** are closer to independence; i.e. in which mobility is greater.[14]

The Altham statistics confirm the expectation that father-son (G1-G2 and G2-G3) occupational persistence is greater than grandfather-grandson (G1-G3) persistence, for both the U.S. and Britain. This is indicated by the relative proximity of the G1-G3 tables to independence (**J**) compared to the G1-G2 and G2-G3 tables. In Britain, overall two-generation mobility appears to have been quite stable from 1851-1901. In the U.S., on the other hand, mobility was lower between fathers in sons from 1850-1880 than 1880-1900, though this is driven by the aforementioned high persistence of farmers between G1 and G2.

[14] For more on the Altham statistic and its use to compare mobility across tables see Altham (1970), Altham and Ferrie (2005), and Long and Ferrie (forthcoming).

These two-generation mobility tables do not directly reveal the extent to which the transmission of occupation is a non-Markov, multigenerational process. The results in Table XII indicate that grandfather's occupation influenced grandson's, in that the G1-G3 tables are significantly different from independence for both countries. However, we would expect this to be the case even if intergenerational mobility was an AR(1) process as long as the degree of association between two generations was strong enough that mean reversion would not occur in three generations. Evidence for a multigenerational effect can, however, be seen if we compare G2 to G3 mobility for different groups according to the mobility of G2, as is shown in Tables XIII and XIV. Table XIII shows upward, downward, and total mobility for the G2-G3 pair, grouped by G1-G2 mobility.[15] From this, we see that sons (G3) of upwardly mobile fathers (G2) are themselves significantly more likely to be downwardly mobile (36.5%) than sons of non-mobile (20.4%) or downwardly mobile (8.8%) fathers. Likewise sons of downwardly mobile fathers are more likely to be upwardly mobile (52.2%) than sons of non-mobile (22.1%) or upwardly mobile (12.5%) fathers. Of course, some of this is purely mechanical: by definition, no sons of upwardly mobile fathers begin in the lowest category; therefore, there are fewer candidates for upward moves. The reverse holds for the sons of downwardly mobile fathers. However, as Table XIV shows for the British case, this property of the data does not explain all of the differences. Considering only G3 sons of Class III or IV origin (where the cell counts are largest and therefore most reliable), we see that still the multigenerational effect is present: sons of upwardly (downwardly) mobile fathers were more likely themselves to be downwardly (upwardly) mobile. This result is comparable to the positive coefficient on β_2 in columns (3) and (6) of Table V.

Conclusions

Using new nationally-representative data covering three generations in Britain and the U.S. from 1850-1901, we have found strong evidence that occupational mobility was not a simple AR(1) process across two generations. Regression analysis indicates that grandfather's earnings significantly influenced grandson's earnings beyond the direct

[15] This exercise is more informative for the British data, which are ranked across each occupational category, than for the U.S., where currently we define upward and downward mobility only with respect to transitions out of and into unskilled occupations.

influence of father's earnings. In addition, the effect of grandfather's earnings on grandson's earnings exceeds the effect implied by simply squaring the two-generation, father-son effect. Patterns of occupational class mobility reveal a similar effect: sons were more likely to be downwardly mobile if their fathers were themselves upwardly mobile, and vice versa. For both Britain and the U.S. in the second half of the nineteenth century, therefore, assessments of mobility based on two-generation estimates significantly overstate the true amount of mobility. The persistence of earnings and occupational class across generations is greater than has previously been thought. Whether this is true for these countries more recently is a question these data cannot answer; however, these findings lend credence to the idea that our current understanding of economic and social mobility in many countries, based as it is on two-generation studies, could well systematically overstate mobility and understate the impact of family background on educational and occupational attainment.

If this is true, a full assessment of the impact of family background on the occupational prospects of an individual must take into account at least two, and perhaps more, previous generations. With our current data, we cannot rule out the possibility that even more generations might matter. Therefore, to extend our analysis to include more generations, we intend to exploit fully the available census indexes to link as many generations as possible for both the U.S. and Britain in the available censuses. Using twenty-year windows to connect fathers to adult sons, we will be able to construct five-generation linked data for the U.S. (1850-1870-1890-1910-1930) and four-generation data for Britain (1851-1871-1891-1911). With this data, following the methodology employed in the present study, we will be able to test for much deeper generational economic persistence than has previously been possible.

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TABLE I
REPRESENTATIVENESS OF BRITISH LINKED CENSUS DATA
1851-1881 Linkage

	Sons, age 0-19		Males, age 20-35	
	2% Sample	Linked Data	2% Sample	Linked Data
Age (mean)	8.11	8.27	26.93	26.80
Father's Age (mean)	40.72	41.60		
Son's Status				
Student	31.68	33.40		
At home/No occupation	43.45	37.50		
Other	24.87	29.10		
Relation				
Head			45.72	50.06
Son			23.71	29.72
Lodger			10.37	7.45
Servant			5.76	5.21
Visitor			3.13	2.44
Other			11.31	5.12
Marital Status				
Married			51.61	53.85
Unmarried			48.39	46.15
Occupation, 1851				
Agricultural Laborer	18.97	18.73	16.37	19.98
Laborer	7.59	6.53	7.57	6.65
Farmer	5.34	6.45	1.81	2.07
Miner	2.96	2.05	3.11	2.71
Weaver	2.90	3.34	2.66	3.58
Carpenter	2.38	2.46	2.11	2.20
Tailor	2.19	2.06	2.07	2.41
Shoemaker	1.50	1.65	1.36	1.49
Solicitor	0.36	0.33	0.41	0.36
Other	55.81	56.40	61.40	57.57
Region				
South	21.73	21.13	19.72	21.26
Midlands	20.90	20.80	22.15	23.07
London Environs	13.12	15.14	14.17	14.03
Lanc-Cheshire	12.89	13.49	11.81	12.38
York	9.41	10.59	9.64	9.41
London	8.49	5.24	10.49	5.98
East	7.57	8.15	6.56	8.52
North	5.89	5.46	5.45	5.34
N	59,958	13,424	40,317	7,789

Notes: All figures are percentages except where noted. Columns 1 and 2 compare all sons younger than age 19 in the 1851 2% census sample with those sons successfully linked into the 1881 census. Columns 3 and 4 compare all males between the ages of 20 and 35 in the 2% sample with those males successfully linked into the 1881 census. For sons, *Occupation*, 1851 refers to father's occupation; for males age 20-35, it is their own occupation.

Sources: 1851 census 2% sample and new sample of linked individuals.

TABLE II

SUMMARY OF BRITISH DATA

Generation 1(G1) – Generation 2 (G2), 1851–1881	
	12,647 father/son (G1/G2) pairs
	Sons age 0–19 in 1851, 30–49 in 1881
	Average age of father in 1851 = 41.5 years
	Average age of son in 1881 = 38.0 years
Generation 2(G2) – Generation 3 (G3), 1881–1901	
	4,255 father/son (G2/G3) pairs
	Sons age 10-19 in 1881, 30-39 in 1901
	Average age of father in 1881 = 46.7 years
	Average age of son in 1901 = 33.9 years
G1–G2–G3, 1851–1901	
	2,813 grandfather/father/son (G1/G2/G3) sets
	where G2 is 30–49 in 1881 and G3 is 30–39 in 1901

TABLE III

EXAMPLE OF LINKED CENSUS DATA, 1851–1901

1851 Census: Phillips household; Eastergate parish, Sussex, England

County	Parish	First Name	Last Name	Relation	Mar	Occupation	Sex	Age	Birth County	Birth Parish
Sussex	*Eastergate*	*William*	*Phillips*	*Head*	*M*	*Ag Labourer*	*M*	*42*	*Sussex*	*Chichester*
Sussex	Eastergate	Martha	Phillips	Wife	M	-	F	37	Sussex	Walberton
Sussex	*Eastergate*	*William*	*Phillips*	*Son*	*U*	*Ag Labourer*	*M*	*17*	*Sussex*	*Walberton*
Sussex	Eastergate	Mary	Phillips	Daur	U	Scholar	F	13	Sussex	West Hampnet
Sussex	Eastergate	Richard	Rewell	Lodger	W	Ag Labourer	M	85	Sussex	Walberton

1881 Census: Phillips household; Arundel parish, Sussex, England

County	Parish	First Name	Last Name	Relation	Mar	Occupation	Sex	Age	Birth County	Birth Parish
Sussex	*Arundel*	*William*	*Phillips*	*Head*	*M*	*Blacksmith*	*M*	*47*	*Sussex*	*Walberton*
Sussex	Arundel	Jane	Phillips	Wife	M	Blacksmith wife	F	45	Sussex	Arundel
Sussex	Arundel	George	Phillips	Son	U	Bricklayers lab	M	15	Sussex	Arundel
Sussex	*Arundel*	*David*	*Phillips*	*Son*	*U*	*Scholar*	*M*	*8*	*Sussex*	*Arundel*
Sussex	Arundel	Thomas	Phillips	Son	U	-	M	10 m	Sussex	Arundel

1901 Census: Phillips household; Arundel parish, Sussex, England

County	Parish	First Name	Last Name	Relation	Mar	Occupation	Sex	Age	Birth County	Birth Parish
Sussex	*Arundel*	*David*	*Phillips*	*Head*	*M*	*Gen Labourer*	*M*	*28*	*Sussex*	*Arundel*
Sussex	Arundel	Emily	Phillips	Wife	M	-	F	21	Hull	Yorkshire
Sussex	Arundel	Patricia	Phillips	Daur	U	-	F	8	Sussex	Arundel
Sussex	Arundel	Selina	Bolton	Visitor	U	-	F	4	Sussex	Brighton

Note: Three linked individuals used to measure intergenerational mobility shown in italics. For the sake of clarity, some members of each household are not shown.

TABLE IV

Class	Occupations for 1851-1901	1851	1881	1901
I: Professional	Clergy, High-wage government employee	£250.98	£295.33	£198.82
II: Intermediate	Clerk, Teacher	158.46	203.73	217.18
III: Skilled	Skilled worker in engineering, building, shipbuilding and textiles	66.92	85.69	95.80
IV: Semiskilled	Farm laborer, Miner, Railway worker, Low-wage government employee	48.02	58.65	69.26
V: Unskilled	General non-agricultural laborer	44.83	55.88	68.90

Sources: Williamson (1980, 1982)

TABLE V

OLS Regressions of Prior Generations' Outcomes (Occupational Income for Britain, Occupational Wealth for the U.S.) on Son's Outcome

	Britain			U.S.		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Father) (β_1)	0.302***		0.285***	0.191***		0.162***
	(0.014)		(0.018)	(0.025)		(0.027)
ln(Grandfather) (β_2)		0.150***	0.051***		0.152***	0.101***
		(0.015)	(0.016)		(0.027)	(0.028)
Constant	3.242	3.956	3.100	6.023	6.315	5.464
Obs.	4,074	2,704	2,692	2,141	2,141	2,141
Adj. R^2	0.110	0.035	0.116	0.025	0.015	0.031
$(\beta_1)^2$	0.091			0.036		

Note: Standard errors in parentheses. p-values *** < 0.01 ** < 0.05 * < 0.10

TABLE VI

British Occupational Standing of Generations 1 vs. 2, Frequency (Column Percent)

Generation 2 (Fathers, 1881)	Generation 1 (Grandfathers, 1851) 1	2	3	4	5	N
1	14	18	59	6	6	103
	(18.9)	(3.1)	(2.4)	(0.4)	(1.2)	(2.0)
2	17	197	193	77	28	512
	(23.0)	(34.0)	(7.7)	(5.1)	(5.5)	(9.9)
3	32	261	1,803	582	276	2954
	(43.2)	(45.1)	(72.0)	(38.9)	(54.4)	(57.2)
4	6	64	206	627	103	1,006
	(8.1)	(11.1)	(8.2)	(41.9)	(20.3)	(19.5)
5	5	39	242	206	94	586
	(6.8)	(6.7)	(9.7)	(13.8)	(18.5)	(11.4)
N	74	579	2,503	1,498	507	5,161
(Pct.)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: "1" is the highest occupation standing and "5" is the lowest.

Total Mobility =47.0% (45.1% with standardized margins)

Upward Mobility =26.1% (27.5% with standardized margins)

Downward Mobility=20.9% (27.4% with standardized margins)

TABLE VII

British Occupational Standing of Generations 2 vs. 3, Frequency (Column Percent)

Generation 3 (Sons, 1901)	Generation 2 (Fathers, 1881) 1	2	3	4	5	N
1	16	24	50	11	1	102
	(22.2)	(5.5)	(2.2)	(1.3)	(0.2)	(2.5)
2	20	136	261	53	35	505
	(27.8)	(31.0)	(11.5)	(6.3)	(7.7)	(12.4)
3	24	200	1,568	361	245	2,398
	(33.3)	(45.6)	(69.2)	(42.9)	(54.2)	(58.9)
4	7	45	155	262	50	519
	(9.7)	(10.3)	(6.8)	(31.1)	(11.1)	(12.7)
5	5	34	232	155	121	547
	(6.9)	(7.7)	(10.2)	(18.4)	(26.8)	(13.4)
N	72	439	2,266	842	452	4,071
(Pct.)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: "1" is the highest occupation standing and "5" is the lowest.

Total Mobility =48.3% (43.7% with standardized margins)

Upward Mobility =26.8% (28.7% with standardized margins)

Downward Mobility=21.5% (27.6% with standardized margins)

TABLE VIII
British Occupational Standing of Generations 1 vs. 3, Frequency (Column Percent)

Generation 3 (Sons, 1901)	Generation 1 (Grandfathers, 1851) 1	2	3	4	5	N
1	5	12	41	9	4	71
	(11.4)	(3.5)	(3.1)	(1.2)	(1.7)	(2.6)
2	6	75	160	62	18	321
	(13.6)	(22.0)	(12.0)	(8.3)	(7.5)	(11.9)
3	28	174	866	375	143	1,586
	(63.6)	(51.0)	(65.1)	(50.5)	(59.3)	(58.7)
4	1	40	117	166	29	353
	(2.3)	(11.7)	(8.8)	(22.3)	(12.0)	(13.1)
5	4	40	147	131	47	369
	(9.1)	(11.7)	(11.0)	(17.6)	(19.5)	(13.7)
N	44	341	1,331	743	241	2,700
(Pct.)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Note: "1" is the highest occupation standing and "5" is the lowest.

Total Mobility =48.3% (35.3% with standardized margins)

Upward Mobility =26.8% (32.5% with standardized margins)

Downward Mobility=21.5% (32.2% with standardized margins)

TABLE IX
U.S. Occupations of Generations 1 vs. 2, Frequency (Column Percent)

	Generation 1 (Grandfathers, 1850)				
Generation 2 (Fathers, 1880)	White Collar	Farmer	Skilled & Semi-Skilled	Unskilled	N
White Collar	51	122	69	12	254
	(39.8)	(8.4)	(18.9)	(6.3)	
Farmer	45	1,044	106	64	1259
	(35.2)	(71.7)	(29.0)	(33.7)	
Skilled & Semi-Skilled	23	168	144	65	400
	(18.0)	(11.5)	(39.3)	(34.2)	
Unskilled	9	123	47	49	228
	(7.0)	(8.4)	(12.8)	(25.8)	
N	128	1,457	366	190	2,141
(Pct.)	(100.0)	(100.0)	(100.0)	(100.0)	

Note: Total Mobility =39.8% (54.0% with standardized margins)
Upward Mobility = 6.6% [*from* "Unskilled"] (14.0%with standardized margins)
Downward Mobility= 8.4% [*to* "Unskilled"] (14.0%with standardized margins)

TABLE X
U.S. Occupations of Generations 2 vs. 3, Frequency (Column Percent)

	Generation 2 (Fathers, 1880)				
Generation 3 (Sons, 1910)	White Collar	Farmer	Skilled & Semi-Skilled	Unskilled	N
White Collar	119	274	122	38	553
	(46.9)	(21.8)	(30.5)	(16.7)	
Farmer	35	480	58	65	638
	(13.8)	(38.1)	(14.5)	(28.5)	
Skilled & Semi-Skilled	67	266	137	73	543
	(26.4)	(21.1)	(34.3)	(32.0)	
Unskilled	33	239	83	52	407
	(13.0)	(19.0)	(20.8)	(22.8)	
N	254	1,259	400	228	2,141
(Pct.)	(100.0)	(100.0)	(100.0)	(100.0)	

Note: Total Mobility =63.2% (64.7% with standardized margins)
Upward Mobility = 8.2% [*from* "Unskilled"] (17.5% with standardized margins)
Downward Mobility=16.6% [*to* "Unskilled"] (17.8% with standardized margins)

TABLE XI
U.S. Occupations of Generations 1 vs. 3, Frequency (Column Percent)

	Generation 1 (Grandfathers, 1850)				
Generation 3 (Sons, 1910)	White Collar	Farmer	Skilled & Semi-Skilled	Unskilled	N
White Collar	47	349	113	44	553
	(36.7)	(24.0)	(30.9)	(23.2)	
Farmer	21	499	77	41	638
	(16.4)	(34.2)	(21.0)	(21.6)	
Skilled & Sei-Skilled	38	321	118	66	543
	(29.7)	(22.0)	(32.2)	(34.7)	
Unskilled	22	288	58	39	407
	(17.2)	(19.8)	(15.8)	(20.5)	
Col	128	1,457	366	190	2,141
(Pct.)	(100.0)	(100.0)	(100.0)	(100.0)	

Note: Total Mobility =67.2% (69.1% with standardized margins)
Upward Mobility = 7.1% [*from* "Unskilled"] (18.0% with standardized margins)
Downward Mobility=17.2% [*to* "Unskilled"] (18.0% with standardized margins)

TABLE XII
Altham Statistics d(P,Q) Assessing Each Table's Distance From Independence and Its Distance from Other Tables

Table	d(P,J)	d(Q,J)	d(P,Q)
Britain:			
P: Grandfathers (1851)	43.91***		
vs. Fathers (1881)			23.34***
Q: Fathers (1881)		43.20***	
vs. Sons (1901)			
P: Fathers (1881)	43.20***		
vs. Sons (1901)		27.89***	
Q: Grandfathers (1851)			29.36***
vs. Sons (1901)			
U.S.:			
P: Grandfathers (1850)	16.43***		
vs. Fathers (1880)			8.88***
Q: Fathers (1880)		10.28***	
vs. Sons (1910)			
P: Fathers (1880)	10.28***		
vs. Sons (1910)		6.12**	
Q: Grandfathers (1850)			6.12***
vs. Sons (1910)			

Note: d(*x*,J) is the distance from the row-column association in table *x* to that under independence (in Table J with 1s in each cell); d(*x*,*y*) is the distance between the row-column association in table *x* and that in table *y*.
p-values for χ^2 test of H0: d(*x*,*y*)=0 *** < 0.01 ** < 0.05 * < 0.10

TABLE XIII

Father to Son Mobility By Grandfather to Father Mobility, Britain & U.S.

	Father to Son Mobility					
Grandfather to	Britain			U.S.		
Father Mobility	Total	Up	Down	Total	Up[a]	Down[b]
Upward	49.0%	12.5%	36.5%	61.7%	–	17.7%
No Change	42.5	22.1	20.4	61.6	22.4	18.4
Downward	61.0	52.2	8.8	78.8	78.8	–

Note: [a] From unskilled only
[b] To unskilled only

TABLE XIV

MOBILITY OVER THREE GENERATIONS IN BRITAIN

Mobility of G3 (1881-1901), By Mobility of G2 (1851-1881)

	G2 Class, 1881 (No Change from G1)					
G3 Class, 1901	I	II	III	IV	V	Total
I: Prof	39.13%	5.06%	2.53%	1.01%	0.00%	2.58%
II: Int	34.78	40.08	12.13	5.94	0.88	12.83
III: Skilled	17.39	38.52	68.35	37.10	53.51	57.87
IV: Semi-S	0.00	9.73	6.77	36.81	7.89	13.78
V: Unskilled	8.70	6.61	10.21	19.13	37.72	12.93
Total (%)	100%	100%	100%	100%	100%	100%
Total (N)	23	257	1978	690	114	3062

	G2 Class, 1881 (G2 class > G1)					
G3 Class, 1901	I	II	III	IV	V	Total
I: Prof	20.65%	4.42%	1.06%	(2.59%)	-	3.15%
II: Int	27.17	24.78	11.02	(2.59)	-	14.49
III: Skilled	36.96	49.85	66.84	43.97	-	59.36
IV: Semi-S	(9.78)	11.21	7.84	23.28	-	9.93
V: Unskilled	(5.43)	9.73	13.24	27.59	-	13.08
Total (%)	100%	100%	100%	100%	0%	100%
Total (N)	92	339	944	116	0	1491

	G2 Class, 1881 (G2 class < G1)					
G3 Class, 1901	I	II	III	IV	V	Total
I: Prof	-	(0.00%)	3.88%	(1.61%)	(0.55%)	1.74%
II: Int	-	(16.67)	13.73	9.32	5.31	9.00
III: Skilled	-	83.33	68.36	47.59	52.56	57.11
IV: Semi-S	-	(0.00)	6.87	27.33	13.19	15.14
V: Unskilled	-	(0.00)	7.16	14.15	28.39	18.76
Total (%)	0%	100%	100%	100%	100%	102%
Total (N)	0	18	335	311	546	1210