AMERICAN MOBILITY AND THE EXPANSION OF PUBLIC EDUCATION

John Parman
Department of Economics
University of California - Davis
jmparman@ucdavis.edu

September 3, 2009

Abstract

Educational institutions and intergenerational mobility are closely related with access to schools a major determinant of a child's future success. This paper offers new insight into this relationship with a study of mobility during the United States' expansion of public schools in the early twentieth century. A new intergenerational dataset is used to establish a sharp decline in income mobility over the twentieth century and a negative correlation between public school expansion and mobility. Educational attainment estimates reveal that this negative relationship was a product of wealthy families being more responsive to improving school access than poor families.

1 Introduction

Economic mobility and school access are inextricably linked. Nearly every aspect of equality of opportunity in modern society centers around a child's access to educational resources and an environment conducive to utilizing those resources. Yet despite the acknowledgment that education and mobility are closely related, the precise details of that relationship are often ambiguous. Educational institutions fill two distinct and opposite roles in the determination of intergenerational mobility. They provide the means of advancement for children from poor backgrounds, offering the primary channel through which an individual can move up the socioeconomic ladder. However, they also serve as a means of transforming parental income into children's future success through the acquisition of higher quality education. These two roles of education have opposite effects on the strength of the relationship between parental income and the success of children. Depending on which role dominates, evolving educational institutions can be responsible for either increasing mobility or increasing rigidities in class structures from one generation to the next.

This paper considers the relationship between American educational institutions and intergenerational mobility rates in a historical context, focusing on the expansion of the public school system in the early twentieth century and its impact on intergenerational income mobility. In particular, I examine Iowa at the turn of the century, a time when the state exhibited a rapidly changing mix of school types and qualities as common schools were being replaced with modern grammar schools and high schools. By matching Iowa census records with federal census data and school district records, I create a dataset of father-son pairs that allows for both comparison of intergenerational mobility rates across communities with differing educational opportunities and identification of the responsiveness of individual schooling choices to changes in educational access and quality. These new intergenerational data provide a unique opportunity to understand the mechanisms through which changing educational institutions altered American class structures.

These Iowa data reveal that income mobility declined as access to grammar schools and high schools improved. The educational attainment decisions of individual families reveal the source of this result: wealthy families, initially constrained by a lack of local schooling resources, responded strongly to the expansion of public schooling while the constraints facing poor families rendered the new availability of schools largely irrelevant to their educational investment decisions. The results of this study underscore the importance of understanding the relevant preferences and constraints of both poor and wealthy families that guide investment in their children when evaluating the impact that the introduction and expansion of public education had on American mobility and the potential effects of further educational reform on class structure and the distribution of wealth.

The remainder of this paper presents a brief history of American mobility and public education followed by an empirical study of mobility and education during the expansion of Iowa's public school system. In the following section, I explain why the first half of the twentieth century in America is an appealing period in which to examine the relationship between education and mobility. This is followed by an argument for Iowa at the turn of the century as a particularly compelling focus of study. Next, I describe the construction of an intergenerational dataset of Iowa residents with detailed income and educational attainment information. These Iowa data are used to confirm that the previously established drop in American occupational mobility rates over the twentieth century is mirrored by a substantial decline in income mobility. I then use township level public schooling data to show that declines in income mobility and increased persistence in the tails of the income distribution were correlated with the introduction of modern public schools. Finally, individual educational attainment decisions are estimated and used to explain the observed changes in mobility as a product of greater increases in educational investments by wealthy families relative to poor families in response to increasing school access.

2 Mobility and the Evolution of Public Schools over the Twentieth Century

Current income mobility rates in the United States are similar to or below those of other countries. International comparisons of intergenerational income elasticities reveal that the intergenerational income elasticity in the United States is comparable to or higher than elasticities measured for other developed nations, suggesting that if anything the United States is a somewhat less mobile society, and that those elasticities have been fairly stable in recent decades.[1] However, historically this has not been the case. Joseph Ferrie's study of intergenerational occupational mobility rates in the United States and Britain reveals that the U.S. had high levels of mobility in the late 1800s that converged over the first half of the twentieth century to the more modest international levels.[2] These occupational mobility rates do not translate perfectly into income mobility rates due to overlap in income ranges across occupational categories and their inability to capture income mobility within an occupational category. However, they do suggest that the American income mobility rates observed in modern studies are likely significantly lower than their levels at the beginning of the twentieth century.

Several changes in the American economy over the twentieth century could have contributed

[1] See Solon, "Cross-country Differences," Solon and Lee, "Trends," and Hertz, "Trends."
[2] Ferrie, "History Lessons."

to this decline in mobility. Major shocks including both world wars and the Great Depression as well as more gradual transitions such as the closing of the frontier and rural to urban migration could all have altered labor markets and influenced mobility rates. While the influence of these changes on mobility are all worthy of study, the major institutional transition of interest in this paper is the evolution of the public education system.

At the end of the nineteenth century, educational institutions in the United States bore little resemblance to the modern school system. The first decades of the twentieth century ushered in the compulsory attendance laws, public funding of education, and the grammar schools and high schools that are all now basic features of the public education system.[3] This transformation of American educational institutions led to dramatic increases in educational attainment and literacy rates.[4] While occurring at different times in different areas of the country, the whole of the movement took place during the first half of the twentieth century, making it concurrent with and a potential contributing factor to the decline in American mobility.

Beyond the coincidence of its timing, the growth of public education provides a promising explanation of the mobility decline because of the central role schools play in the transmission of economic success from one generation to the next. Educational attainment has a significant impact on earnings, a fact that is particularly true at the time of the public school transformation as evidenced by the large returns to education during the high school movement estimated by Claudia Goldin and Lawrence Katz.[5] An individual's educational attainment depends on family resource constraints. In this respect, access to education is a clear channel through which parental income affects children's future earnings. The introduction of public education altered the financial and geographical access constraints individuals faced when choosing levels of educational investment and therefore directly impacted the determinants of mobility.

The direction of this impact is ambiguous. Intuitively, the expansion of public schools should have created a more egalitarian school system and consequently greater mobility. Models of the transmission of earnings across generations in the tradition Gary Becker's work on

[3] See Goldin, "America's Graduation," Moehling, "State Child Labor Laws," Lleras-Muney, "Were Compulsory Attendance and Child Labor Laws," and Goldin and Katz, *Race*.

[4] See Goldin, "America's Graduation" and Goldin and Katz, *Race*.

[5] Goldin and Katz, "Education" and Goldin and Katz, *Race*.

human capital and the family indeed predict an increase in intergenerational income mobility with a rise in government spending on education.[6] However, others, most notably Arthur Goldberger, note that these results depend on an assumption that private and public education are substitutes.[7] If they are instead complements, it is possible that improvements in public schooling could lead to declines in intergenerational mobility. As Nathan Grawe points out in a discussion of the theoretical literature on education and mobility, conflicting results from theory suggest that identifying the effects of changes in educational institutions on mobility is ultimately an empirical question.[8]

Empirical work on the relationship between schools and mobility has been limited by a lack of appropriate data. There is a small body of evidence suggesting that in practice additional government spending on education can actually lead to declining mobility. Efforts to improve access to higher education in Britain provide a modern example of this; wealthy families were able to take fuller advantage of the expanded opportunities leading to an overall decline in intergenerational mobility.[9] Grawe demonstrates that for the United States in recent decades, states with lower quality public education, proxied by average class size, actually have higher rates of intergenerational mobility.[10] Grawe's results are of particular interest to this paper as they concern the same public primary and secondary schools that are the focus of this study. Grawe is limited to school measures at the state level masking much of the heterogeneity in school characteristics. The historical data introduced in this paper afford an opportunity to consider variation in school characteristics at the district level, offering a very different perspective on heterogeneity in schools and mobility rates. I will explore whether the negative relationship between public school quality and mobility identified by Grawe for the modern public school system was present in the early days of public school expansion when the data is disaggregated to the district level. The results will offer insight into whether declines in American mobility occurred in spite of public school improvements or in part because of them.

[6] See Becker, *Human Capital*, Becker and Tomes, "Human Capital," and Solon, "Model."
[7] Goldberger, "Economic and Mechanical Models."
[8] Grawe, "Primary and Secondary School."
[9] Blanden et al., "Changes" and Blanden and Machin, "Educational Inequality."
[10] Grawe, "Primary and secondary school."

3 Iowa's School System at the Turn of the Century

While the motivation for examining educational institutions in a study of mobility is clear, the mechanics of doing so are far from obvious. From a data perspective, information on income is rare historically. The sort of panel studies used to estimate modern mobility rates simply have no historical counterpart. Income data is extremely rare prior to 1940, let alone information on both a father and son's incomes. There is a similar paucity of educational attainment data. Beyond data issues, there is a more fundamental problem that even in the presence of ideal data, the expansion of public schools in the United States was far from an abrupt transition. With public education decisions made at the state and local level, the appearance of high schools and general improvements to public education occurred at different times in different areas over a period of decades, a period which, as discussed earlier, witnessed several major shocks and transformations to the American economy. A solution to these problems is to exploit the uniqueness of Iowa as a leader in education and, equally important, a leader in data collection.

Iowa was one of the first states to begin the transition to modern public graded schools and high schools. At the end of the nineteenth century, Iowa's school system consisted primarily of private religious academies and single room common schools, the little red schoolhouses found in nostalgic accounts of the Prairie. A series of changes occurred in the late nineteenth century that led to dramatic changes in the school system. Between 1857 and 1870, several pieces of legislation were introduced that increased the ability of townships to vote for the creation of schools and fund those schools through local taxes, increasing overall education expenditures and reducing the tuition burden on students. Between 1870 and 1900, the number of high schools in Iowa increased from 40 to over 200.[11] In just the five years between 1895 and 1900, the number of graded schools increased by nearly 20 percent.[12] In addition to this rise in the number of graded schools, there was a movement at the turn of the century toward school consolidation in the rural school districts, increasing the quality of education available to children in rural areas. The result of all of these changes was a dramatic rise in both educational access and school quality between 1890 and 1910.[13] This movement toward higher

[11]See Smisher, "Century" for these figures and a discussion of nineteenth century Iowa school legislation.

[12]Iowa Dept. of Public Instruction, *Iowa education directory*, 1900.

[13]For a comprehensive accounting of the forces behind public school expansion in the United States, see chapters

quality education and modern graded schools in Iowa preceded much of the rest of the nation by two decades, with the bulk of the transformation of Iowa schools occurring prior to World War I. Iowa school districts in 1900 covered a wide range of school types and quality, from one room common schools with a handful of students to large high schools accredited by Iowa universities.

The position of Iowa as a leader in the expansion of public education is echoed by the state's efforts to maintain detailed records of educational statistics. The county superintendents of schools were required to gather data on enrollments, teachers, expenditures, revenues and other variables for all of the school districts in their county each year and submit this information to the Department of Public Instruction. These statistics were compiled into annual reports and published. The original data are stored at the state archives and are now available on microfilm as far back as 1873. These records provide an extraordinary level of detail on each school district throughout the transition to modern public schools.

These data on school districts offer an impressive level of detail on the educational resources available to children growing up in Iowa at the turn of the century. Combining these data with individual level data from the Iowa state census allows for identifying how families utilized these resources. With the 1915 Iowa census, the state sought to produce data on the exact extent to which Iowa was a leader in education. To this end, a series of questions on educational attainment was included in the census. Each respondent was asked for the number of years they attended common school, grammar school, high school and college. This represents a dramatic improvement over the traditional educational attainment questions common to state and federal censuses that were limited to literacy and current enrollment status. Beyond this education information, the 1915 census also asked individuals for their annual earnings, making the census the only large survey containing both income and educational data for the United States prior to the 1940 federal census. By linking adult sons to their fathers in the Iowa census, a process described in detail in the next section, an intergenerational dataset can be generated containing two generations of income and educational attainment data. The uniqueness of the Iowa income data coupled with the matching procedure present the first opportunity to estimate intergenerational income mobility and study its determinants in a

five and six of Goldin and Katz's *The Race Between Education and Technology.*

historical context.

With a rapidly changing mix of schools, a wealth of school district data, and educational attainment and income data for the entire state population, Iowa is an extraordinarily attractive candidate for a study of the relationship between education and mobility. While Iowa was an outlier in terms of the timing of the evolution of its educational institutions, the changes to those institutions were of the same nature as the changes that would eventually occur throughout the rest of the nation. With appropriate caveats, identifying the effect of the introduction of modern public schooling in Iowa on intergenerational mobility will offer meaningful insight into the contribution of changing educational institutions to the overall decline in American mobility in the first half of the twentieth century and the relationship between educational institutions and mobility in general.

4 Constructing an Intergenerational Dataset

The data for this study are drawn from three main sources. The first two are the reports of the county superintendents of schools and the 1915 Iowa state census discussed in the previous section. The third is the 1900 federal census. Given that education and income are observed for only a single cross section of Iowa residents, it is necessary to use the federal census schedules to reconstruct the childhood households of the observed individuals and acquire the parental occupation and earnings data necessary for a study of intergenerational mobility. This section details the relevant features of each individual data source and describes the process of building the intergenerational sample.

The construction of an intergenerational dataset begins with the sample of the 1915 Iowa state census transcribed by Goldin and Katz for their study on the returns to education.[14] They sample ten rural counties and the three counties with large urban populations (containing the cities of Davenport, Des Moines and Dubuque). The resulting sample includes roughly 60,000 individuals. All of the data available in the state census are transcribed. For the purposes of this paper, the relevant variables include age, birthplace, parents' birthplaces, year of immigration if applicable, years of schooling by school type (common, grammar, high

[14] Goldin and Katz, "Education."

school, college), occupation, months employed in the previous year, and annual earnings for the previous year.

From this sample of individuals, I select all males between the ages of 20 and 35. These individuals will constitute the sons of the father-son pairs in the final intergenerational dataset. The age range is chosen such that the men are old enough to have moved out of their parents' household by 1915 but young enough that their fathers can still be located in the 1915 Iowa state census. A major restriction in choosing the sample is the fact that educational attainment and income are only available in the 1915 census. If both father and son's total educational attainment and income are to be observed, it is necessary for both the father and son to be living adults in 1915, hence the limited age range.

These young adult males are then located in records of the 1900 federal census. The 1900 federal census is the only census in which the majority of the sons, aged 5 to 20 at the time of the census, will be living with their parents. The complete population schedules of the 1900 federal census are searched by son's name, birthplace and age using an online database. Once a son in matched to the federal census, information on his parents and siblings is transcribed from an image file of the original 1900 census form. Parents' birthplaces are recorded and used to confirm the accuracy of the match. Sibling information is used to determine the birth order of the individual. The father's name, age, birthplace, occupation and parents' birthplaces are all recorded.

The father can then be located in the 1915 Iowa state census through a combination of searching the Goldin-Katz sample and the original census records available on microfilm at the Newberry Library in Chicago.[15] Name, age, birthplace and parents' birthplaces provide the criteria for identifying correct matches. Once located in the 1915 Iowa census, the 1915 location, occupation, educational attainment, months employed and annual earnings of the father are recorded.

The end result of this process is a sample of father-son pairs for which the locations of both fathers and sons in 1900 and 1915 are known, occupation and earnings of both are known in 1915, overall educational attainment for both is known, and father's occupation is

[15] An electronic index of these records is now available online on a subscription basis at www.ancestry.com, allowing searches of the census by name, birthplace, location and age. Educational attainment, annual earnings and occupation are not transcribed and still require viewing images of the original census cards.

known in 1900. These variables allow for measures of geographical, occupational and income mobility. As discussed in the previous section, the intergenerational income data are unique for a historical dataset. Furthermore, because the dataset is constructed from complete census records, the final sample is comparable in size to the modern panel studies for the United States used to estimate intergenerational income elasticities. Table 1 provides summary statistics for the final sample of father-son pairs. Column 1 corresponds to the father-son pairs for which incomes are observed for both the father and son. Column 2 corresponds to those fathers found in the 1915 Iowa census but who were either unemployed or retired, allowing for educational attainment and occupation (based on the 1900 census) to be observed but not income. Column 3 corresponds to fathers who were found in the 1900 federal census but not the 1915 census and consequently have an occupation observed but neither income nor educational attainment. Column 4 corresponds to all males in the Goldin-Katz sample between the ages of 20 and 35, including those individuals that could not be found in the 1900 federal census. The sample sizes are fairly large, ranging from 1,094 father-son pairs with complete income and occupation information to 3,488 pairs when including all observations for which there is at least an occupation for the father. The effects of the high school movement can be seen by noting the jump in average educational attainment of over a year from the fathers' generation to the sons'. The lower earnings of the sons are attributable to the difference in average age between the sons and fathers.

While this sample of father-son pairs does have educational attainment data, it lacks information on educational access and quality, both of which are central to decisions about educational attainment and likely to be major factors in the extent to which education influences mobility. To incorporate these data into the father-son sample, the county superintendents of schools records from 1900 are transcribed and the sons are matched to their respective school districts based on their 1900 household locations. For the majority of individuals, this means assigning them to the school district for their township. There is a complication when townships contain independent school districts within the township-wide district, occurring most frequently when a larger town exists within the township. In these cases, the township and independent district data are aggregated together and all individuals in the township are assigned to this constructed aggregate school district. The main motivation for assuming individuals may attend any school in their township is that independent districts often contain the only high school within a township. Under the strict division of children by whether they live within the boundaries of the independent district or not, the possibility of an individual living outside of the main town attending the town's high school is not allowed, giving an underestimate of the education an individual has access to. Enrollment levels in these independent districts often exceed the enumeration of school-aged children within the district, confirming that out-of-district students are attending the schools. Incorporating the county superintendent data adds information on the availability of schooling types, local education expenditures, school district taxes, tuition levels, costs of books, teacher quality and curriculum to the father-son pairs. This intergenerational dataset, with its detailed income, education and school district data, will serve as the foundation of our empirical investigation of schooling and mobility.

The data present several options for measuring intergenerational mobility. With the occupations of sons and fathers observed, one plausible measure of mobility would be occupational transitions. However, occupational mobility can be difficult to translate into changes in welfare due to extensive variation in incomes within occupational categories. The household locations in 1900 and 1915 allow for measures of geographical mobility. While geographical mobility may be useful in explaining how occupational and income transitions are achieved, taken by itself it too suffers from a lack of clear welfare implications. The most attractive measure of mobility utilizes the unique intergenerational income data in the sample. With these data, intergenerational income elasticities, the intergenerational mobility measure most commonly used in modern studies, can be estimated.[16] Income is an appealing variable as its scale is understood and changes in income have a clear normative interpretation.

Given ideal data, one would obtain the intergenerational income elasticity by simply regressing son's permanent log income on father's permanent log income, with the coefficient on father's permanent log income being the intergenerational income elasticity. A larger value for this elasticity indicates less income mobility. While this sounds relatively straightforward, in practice the proper estimation of the intergenerational income elasticity is quite difficult.

[16] The intergenerational income elasticity is only one of many income mobility measures. Several alternative mobility measures are presented later in the paper.

The trouble stems from having only annual income as a proxy for permanent income. Annual income varies from year to year because of both random, transitory shocks and systematic changes in income over the life cycle. Both of these sources of variation make any single observation of annual income a poor proxy of average annual income over the lifetime of the individual. The measurement error introduced by using annual income in a specific year as a proxy for permanent income will bias estimates of the intergenerational income elasticity downward and overstate the degree of intergenerational mobility observed.

The contribution of age-specific changes in income can be controlled for through the inclusion of polynomials in sons' and fathers' ages when regressing son's log income on father's log income, capturing the concave shape of the typical life cycle earnings profile. Controlling for age in this manner is particularly important given that fathers and sons are observed at very different stages in the life cycle. Due to differences in earnings over the life cycle, the observed incomes for fathers will tend to be greater than their average annual income over the life cycle while observed incomes for sons will tend to to be lower than their average over the life cycle. Allowing the coefficients on the sons' age terms to differ from those of the fathers will allow for the shape of the lifetime earnings profile of the fathers' cohort to differ from that of the sons' cohort.

A second problem with systematic earnings differences over the life cycle pertains to differences in the shape of the lifetime earnings profile for low and high income individuals. The steeper earnings trajectory early in life of high lifetime earnings individuals relative to low lifetime earnings individuals leads to different estimates of intergenerational income elasticity depending on the age at which individuals are observed.[17] The steeper trajectory of the earnings profile for high income individuals results in annual income being closer to the cohort's mean early in the life cycle and diverging from the mean later in life. As a result, measures of intergenerational income elasticity using young adults tend to underestimate the true elasticity while measurements relying on older individuals will provide an overestimate. To control for the divergence of earnings over the life cycle, I follow the approach of Gary Solon and Chul-In Lee and interact son's age with father's income, allowing the intergenerational income

[17] See Grawe, "Lifecycle Bias" and Haider and Solon, "Life-cycle Variation."

elasticity to vary with son's age.[18] Incorporating these age controls and interaction terms, the equation used to estimate the intergenerational income elasticity is given by

$$\begin{aligned} \ln y_{i,s} &= \gamma_0 + \gamma_1 \ln y_{i,f} + \gamma_2 A_{i,s} \ln y_{i,f} + \gamma_3 A_{i,s}^2 \ln y_{i,f} + \\ &\quad \gamma_4 A_{i,f} + \gamma_5 A_{i,f}^2 + \gamma_6 A_{i,s} + \gamma_7 A_{i,s}^2 + u_i. \end{aligned} \tag{1}$$

where $y_{i,s}$ and $y_{i,f}$ are the son's and father's respective annual incomes and $A_{i,s}$ and $A_{i,f}$ are the son's and father's respective ages. By defining $A_{i,s}$ to be son's age at the time of the income observation minus 30, γ_1 can be interpreted as the intergenerational income elasticity for an individual at the age of 30, a measure comparable to the elasticities estimated in modern studies.

The transitory fluctuations in income present a less tractable problem. The standard approach to minimizing the bias introduced by these fluctuations is to average several observations of log annual income, a luxury not afforded by the Iowa data. With only the 1915 Iowa census reporting earnings, we are limited to a single observation of annual income. This inability to average over several periods makes the measurement error more severe and the downward bias on the intergenerational income elasticity estimate greater than in modern studies. While we cannot correct for this bias, we will provide modern intergenerational income elasticities measured both using single income observations and income averaged over several periods to provide a sense of the size of the bias.[19]

5 Intergenerational Income Mobility at the Turn of the Century

Table 2 presents the intergenerational income elasticity estimates using the 1915 Iowa father-son pairs. Columns 1 and 2 give income elasticity estimates for Iowa in 1915 using both annual

[18] Solon and Lee, "Trends."

[19] While the bias resulting from using a single observation of income as a measure of average lifetime income is of greatest concern, there is another measurement error issue that should be mentioned. There is a possibility that, through the linking procedure, some father-son pairs are incorrectly matched in the Iowa data. Such mismatches produce a mean-reverting measurement error for both the father's income and father's age variables in the Iowa sample that is not an issue for modern mobility studies using panel data. For a fuller discussion of this problem and a check of the robustness of the results to different rates of mismatched data, see the appendix.

earnings and monthly earnings, defined as annual earnings divided by months employed. While annual earnings provide a better measure of overall welfare, the average monthly earnings may offer a clearer picture of the differences in the wage rates of fathers and sons. Both earnings measures produce similar estimates of the intergenerational income elasticity, suggesting that a ten percent increase in father's earnings leads to a roughly one percent increase in predicted earnings for a son of age thirty.

To put the magnitude of these estimates in context, it is instructive to consider similar estimates from modern studies. Studies by Tom Hertz and Solon and Lee have estimated intergenerational income elasticities for the modern United States in the range of .3 to .5, substantially larger than the values for the Iowa sample.[20] Even when using a single observation of income, and therefore producing an attenuation bias similar to the bias affecting our results, Solon gets estimates of the modern intergenerational income elasticity ranging between .29 and .41, still substantially larger than our estimates.[21][22]

While the intergenerational income elasticity for Iowa in 1915 is quite small by modern standards, there is a question of whether it truly signifies in high rates of intergenerational mobility for early twentieth century America or whether it is instead a product of the sample composition of the Iowa dataset. With a large proportion of the Iowa sample made up of farmers, concerns of variability in annual income arise. As a group, farmers have a wide range of annual incomes in the 1915 Iowa census, with farmers representing many of the poorest and richest individuals in the sample. This variability likely extends beyond differences across individuals to differences over time for any given individual, with farm output and crop prices fluctuating year to year. All of this variation decreases the precision of annual earnings as a proxy for lifetime earnings, leading to lower intergenerational income elasticity estimates. Given that farmers represent such a large fraction of the Iowa sample, one must be concerned that the low income elasticities for Iowa are a direct result of variability in farmers' incomes, not a true indicator of greater mobility.

[20] See Solon, "Intergenerational Income Mobility," Solon and Lee, "Trends," and Hertz, "Trends."

[21] Solon, "Intergenerational Income Mobility."

[22] These various studies of modern income mobility use different ranges of ages and have models that differ in a variety of ways. In the appendix, we provide estimates using data from the 2001 Panel Study of Income Dynamics (PSID) that match the exact methodology used on the Iowa data. The results from these regressions are consistent with those of the other modern studies, producing intergenerational income elasticities ranging from .29 to .33.

To assess whether the results are being driven by having a large number of farmers in the sample, we estimate the elasticities for the Iowa sample excluding farmers. The results, provided in columns 3 and 4 of Table 2, reveal that while the farming fathers and sons did depress the intergenerational income elasticity estimates, the intergenerational income elasticity for non-farmers in 1915 was still well below that of modern individuals, strengthening the conclusion that there was a substantial degree of income mobility in early-twentieth-century America.

A lingering sample composition concern regards migration out of state, a potentially significant issue considering the high levels of geographical mobility at the time.[23] Constructing the intergenerational sample requires that all sons reside in Iowa in 1915. Those sons that move out of the state are never included in the dataset, making the regression sample overrepresentative of stationary individuals. It is quite reasonable to assume that more geographically mobile individuals may exhibit different income mobility patterns than less geographically mobile individuals. Failing to include individuals that move out of Iowa will bias the intergenerational income elasticity estimates in an unknown direction. Table 3 offers some insight into the extent of this problem by comparing the characteristics of those sons in the sample who were stationary between 1900 and 1915 and those who moved across long distances. The descriptive statistics in Table 3 reveal that individuals who move long distances within Iowa are indeed different from stationary individuals, having higher incomes, lower unemployment and more years of education on average. These differences in observable characteristics suggest that including sons who move out of state, if possible, would lead to different intergenerational income elasticity estimates.

Beyond these measurement and sample selection issues, there is a more fundamental concern that the intergenerational income elasticity, even if estimated properly and precisely, can offer only a limited view of mobility. The intergenerational income elasticity provides a convenient measure of mobility; its estimation is straightforward, its prevalence in the intergenerational mobility literature allows direct comparisons to published mobility rates for other

[23]Based on a sample of 1,719 individuals Iowa males in the same age range as those in our dataset matched from the 1900 federal census to the 1920 federal census, over 40 percent of the individuals moved out of the state of Iowa. More discussion of this sample and its implications for geographical mobility is provided in the section on school characteristics and mobility.

countries and it offers a convenient way to analyze the effects of continuous measures of school quality on mobility (a task carried out in the next section). However, it is by no means a perfect mobility measure. In particular, it only captures the relationship between a father's income and the expected value of his son's income; the intergenerational income elasticity cannot distinguish between an economy in which the variance in sons' incomes conditional on the income of their fathers is large and an economy in which that variance is small as long as the expected values of the son's income are the same.

An alternative class of mobility measures that can be applied to the Iowa data look at movement between different quantiles of the income distribution. These measures assess how closely correlated a son's position in the income distribution is to that of his father but fail to capture absolute gains or losses in income common to all sons or the widening or narrowing of the income distribution. Several of these measures based on transitions between income quintiles are summarized in Table 4. Equivalent measures calculated using the PSID are provided as modern benchmarks. Goodman and Kruskal's gamma and Kendall's tau-b are both measures of the surplus of discordant pairs over concordant pairs in the income transition matrix.[24] These measures approach zero under perfect mobility and one in the case of perfect immobility. The average difference in quintiles measure indicates not only how likely it is for a son to move to a different quintile but also how far in the income distribution the son moves. The final set of mobility measures are simply the percentage of sons persisting in their fathers' income quintile.

All of these alternative measures of mobility reinforce the findings from the intergenerational income elasticity estimates: income mobility was substantially higher in Iowa in 1915 than it is today. Sons were more likely to occupy a different position in the income distribution than their fathers and distances moved across the distribution were greater at the turn of the century than in modern times. These results coupled with the intergenerational income elasticity estimates demonstrate clearly that there was substantial income mobility in America at the start of the twentieth century.

[24] In the context of intergenerational mobility a pair of father-son income quantile observations (q_f^1, q_s^1) and (q_f^2, q_s^2) would be concordant if q_f^1 is greater than q_f^2 and q_s^1 is greater than q_s^2 and discordant if q_f^1 is greater than q_f^2 but q_s^1 is less than q_s^2.

6 School Access, School Quality and Mobility

The Iowa data confirm that a major decline in income mobility occurred over the twentieth century. The question that remains is whether the data can provide any evidence that the rise of the modern public education system could have played a part in this decline. To answer this question, I turn from intertemporal comparisons to an examination of differences in mobility rates across locations in Iowa at the turn of the century.

Heterogeneity in school types and quality across Iowa school districts at the height of the transformation to modern public schools provides a unique opportunity to directly study the relationship between educational institutions and mobility. In particular, the inclusion of a measure of school quality interacted with father's log income in equation (1) offers a means of assessing whether the evolution of the public school system was altering mobility patterns in Iowa by testing whether intergenerational income elasticities varied across school districts of differing quality.

The inclusion of school quality transforms the regression equation into

$$\begin{aligned} \ln y_{i,s} &= \gamma_0 + \gamma_1 \ln y_{i,f} + \gamma_2 A_{i,s} \ln y_{i,f} + \gamma_3 A_{i,s}^2 \ln y_{i,f} + \\ &\quad \gamma_4 A_{i,f} + \gamma_5 A_{i,f}^2 + \gamma_6 A_{i,s} + \gamma_7 A_{i,s}^2 + \gamma_8 S_i + \gamma_9 S_i \ln y_{i,f} + u_i \end{aligned} \quad (2)$$

where S_i is a measure of the school quality in the school district of father-son pair i in 1900. The term containing only S_i allows the income distribution of the sons to shift with a change in school quality. The coefficient γ_9 represents the marginal change in the intergenerational income elasticity resulting from an increase in school quality. A positive value for γ_9 would indicate that an increase in school quality is associated with an increase in the intergenerational income elasticity, implying a decline in income mobility.

A crucial assumption underlying this approach is that location choices, both in terms of where families locate and where schools are built, are exogenous.[25] If families relocate based

[25]An additional assumption being made is that the 1900 school district data are a good proxy for the educational resources over the son's entire career. This will not be the case if families moved across districts during the son's school years or if the school district characteristics were changing significantly from year to year. Both of these possibilities make 1900 school district quality a noisy measure of school district quality over the son's entire educational career. While this creates problems for interpreting the magnitudes of estimated coefficients as they will tend to be biased toward zero, it does not affect the interpretation of the sign of the coefficients which is what is of central interest in this paper.

on school quality or if school location is a product of variation in communities' tastes for public education, the school quality variable will be correlated with preferences for education, home environment and other unobserved characteristics relevant to a son's earnings. Ruling out the endogeneity of location decisions is quite difficult. Looking at the distribution of earnings within districts conditioning on school access and quality, presented in Table 5, there is no discernible relationship between the location and quality of schools and the location of wealthy families; there is no trend in either the mean or the shape of the earnings distribution as school access and quality rise. The similarity of the earnings distributions across school districts of different qualities and access suggests that schools were not being built with a higher frequency in wealthier districts and that there was no net migration of wealthy families, those most capable of moving, toward better school districts. While these earnings distributions help alleviate worries of correlations between school location and the financial resources of parents, they cannot dismiss concerns of families sorting themselves among school districts according to preferences for education in a manner uncorrelated with income.[26]

An additional concern about geographical mobility is that individuals raised in good school districts may be either more likely or less likely to move out of their districts after completing their education, raising the possibility that the probability of an individual dropping out of the intergenerational sample could be correlated with school district characteristics. To determine whether this is a major problem, I construct a sample of individuals in the same birth cohort as the sons in the intergenerational sample living in the sample counties in 1900 matched to their location in 1920 using the federal census.[27] This allows me to estimate the percentage of individuals who have actually moved out of Iowa (as opposed to simply not

[26]This issue of the potential endogeneity of school locations highlights one of the key advantages of using historical data. Modern school districts are the product of decades of change including gradual infrastructure development or decay, geographical mobility patterns of high and low income households, and constraints arising from a complex mix of local, state and federal funding and the various restrictions and incentives that go along with those funding sources. The Iowa school districts at the turn of the century are not firmly entrenched as institutions. By observing these schools in their infancy, we have an opportunity to observe the effects of schools before the community and those schools coevolve, creating a host of endogeneity problems related to correlations between wealthy residents, active parents and good schools. This approach of comparing mobility rates across school districts of varying quality would be impossible using modern data but is made feasible by the speed with which the public school system expanded in all areas of Iowa at the turn of the century.

[27]This sample was created using the following procedure. For each county in the intergenerational sample, I began with the original 1900 census manuscripts. The information for first male of the appropriate age on each page of the manuscripts was transcribed, producing a sample of 1719 males. These individuals were then searched for in the 1920 federal census, with 510 of them being found. The individuals were then matched to the 1900 school district records based on the township they lived in according to the 1900 census records.

being found in the Iowa census records) conditional on childhood school district characteristics. Table 6 gives the correlations between the percentage of individuals that were found in 1920, the percentage found in 1920 outside of a sample county and the percentage found outside of Iowa and measures of school district access and quality. The results in the table make it clear that the probability of moving out of the sample counties (and therefore dropping out of the intergenerational sample) is only very weakly correlated with the school district characteristics. These results downplay concerns that differences in the geographical mobility and consequently the sample composition of individuals from good and bad school districts are driving the income mobility results presented in this section.

At this point, it is necessary to be more specficic about what is meant by school quality or access. The detail of the county superintendent records allows for a variety of school district measures. Two main categories of measures will be used, measures of geographical access to schools of various types and measures of the quality of education provided at those schools. Variables constructed in the first category include an indicator variable for the presence of graded schools in a district, the number of classrooms per square mile and the number of graded classrooms per square mile. Measures of the quality of available schooling include taxes per student, total expenditures per student, students per classroom, the student-teacher ratio and the amount of subsidy per student, defined as the difference between annual spending per student and annual tuition charged to an out-of-district student. Summary statistics of these measures are given in Table 7.

The summary statistics reveal stark although not entirely unexpected differences between rural and urban school districts. As one would predict, urban areas have on average far more classrooms per square mile. Spending and taxes are only slightly higher for urban school districts but the subsidy per student is much larger, indicating a greater reliance on taxes rather than tuition as a source of school funding in the more urban areas. While the student-teacher ratio is much higher for urban districts, the low student-teacher ratio in rural districts is a result of common schools with small numbers of students and not the indicator of higher quality instruction that low ratios are assumed to be in modern times.

For the purposes of estimating equation (2), the sample is divided into one subsample of urban individuals and one subsample of rural individuals with separate estimations run for each sample. The motivation for estimating the intergenerational income elasticity separately for urban and rural individuals is not the differences in the means of the schooling variables discussed above; the variances of the measures are sufficiently large that the effect of school quality could be identified separately from differences in mobility purely due to a district being urban or rural. The need for separate estimations is driven instead by differences in the interpretation of the schooling variables between urban and rural areas. In particular, the density of graded classrooms as a measure of geographical access to schools changes its meaning once the number of schools becomes sufficiently large. Observed differences in the number of graded schools across rural districts correspond to large differences in physical access to education. Differences across urban districts are indicating not whether a child has access to a school but instead how many schools students are divided between in a district. Separate regressions for rural and urban individuals allow for clearer interpretation of these schooling measures.

Table 13 and Table 14 of the appendix provide the intergenerational income elasticity regression results for the various school measures for urban and rural school districts, respectively. The estimated coefficients for the schooling measure-father's log income interaction term for both urban and rural school districts are summarized in Table 8. Of the access measures that are statistically significant for rural school districts, all have signs consistent with improvements in school access reducing mobility. The positive coefficients on both the density of all classrooms and density of graded classrooms in a district suggest that improving geographical access to schools increased the intergenerational income elasticity, reducing mobility. The magnitude of this effect is substantial: introducing an additional graded school and high school to a typical rural school district (an addition of twelve graded classrooms to an area of thirty-six square miles) is associated with an increase in the intergenerational income elasticity of nine percentage points.

While physical access proves to be quite important in rural districts, the results suggest that the quality within schools did not appreciably affect mobility. Both spending per student and taxes per student have a positive effect on the intergenerational income elasticity but neither effect is statistically significant. The effect of the student-teacher ratio is significant but, as discussed earlier, difficult to interpret for rural school districts. Many of the lowest student-teacher ratios are for districts with small common schools and consequently may correspond to lower school quality than the higher ratios of districts with large high schools. The subsidy per student, a measure of just how public or egalitarian a district is, is significant and has a positive sign consistent with the expansion of public education reducing mobility.

The urban estimates offer mixed results. Spending per student and taxes per student have large, positive coefficients suggesting that increases in urban school district quality reduced mobility although the coefficient for spending per student, arguably the best available proxy for school quality, is statistically insignificant. Declines in the student-teacher ratio, perhaps an indicator of improvements in quality of instruction in urban districts, led to increases in mobility. The classroom density coefficients have the opposite sign from rural districts but all of the urban districts had a sufficiently large number of graded classrooms that these variables can no longer be considered indicators of meaningful differences in geographical access to schools. Instead they are far more complicated measures, capturing information on the extent to which children are sorted between multiple schools.

The results suggest that during the initial introduction of modern public schools, captured by the experience of the rural individuals in our sample, intergenerational mobility declined as both school access and quality improved. While the effects of school quality on mobility are small and mainly lacking in statistical significance, the estimated effect of geographical access on intergenerational income elasticities is substantial. The introduction of additional grammar schools and high schools in Iowa districts, one of the key features of the high school movement, dramatically decreased intergenerational income mobility.

These intergenerational income elasticities provide a convenient way to summarize and compare the overall level of mobility across school districts of varying quality. However, they do not provide a detailed picture of which individuals are moving up or down in the income distribution. Complementing these intergenerational income elasticity results with an analysis of persistence in or movement to various income quantiles provides a richer account of the variation in income mobility rates across school districts and offer insight into how mobility was achieved. Table 9 presents the percentage of rural sons persisting in their fathers' income quintile. The first column, corresponding to all rural individuals in the father-son sample, bolsters the observation of high mobility in early-twentieth-century Iowa; the percentage of sons remaining in their fathers' income quintile is similar to the percentage that would result from randomly assigning incomes to sons. This picture of extensive mobility begins to change once school district characteristics are considered. When looking separately at those father-son pairs from districts in the top half of the school access distribution and those from districts in the bottom half of the school access distribution, columns (2) and (3) respectively, evidence of declining mobility with rising school access once again appears.[28] In particular, sons from districts with good school access display a great deal more persistence in both the lower and upper tails of the income distribution, with the sons in high access districts of fathers in the bottom or top income quintile much more likely to stay in those respective quintiles than their low school access counterparts.

These noticeable differences in persistence in the upper and lower tails of the income distribution warrant further exploration. Using the occupational, geographical and educational data contained in the father-son dataset, the individual characteristics that affect the likelihood of movement or persistence in the income distribution can be identified. Following the approach of Richard Steckel and Jayanthi Krishnan, I estimate logit regressions for individuals persisting in or moving into both the bottom and top quintiles of the income distribution.[29] The dependent variable for the persistence regressions is an indicator variable taking on a value of one for all observations where both the son and father were in the bottom (or top) income quintile and zero for observations where the father was in the bottom (or top) quintile and the son was in a different quintile. The dependent variable for the movement into the bottom or top quintile regressions takes on a value of one when a father was not in the bottom (or top) quintile but the son was and a value of zero when both the father and son were not in the bottom (or top) quintile. The independent variables include son's education, son's age, dummy variables for whether the son moved across counties or to a city, and a set of dummies specifying the occupational categories (white collar/service, agricultural, blue collar) for both father and son. The estimated coefficients for these variables quantify the relative importance of education, geographical mobility and occupational mobility in achieving income mobility.

[28]School access is defined as the number of graded classrooms per square mile. Top or bottom half is determined by whether a school district was above or below the median of the rural school access distribution. Most rural districts in the top half are still well below the median graded school density of urban school districts.

[29]Steckel and Krishnan, "Wealth."

The most prominent result from the logit regressions, presented in Table 10, is the importance of educational attainment in moving up in the income distribution. An additional year of high school both substantially reduced the likelihood of remaining in the bottom quintile and increased the likelihood of moving into and staying in the top quintile. Occupational transitions were also highly correlated with persistence and movement in the income distribution. Unsurprisingly, remaining in or moving into a white collar occupation significantly increased the likelihood of moving into or staying in the top income quintile as well as staying out of the bottom quintile. Somewhat surprisingly, geographical mobility is not significantly correlated with income mobility. Neither moving to a city nor moving across counties significantly affected movement into or persistence in the tails of the income distribution.[30]

7 School Expansion and Educational Attainment Decisions

The income elasticity regressions demonstrate that access to schools had a significant impact on mobility rates, suggesting that the evolution of public schools affected wealthy families to a different extent than it affected poor families. The analysis of persistence and mobility within the income distribution suggests that these differences in mobility stem from differences across districts in the distribution of educational attainment and the way in which that education translated into occupations and earnings. These findings imply that the differential impact of public school expansion on wealthy and poor families was a result of some combination of differences in the returns to education and in levels of educational attainment for wealthy and poor families. Wage regressions conditioning on parental income, the results of which are provided in Table 15 and Table 16 of the appendix, reveal that the high returns to education found by Goldin and Katz are insensitive to parental income.[31] An additional year of schooling offered the same increase in earnings regardless of family background. This leaves differences in educational attainment decisions as the primary explanation of the observed decline in

[30]This finding that there is no strong relationship between geographical mobility to income mobility comes with a sense of relief; it helps minimize the concerns raised earlier that failure to observe people who migrate out of state may bias mobility estimates.

[31]Goldin and Katz, "Education" and Goldin and Katz, *Race*.

mobility.

To identify differences in the responses of educational investments of wealthy and poor families to increasing school access and quality, I estimate an ordered probit model with years of schooling as the dependent variable. Years of schooling are assumed to be a function of parental income, local school quality measured as spending per student, local school access measured as the number of graded classrooms per square mile, school tuition costs and whether the family lives in an urban or rural area. Including interactions between parental income and the school access and quality variables allows the response to a change in local schools to vary across the income distribution. Positive coefficients on these interaction terms would indicate that wealthy families' schooling investments were more elastic with respect to school access and quality than poor families', offering an explanation for the lower mobility levels in communities with better schools.

A concern with this approach is how much freedom families had to choose schooling levels. If compulsory schooling and child labor laws were binding constraints, educational attainment could be entirely unresponsive to changes in school quality and access. Iowa introduced compulsory schooling with the Compulsory School Act of 1902 and passed its first child labor legislation in 1906. These laws were passed in the middle of the educational careers of the sons in the sample and consequently present a major concern. The combined effect of these laws was that a child was required to have at least 8 years of schooling. The distribution of educational attainment in our sample suggests that these laws were enforced; roughly thirty-five percent of sons in the sample had exactly the minimum eight years of educational attainment. While the timing of the laws is such that the older sons in the sample should have been unaffected, the distribution of educational attainment for the complete sample and for just those sons who were born in 1895 (and therefore fully constrained by the laws) are nearly identical, with 34.5 percent of all sons receiving the minimum eight years of education compared to 35.2 percent of sons born in 1895. Given these compulsory schooling laws, two different measures of educational attainment are used as dependent variables. The first is years of schooling of any type beyond the minimum eight years and the second is years of high school. Years of high school are chosen both because they were fairly unconstrained by compulsory schooling laws and because the returns to an additional year of high school were significantly higher than the returns to an additional year of common or grammar school, making changes in high school more significant in terms of economic welfare than changes in total schooling.

Coefficients for the probit estimates are given in Table 11. The result that stands out the most is the significant effect of school access on educational attainment. Increases the number of graded schools increases educational attainment, and in particular high school attainment.[32] However, the effect is much larger for families with higher parental income. To get a sense of just how much larger, we can use the probit results to predict the change in expected high school attainment for a both a poor son and a wealthy son when varying school access. The expected level of high school attainment from the probit results is just over fifty percent greater, .77 years compared to .50 years, for a son with a father in the ninetieth percentile of the rural income distribution than for a son with a father in the tenth percentile of the rural income distribution when they live in a district with no graded schools. Adding the equivalent of a grammar school and high school to the district (twelve graded classrooms to a thirty-six square mile area) increases the rich son's high school attainment by a quarter of a year while barely changing the poor son's attainment. The high school attainment for the rich son in the high school access district is over twice as large as that of the poor son. Improvements in school access, while increasing educational attainments across the income distribution, were leading to greater increases for children from the wealthy families. Given the high returns to education at the time, roughly a ten percent increase in annual earnings for each additional year of high school, these disparities in high school attainment translate into large disparities in future income.[33]

School quality has a very different effect on educational attainment. Like school access, increases in school quality lead to increases in high school attainment. However, the interaction terms between father's earnings and school quality are insignificant, suggesting that

[32] While the coefficient on graded classrooms per square mile is negative, the contribution of the school access-father's log earnings interaction term is sufficiently large than an increase in school access increases educational attainments across nearly all values of father's log earnings in our sample.

[33] The impact may be even greater than returns to high school estimates suggest. The predicted probability of attaining a full four years of high school rose nearly five percentage points for wealthy sons while the probability of completing high remained virtually unchanged for poor sons when moving them from a low access district to a high access district. To the extent that part of the returns to attending high school came through credentialing, the importance of which is established by David Labaree's work on Philadelphia high schools from the same period, the increasing probability of high school completion could provide even greater future returns for wealthy children (Labaree, *Making of an American High School*).

the magnitudes of the increases in educational attainment resulting from an increase in school quality are fairly constant across the income distribution.

Improvements in school quality benefited all sons equally while differential responses to improvements in access led to greater gains in educational attainment for sons from wealthier backgrounds.[34] As the logit results revealed, the increases in educational attainment for those from the top of the income distribution relative to the those from the bottom translate into greater persistence in the tails of the income distribution. This is consistent with the mobility results for rural school districts in which differences in school quality did not appreciably affect intergenerational mobility but improvements in school access significantly lowered mobility rates.

8 Conclusion

The Iowa data demonstrate that there was a substantial decline in American income mobility over the twentieth century concurrent with the rise of modern public education. While the expansion of public education benefited people across the income distribution, increasing average educational attainment and wages, the magnitudes of those benefits varied. A greater propensity to take advantage of high school education, whether a product of fewer financial constraints, stronger preferences for education or other factors, led to wealthy families benefiting disproportionately from improvements to public education. At the individual level, these effects were evidenced by large increases in high school attainment for wealthy individuals relative to poor individuals. At the community level, these differences in educational investments translated into decreased mobility and in particular increased persistence in the tails of the income distribution in those townships with more developed public schools.

While this relationship between public school expansion and declining intergenerational mobility can appear disheartening, it must not be viewed as a broad indictment of the public education system. Public education did lead to absolute gains in educational attainment and earnings throughout the income distribution, even if the magnitudes of those gains were

[34] A simple model of educational investment producing these results is provided in the appendix. Additional discussions of situations that can give rise to these patterns of decreasing mobility with improvements in educational institutions can be found in Goldberger, "Economic and Mechanical Models," Grawe, "Primary and Secondary School," and Grawe, "Education."

skewed in favor of wealthy families. Further, the potential benefits of education were equal across the income distribution ex ante; the returns to educational investment were equally high for individuals from poor backgrounds and individuals from wealthy backgrounds. The benefits of the newly created public schools only proved to be unequal as a result of differences in educational investment decisions on the part of the family. The prospects of a son from a poor family were limited not necessarily by the structure of the educational system but by the preferences and financial constraints of his family.

These observations suggest that the emerging public education system, while associated with declining mobility, may still have been the best option available for expanding schools at a time when education was becoming increasingly important in labor markets. If one takes the increasing demand for education by workers and employers as an inevitable product of the growing economy, the proper focus is not whether the introduction of public grammar and high schools decreased mobility, but whether it did so to a greater or lesser extent than the school system that would have arisen in its place. Private schools, particularly religious academies, were spread throughout Iowa at the end of the nineteenth century and could have expanded to serve the increasing demand for education. The public school system observed in Iowa at the turn of the century, with its public subsidization of education, concern for both urban and rural areas, and responsiveness to community preferences and needs through local political institutions, had fewer geographical access and financial constraints than any private system would have. The features of the school system that led to reduced mobility would be a part of any school system that developed and were minimized by a public system.

The extent to which the observed mobility patterns translated into permanent changes in class rigidities is a matter requiring further study. If they were the result of wealthy families adjusting more quickly to changes in educational institutions, it is possible that the effects have dissipated over time. However, if they were instead the result of more fundamental differences in the educational investment decisions of and constraints faced by wealthy and poor families, the effects on mobility may persist over time and would likely have a modern day analogue in college attendance decisions. While questions remain about the lasting effects of public school expansion on American intergenerational mobility and class rigidities, these results do show that at the time of public school expansion, improvements in school access and quality, while promoting absolute gains in educational attainment and income across the income distribution, were contributing to declines in relative mobility and should not be overlooked when considering explanations of the long term decline in American mobility.

References

Becker, Gary. *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education.* Chicago: University of Chicago Press, 1983, second edition.

Becker, Gary, and Nigel Tomes. "Human Capital and the Rise and Fall of Families." *Journal of Labor Economics* 4, 3: (1986) 1–39.

Blanden, Jo, Alissa Goodman, Paul Gregg, and Stephen Machin. "Changes in Intergenerational Mobility in Britain." In *Generational income mobility*, edited by Miles Corak, Cambridge University Press, 2004, 122–146.

Blanden, Jo, and Stephen Machin. "Educational Inequality and the Expansion of UK Higher Education." *Scottish Journal of Political Economy* 51, 2: (2004) 230–249.

Ferrie, Joseph. "History Lessons: The End of American Exceptionalism? Mobility in the United States Since 1850." *Journal of Economic Perspectives* 19, 3: (2005) 199–215.

Goldberger, Arthur. "Economic and Mechanical Models of Intergenerational Transmission." *The American Economic Review* 79, 3: (1989) 504–513.

Goldin, Claudia. "America's Graduation from High School: The Evolution and Spread of Secondary Schooling in the Twentieth Century." *Journal of Economic History* 58, 2: (1998) 345–374.

Goldin, Claudia, and Lawrence Katz. "Education and Income in the Early 20th century: Evidence from the Prairies." *Journal of Economic History* 60, 3: (2000) 782–818.

———. *The Race Between Education and Technology.* Cambridge: Harvard University Press, 2008.

Grawe, Nathan. "Primary and Secondary School Class Size and Intergenerational Earnings Mobility." *Carleton College Department of Economics Working Paper* No. 2007-03 (2007) 1-32.

———. "Education and Economic Mobility." *Pew-funded Economic Mobility Project, The Urban Institute* (2008) 1-34.

Grawe, N.D. "Lifecycle Bias in Estimates of Intergenerational Earnings Persistence." *Labour Economics* 13, 5: (2006) 551–570.

Haider, Steven, and Gary Solon. "Life-cycle Variation in the Association Between Current and Lifetime Earnings." *American Economic Review* 96, 4: (2006) 1308–1320.

Hertz, Tom. "Trends in the Intergenerational Elasticity of Family Income in the United States." *Industrial Relations: A Journal of Economy and Society* 46, 1: (2007) 22–50.

Iowa Department of Public Instruction. *Annual Reports of the Superintendent of Public Instruction*. Des Moines, IA: State of Iowa, 1900a. Microfilm at Iowa State Historical Archives, Iowa City, IA.

———. *Iowa Education Directory*. Des Moines, IA: State of Iowa, 1900b.

———. *Iowa Schools Report, 1880-1920*. Des Moines, IA: State of Iowa, 1920.

Kapteyn, Arie, and Jelmer Ypma. "Measurement Error and Misclassification: A Comparison of Survey and Administrative Data." *Journal of Labor Economics* 25, 3: (2007) 513–551.

Kim, Bonggeun, and Gary Solon. "Implications of Mean-Reverting Measurement Error for Longitudinal Studies of Wages and Employment." *Review of Economics and Statistics* 87, 1: (2005) 193–196.

Labaree, David. *The Making of an American High School: The Credentials Market and the Central High School of Philadelphia, 1838-1939*. New Haven: Yale University Press, 1988.

Lleras-Muney, Adriana. "Were Compulsory Attendance and Child Labor Laws Effective? An Analysis from 1915 to 1939." *Journal of Law and Economics* 45, 2: (2002) 401–435.

Moehling, Carolyn. "State Child Labor Laws and the Decline of Child Labor." *Explorations in Economic History* 36, 1: (1999) 72–106.

Smisher, Jacob. "A Century of School Legislation in Iowa." *Iowa Journal of History* 64: (1946) 174–205.

Solon, Gary. "Intergenerational Income Mobility in the United States." *The American Economic Review* 82, 3: (1992) 393–408.

———. "Cross-country Differences in Intergenerational Earnings Mobility." *Journal of Economic Perspectives* 16, 3: (2002) 59–66.

———. "A Model of Intergenerational Mobility Variation over Time and Place." In *Generational income mobility in North America and Europe*, edited by Miles Corak, Cambridge University Press, 2004, 38–47.

Solon, Gary, and Chul-In Lee. "Trends in Intergenerational Income M." .

State of Iowa. "Census of Iowa for the Year 1915.", 1915. Microfilm at Newberry Library, Chicago, IL.

Steckel, Richard, and Jayanthi Krishnan. "The Wealth Mobility of Men and Women during the 1960s and 1970s." *Review of Income and Wealth* 52, 2: (2006) 189–212.

U.S. Bureau of the Census. "Index to the 1900 United States Federal Census." http://www.ancestry.com, subscription database, 2006a. Digital copy of original records in the National Archives, Washington, D.C.

———. "Twelfth Census of the United States, 1900, Population Schedule." Digital scans of original records in the National Archives, Washington, D.C., 2006b.

U.S. Dept. of Labor. "Child Labor Legislation in the United States." US Government Publishing office, 1915. Publication No. 10 by Sumner, Helen L. and Ella A. Merrit.

Appendix 1: Mismatches and Mobility Estimation

The process of linking the 1915 Iowa census and 1900 federal census presents the possibility that some father-son pairs are incorrectly matched. Relying on name, age and birthplace rather than a truly unique identifier makes the possibility of mismatches unavoidable. While every effort has been made to maintain strict criteria for matches, including discarding observations for which multiple individuals met the match criteria, the possibility of mismatches still looms. This section of the appendix offers a brief discussion of the estimation issues these mismatches create and an assessment of how common mismatches would have to be to account for the estimated difference in mobility rates between the 1915 Iowa and modern mobility estimates.

In its simplest incarnation, this mismatch error could be characterized as a son being paired with his correct father with probability π and incorrectly with a father drawn at random from the population with probability $1 - \pi$. The value of the father's income used in the intergenerational income elasticity regressions is then given by

$$y^*_{i,f} = \begin{cases} y_{i,f} + u_i, & \text{with probability } \pi \\ \tilde{y}, & \text{with probability } 1 - \pi \end{cases}$$

where $y_{i,f}$ is the father's true income, u_i is a classical measurement error term, and $\tilde{y}$ is a randomly drawn income corresponding to some other father in the population. The distribution from which $\tilde{y}$ is drawn can be assumed to be the income distribution of the entire population. Alternatively, and perhaps more realistically, the income could come from a distribution of father's income conditional on the son's age. If the son and father are correctly matched, the income observation of the father will be his true income with some classical measurement error u_i having mean zero and uncorrelated with the true income. The measurement error for the mismatched fathers will be equal to the difference between the randomly drawn income and his true income: $\tilde{y} - y_{i,f}$. Letting ϵ_i represent the measurement error for any given individual i in the sample and assuming that $E(\tilde{y})$ is equal to $E(y_{i,f})$, the measurement error for a sample containing some mismatched individuals can be characterized as follows,

$$\epsilon_i = \begin{cases} u_i, & \text{with probability } \pi \\ \tilde{y} - y_{i,f}, & \text{with probability } 1 - \pi, \end{cases}$$

$$E(\epsilon_i) = 0,$$

$$Cov(\epsilon_i, y_{i,f}) = -(1-\pi)Var(y_{i,f}).$$

This negative correlation between the measurement error and the true value of the father's income implies that the measurement error introduced by mismatching is mean-reverting.

The problem of mean-reverting measurement error is not uncommon in the labor literature, especially in studies using various measures of income. Bonggeun Kim and Gary Solon outline the dramatic effects that mean-reverting measurement error can have on the economic interpretation of wage data.[35] Arie Kapteyn and Jelmer Ypman specifically consider the case of mismatched administrative income data and show that in the simple case where the mismeasured income variable is the single independent variable in a linear regression and mismatches are drawn from the same population as the correctly matched individuals, the estimated coefficient on income is biased downwards by an amount proportional to the rate of mismatches.[36]

The bias introduced in the intergenerational income elasticity estimates by mismatched data is not easily characterized. The estimation equation includes both the mismatched variable and interactions of the mismatched variable with the correctly measured age of the son as regressors. Furthermore, the distribution from which a mismatch is drawn is dependent on the true value of the son's age. A final complication is that the likelihood of a son and father being mismatched may be correlated with characteristics of the son and father including age, income, location, literacy and so on that enter the income elasticity regressions either directly or through the error term. All of these factors make it difficult to assess how large a problem mismatches are for the Iowa data. Unlike the classical measurement error for the income variables discussed in the paper common to both the Iowa and modern data, this source of error is specific to the Iowa sample and consequently could lead to a bias that generates the observed difference in intergenerational income elasticities between the Iowa sample and modern data even if the true elasticities are the same.

While there is no way to confidently state the number of mismatches in the linked Iowa sample, it is possible to introduce mismatches in a sample of observations from the Panel Study of Income Dynamics (PSID) and determine the level of mismatches required to obtain

[35] Kim and Solon, "Implications."
[36] Kapteyn and Ypma, "Measurement."

similar elasticity estimates for both the Iowa and PSID data. To generate random mismatches in the PSID data, an appropriate number of father-son observations are chosen at random to be mismatched. The father's income and age information is discarded. A new age for the father is randomly drawn from the distribution of father ages conditional on the son's age. The father's income is then randomly drawn from the distribution of income conditional on the father's newly chosen age. The new sample of individuals is then used to estimate the intergenerational income elasticity. The original dataset is restored and then the entire process is repeated with new random number seeds.

Figure 1 depicts the results from simulating mismatches in the PSID sample. Mismatch rates of 2 percent to 100 percent are simulated, with 1,000 iterations of the mismatch and estimation procedure completed for each rate. The figure demonstrates that a mismatch rate approaching 50 percent would be required to account for the observed difference in 1915 and 2001 elasticities if the true elasticities are actually the same. Given that matches are identified by name, age, state of birth, father's state of birth and mother's state of birth, the rate of mismatch in the linked Iowa data is likely far lower than this 50 percent figure.

Appendix 2: A Simple Model of Educational Investment

A very simple and intuitive model of educational investment can capture the differential responses to improving schools identified in the Iowa data.[37] Consider a household consisting of one parent and one child. The parent derives utility from consumption in the current period t and the child's income as an adult in period $t+1$. The utility function of the parent is

$$U(c_t, y_{t+1}) = \alpha \ln c_t + (1-\alpha) \ln y_{t+1} \tag{3}$$

where c_t is household consumption in period t and y_{t+1} is the the child's income in period $t+1$.

The parent can increase the future income of the child by investing in education. Let the level of schooling received by the child in the first period be S_t. The future earnings of the child are given by

$$\ln y_{t+1} = \mu + \theta(q) S_t + \nu_{t+1} \tag{4}$$

where $\theta(q)$ is the return to schooling, a function of school quality q, and ν_{t+1} represents the individual specific determinants of income independent of human capital investment.

The problem of the parent is to choose the optimal level of schooling given the household budget constraint in period t,

$$c_t + \pi S_t = y_t + \tilde{y}_t(\overline{S} - S_t) \tag{5}$$

in which consumption and spending on schooling in period t is equal to the earnings of the parent in period t, y_t, plus the earnings of child during the time that he is not in school, $\tilde{y}_t(\overline{S} - S_t)$. The marginal cost of an additional year of school includes both the direct cost π of an additional unit of schooling as well as the foregone earnings of the child, $\tilde{y}_t$ per a unit of schooling. The effects of public school expansion enter the model through the price of schooling π and the school quality parameter q. The reductions in tuition costs would lead to

[37] The model presented here is a modified version of the model proposed by Gary Solon to explain cross-country differences in intergenerational income elasticities (Solon, "Model").

lower values of π. Increasing geographical access to schools also lowers π through decreasing travel costs.[38] Improving school quality increases q and consequently the return to schooling.

Given the above utility function and budget constraint, the optimal level of schooling for the child in period t is

$$S_t^* = \frac{1}{\tilde{y}_t + \pi} y_t + \frac{\tilde{y}_t \overline{S}}{\tilde{y}_t + \pi} - \frac{\alpha}{(1-\alpha)\theta(q)}. \tag{6}$$

Optimal schooling is increasing in parental income and decreasing in the cost of schooling π as one would expect. As school quality rises, increasing the marginal benefit of schooling, the optimal level of schooling rises but the magnitude of the increase is the same across all income levels. However, the effect of changes in the price of schooling do vary with parental income. The slope of schooling as a function of parental income is increasing as the price of schooling falls. As the price of schooling falls as a result of the expansion of public education, the increase in schooling for a child from a wealthy family will be larger than the increase in schooling for a child from a poor family. Incorporating the effects of compulsory schooling laws magnifies these differences between wealthy and poor families. Given a lower bound on educational attainment imposed by compulsory schooling laws, the poorest families will be completely unresponsive to changes in the price of schooling as long as the price is still sufficiently high to make the compulsory level of schooling binding.

While this is a very basic model of educational investment, it does match the responses of families to the main features of the public school expansion: improving school quality, declining costs of attending school and the relaxing of geographical access constraints. Even though the true educational investment decisions of parents are certainly a more complex process, this simple model demonstrates that the educational attainment responses and mobility patterns observed in the data can be easily explained as a rational response of parents who value both consumption and the welfare of their children to changes in the price, quality and availability of public schools.

[38] Decreasing travel costs could also be thought of as reducing the opportunity cost of attending school by decreasing the time given up in order to attend an additional unit of schooling. Because $\tilde{y}_t$ is assumed to be constant, incorporating the reduced travel costs in either π or $\tilde{y}_t$ will have the same effect on the marginal costs of schooling and lead to the same interpretation of the effects of public school expansion.

9 Tables

Table 1: Summary statistics for the father-son Iowa sample

Father's income observed	yes	no	no	All males aged 20 to 35 in Goldin-Katz sample
Father's education observed	yes	yes	no	
Father's occupation observed	yes	yes	yes	
	(1)	(2)	(3)	(4)
Son's annual earnings	651	827	822	765
(1915 dollars)	(488)	(690)	(565)	(586)
Father's annual earnings	1039	--	--	--
(1915 dollars)	(1054)	--	--	--
Son's months unemployed	1.02	0.84	0.82	0.91
	(2.19)	(1.99)	(1.95)	(2.05)
Father's months unemployed	0.73	--	--	--
	(1.92)	--	--	--
Son's age	25.3	29.5	27.4	27.3
	(5.4)	(6.6)	(4.3)	(4.4)
Father's age	57.0	64.6	61.2	--
	(7.4)	(8.6)	(9.1)	--
Son's years of education	9.07	9.27	9.27	8.55
	(2.51)	(2.84)	(2.71)	(3.00)
Father's years of education	7.88	7.69	--	--
	(2.64)	(2.49)	--	--
Number of observations	1094	388	2006	6392

Notes : All values are means for the year 1915. Standard deviations are given in parentheses. An observation is considered one father-son pair.
Sources : Data are from the 1915 Iowa state census. Father and sons are matched using the 1900 federal census.

Table 2: Intergenerational income elasticity estimates for the Iowa sample, son's log earnings as dependent variable

Sample:	All father-son pairs		Excluding farmers	
Earnings Measure	Annual earnings	Monthly earnings	Annual earnings	Monthly earnings
	(1)	(2)	(3)	(4)
Father's log earnings	0.110***	0.114***	0.167***	0.172***
	(0.030)	(0.038)	(0.038)	(0.039)
Father's age	-0.080*	-0.068	-0.024	-0.038
	(0.045)	(0.047)	(0.039)	(0.045)
(Father's age)^2	0.001	0.001	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Son's age	-0.055*	-0.012	-0.067*	-0.021
	(0.029)	(0.016)	(0.039)	(0.016)
(Son's age)^2	-0.007	-0.004	-0.013**	-0.007**
	(0.005)	(0.003)	(0.006)	(0.003)
Son's age x	0.015***	0.012***	0.015**	0.011***
Father's log earnings	(0.004)	(0.003)	(0.006)	(0.004)
(Son's age)^2 x	0.001	0.000	0.001*	0.001
Father's log earnings	(0.001)	(0.001)	(0.001)	(0.001)
Constant	8.407***	5.802***	6.422***	4.701***
	(1.386)	(1.342)	(1.121)	(1.224)
Observations	1094	1017	619	573
R-squared	0.22	0.20	0.28	0.29

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors, clustered by county, are given in parentheses. Son's age is calculated as age at time of observation minus 30.

Sources: Data are from the linked father-son sample based on the 1915 Iowa state census and the 1900 federal census.

Table 3: Summary statistics for the Iowa sample by distance moved between 1900 and 1915

	All sons	Sons moving more than 20 miles	Sons that did not move
Son's earnings	652	893	700
	(488)	(682)	(579)
Father's earnings	1039	1052	1186
	(1054)	(774)	(2041)
Son's months unemployed	1.0	0.1	1.2
	(2.2)	(0.6)	(2.4)
Father's months unemployed	0.7	0.7	0.9
	(1.9)	(1.5)	(2.3)
Son's total years of education	9.1	10.2	9.4
	(2.5)	(3.6)	(2.5)
Father's total years of education	7.9	8.6	8.3
	(2.7)	(2.6)	(2.7)
Son's years of common school	4.0	2.1	2.7
	(4.3)	(3.3)	(3.8)
Son's years of grammar school	4.0	5.6	5.3
	(4.0)	(4.1)	(3.9)
Son's years of high school	0.8	1.7	1.1
	(1.4)	(1.8)	(1.7)
Son's years of college	0.2	0.6	0.3
	(1.4)	(1.4)	(1.7)
Number of observations	1094	28	158

Notes: Moving distances are based on the distance between the son's location in 1900 and in 1915. 'Did not move' refers to sons that stayed in the same township, not necessarily the same dwelling.

Sources: Data are from the linked father-son sample based on the 1915 Iowa state census and the 1900 federal census.

Table 4: Alternative income mobility measures

	Iowa, 1915 (1)	PSID, 2001 (2)
Goodman and Kruskal's gamma	0.082	.258
	(.031)	(.027)
Kendall's tau-b	.065	.208
	(.025)	(.022)
Mean change in quintile	1.51	1.31
	(1.18)	(1.13)
Percentage persisting in father's income quintile:		
from bottom quintile	26.9	34.3
from 2nd quintile	20.2	23.0
from 3rd quintile	19.6	26.0
from 4th quintile	20.9	23.3
from top quintile	25.2	32.5

Notes: All gamma and tau-b values are calculated using income quintiles. Values in parentheses are asymptotic standard errors for gamma and tau-b and the standard deviation for the mean change in quintile. All income quintiles are based on age-adjusted incomes.

Sources: Iowa data are from the linked father-son sample created from the 1915 Iowa state census and the 1900 federal census. The PSID data are from the 2001 Panel Study of Income Dynamics.

Table 5: Summary statistics for the distribution of father's log earnings by school district characteristics

		Mean	Standard deviation	10th percentile	50th percentile	90th percentile
School access quartile:						
	1	6.69	0.82	5.99	6.68	7.60
	2	6.80	0.78	5.52	6.91	7.70
	3	6.69	0.89	5.70	6.68	7.60
	4	6.80	0.72	5.93	6.73	7.60
School quality quartile:						
	1	6.63	0.87	5.30	6.68	7.60
	2	6.80	0.62	5.70	6.91	7.82
	3	6.81	0.73	5.52	6.80	7.60
	4	6.62	0.81	5.86	6.57	7.50

Notes: School access is measured as the number of graded classrooms per square mile. School quality is measured as the spending per student. All statistics refer to the distribution of father's log earnings, where earnings is measured in 1915 dollars.

Sources: Earnings data are from the 1915 Iowa state census. School access and quality data are from the 1900 annual report of the superintendent of public instruction for the state of Iowa.

Table 6: Correlations between geographical mobility and childhood school district characteristics

		Conditional on being found in 1920:	
	Found in 1920 (1=found, 0=not found)	Living in Iowa (1=in Iowa)	Living in a sample county (1=in sample county)
Mean	.30	.57	.42
Correlation with number of graded classrooms per sqare mile	.019	-.126	-.086
Correlation with spending per student	-.023	.025	-.010
Number of observations	1719	510	510

Notes: School district characteristics correspond to the year 1900 for the district the child was living in during that year.

Sources: The geographical mobility measures are based on a sample of individuals matched from the 1900 federal census to the 1920 federal census. School district data are from the 1900 annual report of the superintendent of public instruction for the state of Iowa.

Table 7: Means of schooling measures for rural and urban school districts, 1900

	Rural school districts	Urban school districts
Percentage with graded schools	37.8	100
Students per classroom	40	164
	(16)	(223)
Taxes per student	9.22	11.86
	(3.91)	(3.69)
Spending per student	11.86	13.82
	(5.33)	(3.55)
Student-teacher ratio	23	102
	(13)	(169)
Subsidy per student	-1.34	4.10
	(6.85)	(6.61)
Classrooms per square mile	.24	4.52
	(.13)	(4.07)
Graded classrooms per	.07	3.99
square mile	(.11)	(3.99)
Graded student-teacher ratio	40	40
	(22)	(8)
Percentage of school-aged children	80.6	68.5
enrolled in any school	(20.2)	(17.1)
Percentage of school-aged children	19.1	61.4
enrolled in graded school	(30.6)	(34.5)
Number of districts	143	6

Notes: Standard deviations are given in parentheses. Taxes, spending and subsidies are in 1900 dollars. Subsidy per student is defined as spending per student minus annual tuition (equal to monthly tuition multiplied by the number of months in the school year).

Sources: All data are from the.1900 annual report of the superintendent of public instruction for the state of Iowa.

Table 8: Marginal effects of school quality and access on the intergenerational income elasticity

	Father's log earnings x schooling measure coefficient	
Schooling measure	Rural sample	Urban sample
Graded schools dummy	-0.042	--
	(0.060)	--
Students per classroom	-0.002	0.008*
	(0.005)	(0.003)
Percentage of students	-0.039	-0.755
enrolled in any school	(0.240)	(0.679)
Percentage of students	-0.010	-0.170
enrolled in graded schools	(0.143)	(0.236)
Student-teacher ratio	-0.004***	-0.000*
	(0.001)	(0.000)
Graded student-teacher ratio	0.000	-0.012**
	(0.002)	(0.004)
Classrooms per square mile	0.232*	-0.033**
	(0.128)	(0.009)
Graded classrooms per square mile	0.278**	-0.027**
	(0.111)	(0.008)
Subsidy per student	0.017***	0.000
	(0.004)	(0.011)
Spending per student	0.012	0.024
	(0.008)	(0.068)
Taxes per student	0.014	0.067*
	(0.009)	(0.029)

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors, clustered by county, are given in parentheses. Coefficients represent the change in the intergenerational income elasticity resulting from a change in the schooling measure. Complete regression results are provided in the appendix.

Sources: See text.

Table 9: Percentage of sons persisting in their father's income quintile

Income quintile	All sons	Low school access	High school access
1	25.0	16.9	32.8
2	12.9	16.2	8.3
3	19.0	19.7	18.2
4	19.7	28.3	10.8
5	22.3	12.7	31.6

Notes: School access is proxied by the number of graded classrooms per square mile. Low school access is defined as being in the bottom half of the school access distribution while high school access is defined as being in the top half.

Sources: See text.

Table 10: Logit regression coefficients for persistence in and movement into top and bottom earnings quintiles

	Persist in top	Move into top	Persist in bottom	Move into bottom
Years of schooling, non-high school	-.033	.012	-.110	-.117***
	(.099)	(.049)	(.080)	(.045)
Years of high school and college	.136*	.149***	-.412**	.012
	(.070)	(.046)	(.185)	(.060)
Occupational transitions (father-son):				
white-white	1.193**	.958***	-.823	-2.150***
	(.475)	(.280)	(.876)	(.361)
white-agri		.905		-.675
		(.558)		(.517)
white-blue	1.107	.103	-1.659	-1.512***
	(.790)	(.343)	(1.100)	(.349)
agri-white	.178	.684	.485	-3.050***
	(.721)	(.433)	(.700)	(1.024)
agri-blue		.063	-1.235	-.297
		(.448)	(.833)	(.328)
blue-white	3.280***	.819***	-1.170**	-2.669***
	(1.130)	(.286)	(.537)	(.603)
blue-agri		.725*	-.129	-.688
		(.424)	(.516)	(.666)
blue-blue	.919	.238	-.792**	-1.203***
	(.748)	(.262)	(.403)	(.250)
Moved across counties	.041	.037	-.176	-.052
	(.546)	(.275)	(.427)	(.256)
Moved to a city	-.242	.526	.768	-.418
	(.854)	(.341)	(.636)	(.511)
Constant	-1.643*	-2.212***	.470	.306
	(.880)	(.453)	(.699)	(.399)
Number of observations	234	1116	276	1086
pseudo-R^2	.144	.057	.080	.125

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors are given in parentheses. 'Moved across counties' and 'moved to a city' are dummy variables equal to one if a move occurred. The omitted occupational transition category is agri-agri. 'Years of schooling, non-high school' includes both years of common school and years of grammar school.

A missing coefficient indicates that the variable was dropped from the regression because it predicted failure perfectly.

Sources: See text.

Table 11: Ordered probit regression coefficients, son's educational attainment as dependent variable

Dependent variable	Total years of schooling	Years of high school
Graded classrooms per square mile	-2.934***	-3.259***
	(.500)	(.938)
(Graded classrooms per square mile)^2	.297***	.320***
	(.056)	(.098)
Log(spending per student)	.090	2.425**
	(1.104)	(1.146)
Log(tuition)	-.322	-1.744
	(1.849)	(1.812)
Father's log earnings	.015	.683
	(.360)	(.486)
Father's log earnings	.453***	.501***
x graded classrooms per square mile	(.065)	(.122)
Father's log earnings	-.045***	-.048***
x (graded classrooms per square mile)^2	(.065)	(.013)
Father's log earnings	.012	-.282
x log(spending per student)	(.176)	(.197)
Father's log earnings x log(tuition)	-.044	.196
	(.245)	(.254)
Rural dummy	.022	.178
	(.231)	(.698)
Number of observations	975	974
Pseudo R-squared	.030	.060

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Total years of schooling is years beyond the required minimum of eight. Both total years of schooling and years of high school are rounded to the nearest year.

Sources: See text.

10 Appendix 3: Additional Tables

Table 12: Intergenerational income elasticity estimates using the 2001 PSID sample

Sample:	PSID, 2001	
Earnings Measure	Family income	
Son's age range:	20-35	25-40
Father's log earnings	0.294***	0.334***
	(0.040)	(0.038)
Father's age	0.058	0.070*
	(0.039)	(0.037)
(Father's age)^2	-0.000	-0.001*
	(0.000)	(0.000)
Son's age	-0.182*	-0.092
	(0.104)	(0.095)
(Son's age)^2	-0.007	0.043***
	(0.020)	(0.016)
Son's age x	0.020**	0.012
Father's log earnings	(0.009)	(0.008)
(Son's age)^2 x	0.000	-0.004***
Father's log earnings	(0.002)	(0.001)
Constant	5.710***	4.809***
	(1.176)	(1.203)
Observations	977	1071
R-squared	0.20	0.15

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors, clustered by county, are given in parentheses. Son's age is calculated as age at time of observation minus 30.

Sources: Data are from the 2001 Panel Study of Income Dynamics.

Table 13: Intergenerational income elasticity estimates with schooling measure interactions for son's from urban districts, son's log earnings as dependent variable

Schooling measure:	None (1)	Graded schools dummy (2)	Students per classroom (3)	Percentage of students enrolled (4)	Percentage of students enrolled in graded schools (5)	Student-teacher ratio (6)	Graded student-teacher ratio (7)	Classrooms per square mile (8)	Graded classrooms per square mile (9)	Subsidy per student (10)	Spending per student (11)	Taxes per student (12)
Schooling measure		--	-0.057**	4.281	1.317	0.003**	0.091**	0.238***	0.206**	0.022	-0.158	-0.466*
		--	(0.018)	(4.905)	(1.710)	(0.001)	(0.021)	(0.048)	(0.046)	(0.084)	(0.441)	(0.196)
Father's log earnings x		--	0.008*	-0.733	-0.161	-0.000*	-0.012**	-0.032**	-0.027**	0.000	0.025	0.067*
schooling measure		--	(0.003)	(0.676)	(0.236)	(0.000)	(0.004)	(0.009)	(0.008)	(0.011)	(0.068)	(0.029)
Father's log earnings	0.253***	0.253***	-0.335	0.780	0.350	0.276***	0.741***	0.386***	0.349***	0.290***	-0.092	-0.580
	(0.041)	(0.041)	(0.210)	(0.422)	(0.166)	(0.050)	(0.155)	(0.050)	(0.057)	(0.058)	(0.941)	(0.339)
Father's age	-0.046	-0.046	-0.042	-0.046	-0.049	-0.051	-0.046	-0.045	-0.049	-0.060	-0.047	-0.041
	(0.094)	(0.094)	(0.096)	(0.091)	(0.096)	(0.095)	(0.098)	(0.096)	(0.094)	(0.094)	(0.094)	(0.096)
(Father's age)^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Son's age	0.048	0.048	-0.008	0.033	0.037	0.012	-0.005	0.002	0.010	0.041	0.034	-0.025
	(0.144)	(0.144)	(0.169)	(0.144)	(0.143)	(0.150)	(0.153)	(0.148)	(0.146)	(0.143)	(0.163)	(0.173)
(Son's age)^2	-0.003	-0.003	-0.005	-0.001	-0.004	-0.007	-0.008	-0.006	-0.006	-0.003	-0.003	-0.007
	(0.008)	(0.008)	(0.009)	(0.008)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.008)	(0.009)	(0.010)
Son's age x	-0.002	-0.002	0.006	-0.001	-0.001	0.003	0.005	0.004	0.003	-0.002	-0.000	0.008
Father's log earnings	(0.022)	(0.022)	(0.025)	(0.021)	(0.022)	(0.023)	(0.023)	(0.022)	(0.022)	(0.021)	(0.024)	(0.026)
(Son's age)^2 x	-0.000	-0.000	0.000	-0.000	0.000	0.001	0.001	0.000	0.000	-0.000	-0.000	0.000
Father's log earnings	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Constant	6.570*	6.570*	10.597**	3.375	5.849*	6.497*	2.875	5.531	5.883*	6.430*	8.777	12.236**
	(2.724)	(2.724)	(3.174)	(3.683)	(2.137)	(2.685)	(3.395)	(2.681)	(2.567)	(2.569)	(5.169)	(3.567)
Observations	197	197	197	197	197	197	197	197	197	197	197	197
R-squared	0.39	0.39	0.41	0.41	0.40	0.41	0.41	0.41	0.41	0.42	0.40	0.40

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors, clustered by county, are given in parentheses. There was no variation in the graded schools dummy for urban districts. Subsidy per student is defined as spending per student minus annual tuition per student.

Sources: See text.

Table 14: Intergenerational income elasticity estimates with schooling measure interactions for son's from rural districts, son's log earnings as dependent variable

Schooling measure:	None	Graded schools dummy	Students per classroom	Percentage of students enrolled in any school	Percentage of students enrolled in graded schools	Student-teacher ratio	Graded student-teacher ratio	Classrooms per square mile	Graded classrooms per square mile	Subsidy per student	Spending per student	Taxes per student
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Schooling measure		0.394	0.019	-0.237	0.046	0.025***	0.002	-1.416	-1.686**	-0.111***	-0.088*	-0.097
		(0.410)	(0.029)	(1.569)	(0.910)	(0.007)	(0.013)	(0.882)	(0.758)	(0.028)	(0.049)	(0.060)
Father's log earnings x		-0.044	-0.002	-0.037	-0.012	-0.004***	0.000	0.230	0.277**	0.017***	0.012	0.014
schooling measure		(0.060)	(0.005)	(0.240)	(0.142)	(0.001)	(0.002)	(0.129)	(0.111)	(0.004)	(0.008)	(0.009)
Father's log earnings	0.030	0.054*	0.122	0.058	0.033	0.125***	-0.069	-0.029	-0.001	0.062**	-0.085	-0.067
	(0.036)	(0.028)	(0.185)	(0.229)	(0.031)	(0.039)	(0.145)	(0.050)	(0.039)	(0.021)	(0.095)	(0.098)
Father's age	-0.080	-0.090	-0.083	-0.075	-0.079	-0.089	-0.044	-0.076	-0.079	-0.087	-0.075	-0.074
	(0.060)	(0.055)	(0.062)	(0.059)	(0.061)	(0.060)	(0.252)	(0.060)	(0.060)	(0.058)	(0.062)	(0.061)
(Father's age)^2	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Son's age	-0.050	-0.040	-0.055	-0.048	-0.050	-0.050	-0.078	-0.073	-0.076	-0.093**	-0.086*	-0.088**
	(0.051)	(0.053)	(0.051)	(0.049)	(0.054)	(0.044)	(0.209)	(0.048)	(0.047)	(0.039)	(0.041)	(0.039)
(Son's age)^2	-0.008	-0.008	-0.008	-0.009	-0.008	-0.009	-0.035	-0.009	-0.009	-0.008	-0.007	-0.007
	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)	(0.007)	(0.023)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
Son's age x	0.015*	0.013	0.016*	0.014*	0.015	0.015**	0.018	0.018**	0.019**	0.021***	0.020***	0.021***
Father's log earnings	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.006)	(0.038)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
(Son's age)^2 x	0.001	0.001	0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.001
Father's log earnings	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	8.953***	9.024***	8.131**	8.971***	8.913***	8.543***	8.648	9.197***	9.143***	8.979***	9.670***	9.484***
	(1.801)	(1.788)	(2.970)	(1.611)	(1.860)	(1.859)	(8.071)	(1.730)	(1.804)	(1.837)	(1.685)	(1.575)
Observations	469	469	469	469	469	468	80	469	469	468	469	469
R-squared	0.18	0.19	0.20	0.19	0.18	0.19	0.34	0.19	0.19	0.21	0.19	0.19

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors, clustered by county, are given in parentheses. Graded schools dummy equals one if district has graded schools and zero otherwise. Subsidy per student is defined as spending per student minus annual tuition per student.

Sources: See text.

Table 15: Returns to education estimates conditional on parental income, son's log income as dependent variable

	All Sons (1)	Sons in agricultural sector (2)	Sons not in agricultural sector (3)	All Sons (4)	Sons in agricultural sector (5)	Sons not in agricultural sector (6)
Common school	0.041***	0.058***	0.029***	0.043***	0.064***	0.029***
	(0.007)	(0.013)	(0.008)	(0.007)	(0.014)	(0.008)
Grammar school	0.063***	0.055***	0.060***	0.063***	0.053***	0.060***
	(0.007)	(0.018)	(0.008)	(0.007)	(0.018)	(0.008)
High school	0.112***	0.119***	0.109***	0.109***	0.101***	0.109***
	(0.008)	(0.028)	(0.008)	(0.009)	(0.029)	(0.008)
College	0.124***	0.197***	0.116***	0.129***	0.256***	0.118***
	(0.013)	(0.061)	(0.012)	(0.013)	(0.067)	(0.012)
Common school x				-0.039***	-0.051**	0.003
Father in 2nd quartile				(0.013)	(0.020)	(0.022)
Common school x				-0.015	-0.034**	0.016
Father in 3rd quartile				(0.010)	(0.016)	(0.015)
Common school x				-0.006	-0.005	-0.003
Father in 4th quartile				(0.008)	(0.012)	(0.015)
Grammar school x				-0.009	0.070	-0.011
Father in 2nd quartile				(0.010)	(0.146)	(0.009)
Grammar school x				0.005	-0.032	0.007
Father in 3rd quartile				(0.010)	(0.053)	(0.009)
Grammar school x				0.002	0.023	-0.004
Father in 4th quartile				(0.018)	(0.042)	(0.020)
High school x				0.065	0.119	0.028
Father in 2nd quartile				(0.055)	(0.256)	(0.053)
High school x				-0.000	0.316*	-0.029
Father in 3rd quartile				(0.035)	(0.185)	(0.032)
High school x				0.014	-0.046	0.031
Father in 4th quartile				(0.048)	(0.118)	(0.055)
College x				-0.000	-0.154	0.022
Father in 2nd quartile				(0.134)	(0.338)	(0.138)
College x				-0.048	0.000	-0.021
Father in 3rd quartile				(0.077)	(0.000)	(0.068)
College x				-0.048	-0.259	-0.033
Father in 4th quartile				(0.061)	(0.172)	(0.064)
Native born (1=yes)	0.403	0.681	0.097	0.423	0.809	0.085
	(0.319)	(0.768)	(0.331)	(0.319)	(0.777)	(0.332)
Years in US if foreign born	0.018	0.036	0.004	0.018	0.041	0.004
	(0.012)	(0.028)	(0.012)	(0.012)	(0.028)	(0.012)
Constant	4.807***	4.236***	5.181***	4.779***	4.023***	5.196***
	(0.334)	(0.804)	(0.348)	(0.335)	(0.825)	(0.349)
Observations	2710	715	1995	2710	715	1995
R-squared	0.21	0.16	0.26	0.21	0.19	0.26

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors are given in parentheses. All regressions include a quartic in son's experience. All schooling variables are measured in years.

Sources: See text.

Table 16: Returns to education estimates conditional on parental income using linear splines for years of education, son's log income as dependent variable

	All Sons (1)	Sons in agricultural sector (2)	Sons not in agricultural sector (3)	All Sons (4)	Sons in agricultural sector (5)	Sons not in agricultural sector (6)
Common school ≤ 9	0.032***	0.030	0.035***	0.035***	0.035*	0.034***
	(0.009)	(0.019)	(0.009)	(0.009)	(0.019)	(0.009)
Common school > 9	0.077***	0.122***	0.006	0.074***	0.121***	0.005
	(0.020)	(0.031)	(0.031)	(0.022)	(0.035)	(0.032)
Grammar school ≤ 9	0.056***	0.033	0.064***	0.056***	0.031	0.064***
	(0.008)	(0.021)	(0.009)	(0.008)	(0.021)	(0.009)
Grammar school > 9	0.008	-0.086	-0.003	0.001	-0.799	-0.007
	(0.042)	(0.497)	(0.037)	(0.043)	(0.698)	(0.038)
High school ≤ 4	0.119***	0.114***	0.116***	0.117***	0.104***	0.116***
	(0.009)	(0.030)	(0.009)	(0.010)	(0.032)	(0.009)
High school > 4	-0.078	-0.072	-0.077	-0.085	-0.054	-0.083
	(0.069)	(0.315)	(0.063)	(0.069)	(0.315)	(0.064)
College (if son went to HS)	0.119***	0.275***	0.109***	0.121***	0.294***	0.110***
	(0.014)	(0.086)	(0.013)	(0.015)	(0.089)	(0.014)
College (if son did not go to HS)	0.019	-0.160	0.027	0.031	-0.080	0.028
	(0.031)	(0.121)	(0.029)	(0.032)	(0.136)	(0.030)
Common school ≤ 9 x				-0.048***	-0.072***	-0.000
Father in 2nd quartile				(0.016)	(0.026)	(0.023)
Common school ≤ 9 x				-0.013	-0.033*	0.019
Father in 3rd quartile				(0.011)	(0.018)	(0.017)
Common school ≤ 9 x				-0.010	-0.010	-0.009
Father in 4th quartile				(0.010)	(0.015)	(0.016)
Common school > 9 x				0.084	0.140	0.000
Father in 2nd quartile				(0.127)	(0.172)	(0.000)
Common school > 9 x				-0.056	-0.021	-0.116
Father in 3rd quartile				(0.162)	(0.220)	(0.375)
Common school > 9 x				0.043	0.017	0.303
Father in 4th quartile				(0.062)	(0.083)	(0.325)
Grammar school ≤ 9 x				-0.008	0.082	-0.010
Father in 2nd quartile				(0.010)	(0.146)	(0.009)
Grammar school ≤ 9 x				0.007	-0.036	0.008
Father in 3rd quartile				(0.010)	(0.053)	(0.009)
Grammar school ≤ 9 x				-0.002	0.004	-0.001
Father in 4th quartile				(0.018)	(0.051)	(0.020)
Grammar school > 9 x				0.028	0.000	-0.004
Father in 2nd quartile				(0.400)	(0.000)	(0.354)
Grammar school > 9 x				0.093	0.000	0.115
Father in 3rd quartile				(0.329)	(0.000)	(0.292)
Grammar school > 9 x				0.477	1.407	0.446
Father in 4th quartile				(0.411)	(1.071)	(0.512)
High school ≤ 4 x				0.064	0.214	0.021
Father in 2nd quartile				(0.056)	(0.265)	(0.054)
High school ≤ 4 x				-0.013	0.312*	-0.041
Father in 3rd quartile				(0.036)	(0.186)	(0.033)
High school ≤ 4 x				-0.005	-0.054	0.005
Father in 4th quartile				(0.051)	(0.126)	(0.057)
High school > 4 x				0.000	0.000	0.000
Father in 2nd quartile				(0.000)	(0.000)	(0.000)
High school > 4 x				0.362	0.000	0.413
Father in 3rd quartile				(0.565)	(0.000)	(0.501)
High school > 4 x				0.000	0.000	0.000
Father in 4th quartile				(0.000)	(0.000)	(0.000)

Note: Table is continued on the following page.

Table 17: Returns to education estimates conditional on parental income using linear splines for years of education, son's log income as dependent variable (continued from previous page)

College (if son went to HS) x				0.270	-0.053	0.098
Father in 2nd quartile				(0.282)	(0.348)	(0.261)
College (if son went to HS) x				-0.034	0.000	-0.008
Father in 3rd quartile				(0.078)	(0.000)	(0.070)
College (if son went to HS) x				0.002	0.027	-0.010
Father in 4th quartile				(0.068)	(0.374)	(0.066)
College (if son did not go to HS) x				-0.350	0.000	-0.125
Father in 2nd quartile				(0.317)	(0.000)	(0.308)
College (if son did not go to HS) x				-0.219	0.000	-0.101
Father in 3rd quartile				(0.562)	(0.000)	(0.499)
College (if son did not go to HS) x				-0.236	-0.348	-0.084
Father in 4th quartile				(0.157)	(0.426)	(0.505)
Native born (1=yes)	0.375	0.623	0.090	0.393	0.750	0.080
	(0.319)	(0.767)	(0.331)	(0.319)	(0.778)	(0.332)
Years in US if foreign born	0.017	0.034	0.004	0.017	0.039	0.003
	(0.012)	(0.028)	(0.012)	(0.012)	(0.028)	(0.012)
Constant	4.878***	4.450***	5.143***	4.855***	4.231***	5.155***
	(0.336)	(0.808)	(0.349)	(0.337)	(0.831)	(0.351)
Observations	2710	715	1995	2710	715	1995
R-squared	0.21	0.17	0.26	0.22	0.20	0.26

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: Standard errors are given in parentheses. All regressions include a quartic in son's experience. All schooling variables are measured in years.

Sources: See text.

11 Appendix Figures

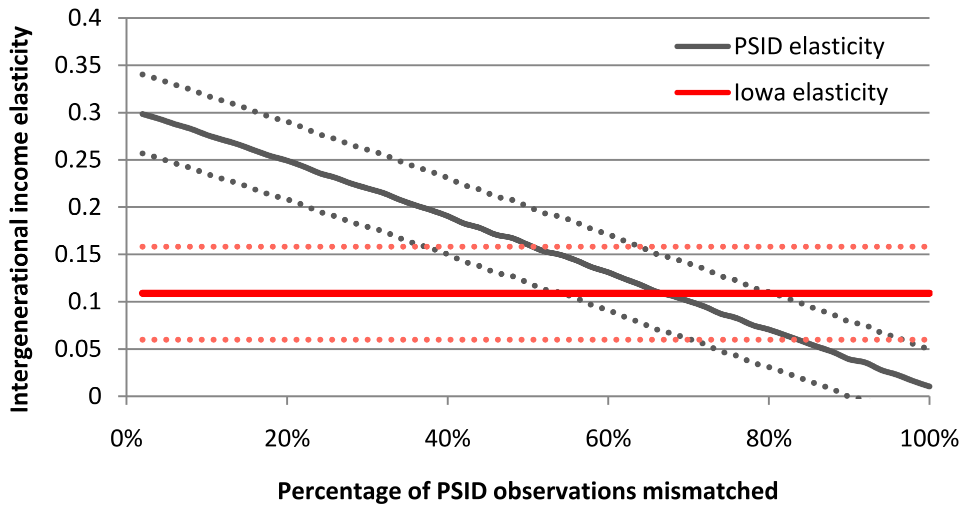

Figure 1: Intergenerational income elasticity estimates for the 1915 Iowa sample and the 2001 PSID sample with random mismatches in the PSID data