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Differences in Intergenerational Mobility across the Earnings Distribution

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Abstract

There is a broad range of work which looks at the transmission of various outcomes—earnings, education, and poverty—between parents and children. If a society is concerned with ensuring equal opportunity for all its members, then it is important to understand the extent to which such outcomes are transmitted from one generation to the next. The degree to which outcomes are transmitted, however, is likely to be related to socioeconomic circumstances and may result in different degrees of intergenerational mobility across groups. In this paper, I examine whether or not the transmission of earnings from parents to children differs across the distribution of parent earnings. I examine non-linearities in the intergenerational earnings mobility using semi-parametric estimates of the relationship between father and children's earnings. When I allow for a flexible, non-linear relationship between father's and children's earnings, it appears that parental earnings have the greatest effect in the middle of the distribution. Hypothesis tests indicate that the effect of father's earnings is significantly greater for daughters and sons in the middle and upper portions of the distribution than for those at the bottom.

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I. Introduction

There is a broad range of work which looks at the transmission of various outcomes—earnings, education and poverty—between parents and children. Research on the intergenerational transmission of earnings has established that in the United States, there is a substantial effect of father's earnings on son's earnings. Over the past decade, a number of studies have found a coefficient of approximately .4 on father's earnings in a regression of son's log earnings on father's log earnings and father's age.[1]

Most of the previous empirical work has focused on the average degree of mobility across the distribution. The degree to which outcomes are transmitted, however, is likely to be related to socioeconomic circumstances and may result in different relationships between parent and children's outcomes across groups. Therefore, a relevant question is: do certain groups face less mobility than others? One of the primary motivations for studying intergenerational transmission of earnings is the concern over equality of opportunity. That is, whether children from poor families have fewer opportunities to attain economic success than children from well off families. The average degree of intergenerational transmission of earnings is certainly important, but to address questions of equality of opportunity, one also needs to know whether the transmission of earnings is the same, greater or less for those at the top and bottom of the earnings distribution as it is for those in the middle of the distribution.

Until recently, no research has focused exclusively on the question of whether there is more or less intergenerational transmission over different parts of the earnings distribution. Some studies have explored differences in mobility across the distribution as an extension of their primary analysis estimating the average degree of mobility. These studies have either looked at transition probabilities between quartiles of the earnings distribution or examined a specific type of nonlinearity in the data. As section III describes, these techniques have limitations and produced mixed evidence. A paper by Corak and Heisz (1999) offers the first analysis which concentrates explicitly on differences in intergenerational

[1] Several studies from the early 1990s, including those by Solon (1992), Zimmerman (1992), and Behrman and

transmission across the distribution using a variety of techniques.[2] They find evidence of a non-linear relationship between the earnings of Canadian fathers and sons, which suggests that parents in some parts of the earnings distribution may face constraints to investing in their child's human capital.

While there have been several analyses of the intergenerational relationship in the United States, few take a focused look at non-linearities. Taking existing studies on the average degree of intergenerational earnings transmission as a point of departure, I examine non-linearities in the relationship between the earnings of fathers and sons and fathers and daughters in the United States using the Panel Study of Income Dynamics. The goal of this paper is to document whether non-linearities in intergenerational transmission of earnings from fathers to sons and fathers to daughters exist. Possible mechanisms which might generate any nonlinearities in intergenerational transmission are noted in the final section of this paper, but the exploration of them is beyond the scope of this paper.

Section II will outline a basic model of intergenerational transmission and suggest some theoretical motivations behind a non-linear relationship between parent and child earnings. In section III, I will lay out how non-linearities have been examined to date and the difficulties in examining them, and outline the approach I undertake in this paper. A description of the data follows in section IV. Section V contains the empirical results in which I use semi-parametric estimates and splines to examine differences in intergenerational mobility across the distribution of father's earnings. The final section discusses the implications of these results for analyses of intergenerational mobility.

II. Models of Intergenerational Transmission

In models of intergenerational transmission, the permanent earnings of offspring are related to that of their parents via the earnings power transmitted from the parents to the child. The permanent earnings

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Taubman (1990) produced estimates of approximately .4.

[2] Mulligan (1997) offers a thorough theoretical discussion of non-linearities in intergenerational transmission, but imposes a single parameterization on the data to test this.

of the parents reflect genetic and taste endowments, a portion of which is transferred to the child directly, and income, which can be used to make investments in the child's human capital. The purchases of educational services, health inputs, or quality neighborhoods are a few examples of such investments. The most widely used formalization of the relationship is from the model presented by Becker and Tomes (1986), in which the natural log of child's permanent earnings (Y_c) is a function of the natural log of parents' permanent earnings (Y_p), a constant (α_c), and an error term representing market luck (l_c^*). The coefficient on parent earnings (β) reflects both the marginal propensity to invest in the child (γ) and the endowment transmitted to the child (η). The constant represents the average social endowment and market conditions facing each generation. These factors range from the average quality of education to the general labor market conditions in their first few years of work. Individual heterogeneity in market luck is captured by the term l_c^*.

$$Y_c = \alpha_c + (\gamma + \eta)Y_p + l_c^* \tag{1}$$

$$Y_c = \alpha_c + \beta Y_p + l_c^* \tag{2}$$

The effect of parental resources is given by $\beta = \gamma + \eta$. As β approaches zero, it corresponds with a state of almost complete mobility, and higher values of β denote increasingly less mobility across generations.

Underlying this model is the premise that parents care about children's consumption and make choices to transfer a certain amount of earnings power and income to their children. Parents do not control the genetic endowment transferred to the child[3], but do make choices that affect the child’s earning power through human capital investment and by influencing the child’s preferences for market and

[3] On some level, parents can adversely affect the health and cognitive endowment transmitted to the child in utero but generally do not control the transmission of genetics to their children.

nonmarket work. It is such investment choices which could generate differences in the degree of intergenerational transmission of earnings across the distribution of parental earnings.

The presence of constraints to making human capital investments is one model that would introduce a non-linearity into the intergenerational earnings relationship. According to the Becker-Tomes (1986) model, the optimal level of investment in a child's human capital will be where the rate of return to these investments equals the rate of return on assets. When the return to assets exceeds the returns to schooling, parents can increase their child's consumption more by transferring money or assets than through human capital investments. As long as log earnings are linear in endowments and parents are not constrained in making the optimal human capital investment, the correlation of earnings across generations will reflect the return to inherited endowments. In the context of equations (1) and (2), this means simply that $\beta = \eta$ in such families. If low-income parents with high ability children are not be able to borrow sufficiently to make the optimal investment in human capital for their children, the measured intergenerational relationship for such families will reflect both the impact of inherited endowments of human capital (η) and the parents' propensity to make human capital investments in their offspring (γ). Therefore, one would expect the overall degree of intergenerational transmission of earnings, β, to be higher in such constrained familes than in families who were not constrained in investing in their children's human capital.

The Becker-Tomes (1986) model of intergenerational transmission of earnings clearly suggests that in the presence of constraints to human capital investment, the effect of parents earnings on children's earnings (β) will decrease with parents' earnings. That, is, their model suggests that the relationship is concave. This concavity of this relationship relies on a number of assumptions, which, if violated, may result in a different pattern across the distribution of parent earnings.

One assumption, which may not hold, is that ability or endowment is linearly related to log earnings. If there are increasing returns to ability and ability is also positively correlated with parental earnings, there will be a stronger rather than weaker transmission of earnings and higher in high earnings families. A positive correlation between parents' earnings and child's ability could also generate a scenario in which parents in the middle of the distribution might be more constrained in making optimal human capital investments in their children than parents from the lower tail of the earnings distribution. In such cases, the increase in the optimal level of human capital investment may outstrip the ability to finance such investments.[4] For daughters, differential selection into the labor force could also affect any estimates of differences in intergenerational earnings transmission because of biases they may impart on γ, the component of β which reflects the estimated return to investment in human capital.

In sum, the theoretical model implies that the parent-child intergenerational earnings relationship is not necessarily linear, but also that this relationship is not necessarily concave. One must be careful in specifying any non-linearities in the intergenerational earnings relationship, because the change in mobility across the distribution may be in more than one direction and occur in more than one portion of the distribution. Therefore, it is sensible to examine it as an empirical question. This paper's contribution will be to examine semi-parametrically the extent to which nonlinearities exist in the intergenerational transmission of earnings without having to impose a priori a functional form on such differences.

III. Empirical Studies of Distributional Differences in Intergenerational Mobility

Two approaches have been employed to examine differences in intergenerational transmission of earnings across the distribution: transition matrix analyses and imposing a non-linear parameterization of the relationship. Most of the work has been done with transition matrices. These analyses divide the parent and child earnings or income distributions into equal portions—quartiles, quintiles or deciles—and

[4] This is not to imply that those in the lower portion of the earnings distribution do not have an endowment which would correspond to, for example, a positive return on a university education; rather, that if some component of ability is correlated with parents' income, there will be more children in middle income households with such a level of ability and therefore, the optimal level of human capital investment, *on average*, will be higher for the middle income household.

estimate the probability that the child falls into each segment of the next generation's distribution. The authors then commented on the empirical distribution in relation to what would occur under perfect mobility. With perfect mobility, the segment the child ends up in should be independent of the segment the parent was in. For example, if the distributions are divided up into quartiles, then a child born to a father in the bottom quartile will have 25% chance of ending up in each quartile of his/her generation's distribution under perfect mobility.

The main conclusion from the transition matrix analyses was that more immobility exists at either end of the earnings distribution than in the middle. Using the United States' National Longitudinal Survey, Zimmerman (1992) showed that sons born to fathers in the bottom quartile had a 40% chance of staying in the bottom quartile and only a 12% chance of rising to the top quartile. In the middle quartiles, the probabilities were closer to the 25% one would expect under perfect mobility. Moreover, sons at the bottom of the earnings distribution only have a 31% chance of moving to the top half. Peters (1992) uses the NLS but also examines father-daughter pairs.[5] For sons, her results are similar to Zimmerman's. Daughters appear to have greater earnings mobility: for every quartile of father's earnings, daughters have close to a 25% chance of ending up in each quartile of their distribution.

Evidence from other countries is also suggestive of less mobility at the ends of the distribution. One of the earliest studies by Atkinson, et al. (1983) used a British panel from the city of York. There appeared to be much less mobility for those in the bottom and top quartiles of the distribution. Forty-four percent of the sons in the bottom quartile of the father's distribution remained there, while 50% of the sons at the top also did not move between quartiles. More recent work by Dearden, Machin and Reed (1997) finds very similar results using a national sample from Great Britain. Corak and Heisz (1999) present

[5] Early transition matrix analyses (Zimmerman 1992, Atkinson, et al. 1983) used only single years of earnings, but these ignore the important problems of measurement error from using single year earnings measures as a proxy for permanent earnings and differences in where the parents and children are observed on their life cycle earnings profiles. Several authors have since moved to using multiple year averages of earnings and adjusting earnings for age or experience differences.

results from a large sample of Canadian fathers and sons. In both quartiles and deciles, those at the top and bottom have a higher tendency to remain in the same group.

Although these studies conclusively point towards less than perfect mobility, it is not clear that the transition matrices represent a greater degree of mobility at one end of the distribution than the other. The transition matrices corresponding with perfect mobility imply parents' and children's earnings are independent. The empirical evidence and models of human capital transmission strongly indicate that this is not the case. A more appropriate null hypothesis would be to compare what a transition matrix would look like if the relationship between parent child earnings were the same in all parts of the distribution.[6]

Moreover, the transition matrices are biased towards finding more rigidity at either end by construction. Atkinson, et al. (1983) point out that because those in the bottom and top can only move in one direction, but those in the middle can move up or down, there will be greater probability of those born into the bottom and top remaining in those same segments. Corak and Heisz (1999) suggest dividing the data into smaller segments, such as deciles and single percentiles, and looking at the segments adjacent to the top and bottom. When looking at the second and ninth deciles, however, they find that the probabilities of remaining in those deciles are still higher than the chance that a person will move up or down. Breaking the data into such fine cells requires much larger sample sizes on parent-child paris than are available in most longitudinal data sets.

The second principal way differences in intergenerational mobility have been explored in the literature is through direct parameterization of the non-linearities. The majority of these studies have focused on testing whether low income parents are constrained in making human capital investments in their children, and hence, have a stronger intergenerational earnings relationship than high income parents. In a study using the PSID, Behrman and Taubman (1990) proposed that the relationship between father's and children's earnings might be quadratic. The greater the level of father's earnings, the less likely they

[6] Construction of such a null hypothesis transition matrix requires assumptions about the joint distribution of

will face constraints to investing in their children's human capital, and therefore the effect of father's earnings will diminish at high levels. An F-test for the non-linear specification does not reject it, but rather than having the effect of parental earnings decrease, it increases at higher levels of father's earnings and suggests less mobility at the top rather than bottom of the distribution.[7,8] Peters (1992) used a cubic specification in a similar analysis of NLS data. A test does not reject the cubic specification when compared to a linear one, but the table of results only gives the marginal effect of father's earnings.[9] There is no characterization of how this might differ across the distribution, or why one might expect it to follow a cubic relationship. While these parameterizations may characterize the relationship between father-child earnings better than a linear one, it is not at all clear that they are the correct ones either.

In addition to direct non-linear functions of father's earnings, a few authors have also tried to capture non-linearities by allowing the coefficient on father's earnings to vary for different groups. Mulligan (1997) investigates the implication of the Becker-Tomes model where only parents who can afford to make the optimal level of human capital investments in their children will make financial transfers to their children. Those who face constraints will not make such transfers. Therefore, if the liquidity constraints are binding, one will see a larger coefficient on father's log earnings in the sample that did not receive a transfer from their parent. In regressions using data from the PSID, Mulligan finds no consistently meaningful differences between the coefficient on log father's wage in each group and concludes that there are no meaningful differences in intergenerational transmission for those who face constraints and those who do not.[10]

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earnings in the two generations.

[7] Behrman and Taubman (1990), Table 3 and p. 123-4.

[8] Solon (1992) also estimates the relationship between son's and father's log earnings with a quadratic in father's earnings. The coefficient on the square of father's log earnings is not significant.

[9] See Tables 4 and 5 in Peters (1992).

[10] See Mulligan, p. 237-41.

Mulligan defines the families who are not constrained in making human capital investments by whether the son reports receiving or expecting to receive an inheritance of $25,000 or more.[11] Just because parents were able to transfer large amounts of money to their children at the end of their life, however, does not mean that they did not face constraints at the time they were making human capital investments in their children. These investments tend to be large lump sum amounts, such as housing in areas with better school systems and paying for college tuition.[12] There may also be parents who are not observed to transfer such a large amount to their children, but who did not face constraints in making investments in their children's human capital.

Peters (1992) interacts the log of father's income and earnings with characteristics of the households, such as whether they were high or low income, came from large families, received welfare, and had a father attending college. There is some evidence that sons of fathers who had been to college have more mobility than those whose fathers did not attend college, but this effect does not carry over to daughters. Daughters of high-income fathers also seem to have greater mobility, as do non-whites. The background variables with which parental earnings are interacted, such as welfare receipt, having a broken home, having a father who attended college, and an indicator for families with earnings above the mean, are also likely to be quite collinear so it is unclear where the true effect lies.

Together these studies yield very mixed evidence on differences in earnings transmission. In all cases, however, the specifications impose a particular form for the non-linearity in the father-child earnings relationship, which may or may not be correct. So it is unclear whether or not the parameterization or non-linearities in general are being rejected.[13] More flexible estimation strategies

[11] In Mulligan's sample, 15 percent of the families face no contraints to human capital investment. This figure is consistent with other estimates of expected bequests. See McGarry (1999).
[12] Behrman and Taubman (1990) cite evidence from Zeldes (1989) and others that short-term liquidity constraints impede persons from smoothing consumption over the life cycle in the United States. This may mean that earnings at the time of critical educational investments, rather than permanent earnings are important.
[13] Han and Mulligan (2001) point out a number of biases that may also interfere with trying to parse out the effect of parents' earnings on children's earnings into the separate components of human capital investment (γ) and the inherited endowment (η). The analysis in this paper is focused on the combined effect, β.

which do not impose a structure on the relationship might yield a more reliable picture of differences in intergenerational mobility.

There is one paper which employs such a flexible analysis. Corak and Heisz (1999) use a nearest-neighborhood estimator of locally weighted least squares regressions on a sample of about 33,000 Canadian father-son pairs. They plot the nearest neighbor estimates for son's log earnings alongside those from a least squares regression on the same data. Not only does the least squares regression line lie outside of the 95 percent confidence interval for the semi-parametric estimates, but the semi-parametric relationship between father and sons earnings is very non-linear. At the very bottom of the distribution there appears to be either no relation or a negative relationship between father and son's log earnings, the relationship then increases steadily at higher levels of father's earnings, peaking at .3 at the median.[14] Their OLS estimate of the relationship yields a coefficient of .2.[15] Corak and Heisz conclude that the inverted V-shape for the relationship between father's earnings and the elasticity of son's earnings is consistent with the non-linearities postulated by theory in Becker and Tomes.

The results of Corak and Heisz (1999) prompt one to take another look at differences in intergenerational mobility across the distribution in the United States. The transition matrix evidence for the U.S. suggested substantial immobility at the top and bottom of the earnings distribution, but the bias towards finding less mobility because of ceiling and floor effects limits the conclusions one can draw. To date, the regression evidence is mixed and the tests of non-linearities have low power due to the restrictive parameterizations used in these analyses.

In the next section, differences in the intergenerational earnings relationship between fathers and sons and fathers and daughters are examined using semi-parametric estimates from locally weighted smoothed regressions. These smoothed semi-parametric relationships will be used to suggest a particular

[14] Corak and Heisz (1999), Figure 3a and p. 524.

[15] ibid., p. 527. Solon (1992) demonstrates that β's of .2 and .4 correspond with meaningful differences in intergenerational mobility: when β=.2, a son whose father is in the bottom 20% of the earnings distribution

form for a piecewise linear spline or other parameterization for the parent-child earnings relationship. An advantage of the spline is that one can include additional covariates to directly control for age differences and time effects. Moreover, using the spline estimates, testing whether or not the coefficients on different segments of the father's earnings distribution are equal offers a direct test as to whether or not the intergenerational earnings relationship is linear. The guidance from the semi-parametric estimates will minimize errors in specifying where the knots of the spline should lie.

IV. Data

The sample consists of father-son and father-daughter pairs from the 1968-1993 waves of the Panel Study of Income Dynamics (PSID). The PSID started in 1968 and collected information on a representative sample of U.S. households, and a second sample focusing on poorer households. The survey collected information on the earnings, education and income of the household head and spouse as well as demographic information on each individual in the household. It is one of the longest and largest panels containing non-retrospective information on multiple generations of families in the United States.

I use both the representative SRC sample and the Survey of Economic Opportunity (SEO) oversample of poor households that comprised the first wave of the PSID. There has been significant attrition in the panel, both from the original 1968 households and as children split off from these households. The inclusion of the SEO sample will help compensate for the fact that individuals with low levels of education and from low income households have been more likely to attrite from the panel.[16]

To ensure correct father-child matching, the sample only includes children under 18 living in 1968 households.[17] After eliminating children who are never observed as either a household head or wife in the PSID, children who die, and fathers who are self-employed, there are 2,092 father-son and 2,326 father-

has a .37 chance of having earnings above the median, but only a .24 chance if β=.4.

[16] See Fitzgerald, Gottschalk, and Moffitt (1998), p. 342-343.

[17] No distinction is made between biological and non-biological fathers in this sample.

daughter pairs in the sample. The focus is on father's rather than mother's earnings, because fathers are the principal earners in most households, providing on average 89% of the household's earnings.[18] Lillard and Kilburn (1997) have shown that conditional on father's earnings, mother's earnings has no effect on son's earnings and little effect on daughter's earnings, so the exclusion of mother's earnings is unlikely to impart much bias.[19]

One of the main issues in estimating the degree of intergenerational transmission is obtaining good measures of earnings and income. Both the Becker-Tomes model and several authors stress that permanent earnings rather than the year-to-year reports typically found in survey data is the correct measure to use. Solon (1992), Zimmerman (1992), and Altonji and Dunn (1991) demonstrated how using multiple year averages of parental income or earnings can reduce the downward bias from transitory variation in earnings. Therefore, I take an average of annual earnings reports over five years for the fathers and over three years for sons and daughters. To be included in the sample, there had to be at least two years of non-missing earnings information in any of the PSID waves from 1969-1993 for the adult child after they have left their 1968 household. For fathers, there had to be at least three years of non-missing earnings information between 1968-72.

To the extent that even multiple year observations on individuals only capture part of their earnings history, the age differences also will affect the estimates. Thus almost all models employ some adjustment for age. Following most other authors who have examined intergenerational mobility in the PSID, I take father's earnings from the 1968 through 1972 waves. The objective of taking the earliest waves is to minimize the difference between the stages of life cycle at which parents and children's earnings are measured. An added advantage of using the first five waves is that the sample of fathers will be the least

[18] Conditioning on fathers' earnings means that single mothers and their children are excluded from the analysis. While they are disproportionately in the bottom of the distribution (mean earnings for my sample of single mothers in the 1968-72 waves is about $11,000), 127 mother-son and 84 mother-daughter pairs would be added to the sample. I repeated the analyses including these pairs in the sample and their inclusion did not change the results.

[19] In results not presented here, using family earnings instead of father's earnings produced similar results. These

affected by attrition. Earnings are ignored before age 24 and after age 65, when the degree of participation in the labor market may be very different than in an individual's prime earnings years. By imposing the age and non-missing earnings restrictions on the sample, 444 of the father-son pairs and 385 of the father-daughter pairs were eliminated from the sample.

I further limit the sample to persons with a full-time commitment to the labor force.[20] The labor supply restriction will preclude confounding low earnings at a full time job with low annual earnings because of less than full-time labor supply.[21] When I condition on being a full-time worker during the years in which earnings are measured, it eliminates 632 of the daughters in the sample, but only 183 sons. Another 200 daughters and 227 sons are excluded because they have missing labor force participation data. Missing or low labor force participation of the father resulted 342 fewer father-son pairs and 316 fewer father-daughter pairs. For the empirical analysis, this leaves a sample of 1689 father-child pairs, 896 of whom are sons and 793 who are daughters.

There is some concern that the results for daughters may be biased by selection into the labor force. The difficulty in controlling for heterogeneity in female labor force participation has prompted many authors to limit their intergenerational analyses to fathers and sons.[22] If the selection into the labor force for daughters is positive, it may inflate the returns to human capital for daughters and raise the estimate of β, thus understating the degree of intergenerational mobility. If less able women are more likely to work because they have less attractive prospects in the marriage market, then negative selection may reduce the measured effect of intergenerational transmission of human capital through father’s earnings. What matters, however, is whether or not there is differential selection of daughters across the distribution of

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estimates are available upon request from the author.

[20] The persons had to have usual weekly hours of at least 35 hours per week for 50% of the years in which they report earnings.

[21] Selecting on women with a strong commitment to the labor force will also minimize the fluctuations in permanent earnings which might result from women dropping in and out of the labor force for childbirth. Women who work full-time may be less likely to drop out of the labor force for long periods of time.

[22] Behrman and Taubman (1985), Altonji and Dunn (1991), Peters (1992), Couch and Dunn (1997), Warren and Hauser

father's earnings. In the analysis, the degree of intergenerational mobility is determined by how these women do relative to one another, not relative to men. If the selection affects all women equally, then it may not affect the relative comparisons across the distribution.

When I look at the decrease in the daughters' sample due to either not working or low labor force participation, there are differences in daughter's labor force participation by father's earnings quartile. A higher fraction of daughters whose fathers are in the top half of the earnings distribution work full-time. In the top two quartiles of father's earnings distribution, between one-fifth and one-quarter of the otherwise eligible father-daughter pairs are dropped from the sample because the daughters do not work full-time. Over 30% of daughters whose fathers' earnings were below the median, however, were excluded because they did not work full-time. A full structural model of labor supply is beyond the scope of this paper, but a comparison of education differences in daughters who are excluded from the sample for not working full-time with those that are in the sample suggests that any selection operating through human capital investment is positive across the distribution of father's earnings. In every quartile of father's earnings, daughters with full-time participation in the labor market have significantly higher levels of education than those who are excluded for low labor supply.

Table 1 presents summary statistics for age and earnings of fathers, sons and daughters.[23] For more than 67% of the sample, I have observations on five years of father's earnings. The average age of fathers over this period is 40, when they are in the middle of their prime earnings years and on the portion of the age-earnings profile where it flattens out.[24] In the father-son sample, father's average annual earnings was $33,812. The lowest earner averaged $4,357 and the top earner made $113,151. Father's average earnings was $34,455 and ranged from $6,114 to $119,393.

(1995) and Lillard and Kilburn (1997) look at both sons and daughters.

[23] All earnings data are adjusted to 1992 dollars using the CPI for 1967-92; the PSID earnings data refer to your earnings in the last year and therefore earnings in the 1968 survey correspond to 1967.

[24] See Chapter 4 in Mincer (1974).

For the children's sample, there is a tradeoff between trying to take the observations when they are farthest along on their life-cycle earnings path and sample attrition. I average earnings over three years and take the latest available average for each son or daughter. Indicator variables are included in the regression for the year at which the child's earnings is observed to control for business cycle effects. For over 60% of the sample, the earnings data were taken from 1990-92, and only for 8%, were earnings pre-1986. I take 3-year averages instead of 5-year averages for the adult sons and daughters to preserve as many observations as possible.

The average age of sons is 33, 3.5 years older than the sample of eldest sons from the 1984 PSID examined by Solon (1992). At the mean, sons earned $30,147 and their earnings range from $1,568 to $124,142. Daughters are approximately the same age, and not surprisingly, earn less. Mean earnings for daughters is $21,134 and ranges from a low of $1,661 to a high of $178,098. The mean earnings of sons and daughters in the sample is lower than mean earnings for a comparable group in the U.S. population, according to data from the 1992 Current Population Reports.[25] This is likely the result of including the poor and minority oversample in analysis. If the PSID sample is limited to sons and daughters who were in the 1968 representative sample, the mean for PSID sons is approximately the same as in the Current Population Report, and for PSID daughters, the means are much closer.

One concern with using the PSID is attrition in the panel over time. Fitzgerald, Gottschalk and Moffitt (1998) find that persons with lower education levels or from lower income households are much more likely to have attritted from the PSID. Still, the authors find that such observable characteristics, while being significantly related to the probability of attrition, explain at most 10% of the attrition in the PSID samples, and by some estimates, as little as 2-3% of the attrition. They conclude that any bias in estimating intergenerational relationships is likely to be small. The attrition of sample members from the

[25] Mean earnings for male, full-time, year round workers aged 25-44 was $34,636 in 1992, according to author's calculations using figures reported in the U.S. Bureau of the Census's Current Population Report, Series P-60. The mean for a similarly defined sample of females was $24,602.

bottom of the parental earnings distribution is one motivation for including the oversample of poor households in the analysis.

The sample in this paper is defined very similarly to past intergenerational analyses using the PSID. This is borne out by comparing the results of OLS regressions in Table 2 of children's log earnings on father's log earnings and a quadratic in the children's and father's ages with results in the literature. For sons, Solon (1992), Zimmerman (1992), and Behrman and Taubman (1990) all find a coefficient of .4 on father's log earnings and the coefficient in Table 2 is also .4. Shea (1999) has similar estimates on intergenerational mobility for daughters and obtains a coefficient of .45 on father's log earnings, which is similar to my estimate of .42. Generally, the OLS regression results in Table 2 suggest that the sample used in this paper can be considered comparable to those used in past analyses of intergenerational mobility in the U.S.

V. Empirical Results

To examine the functional relationship between father's log earnings and children's log earnings, I estimate the relationship between father-son and father-daughter earnings using a semi-parametric technique. The semi-parametric technique creates smoothed values of the log of children's earnings from father's log earnings using linear nearest neighbor estimates which does not impose a specific form by which the slope might change over the distribution of father's earnings.[26] The estimation procedure uses 15% of the sample on either side of each observation.[27] Since complete spans are censored at the bottom and top of the distribution and therefore the estimates are not as well behaved, I drop fathers with the

[26] These models are estimated using Stata's "running" procedure.

[27] The span value is .3 or 30% of the observations overall (15% on either side). This bandwidth is larger than the default of .26 suggested according to the formula given by Sasieni and Royston (1998), but when the semi-parametric plots are estimated using this smaller bandwidth, they produce curves that appear undersmoothed, but are otherwise approximately the same shape.

lowest and highest 5% of earnings from the sample when plotting the estimated relationships between father-child earnings.

The slope of the lines are an estimate of β, the degree of intergenerational earnings transmission. Children's earnings are independent of their father's when the slope of the line approaches zero, and there is complete immobility as the slope approaches one. If the slope of the smoothed semi-parametric relationship between father's and son's or daughter's earnings is steeper over a certain portion of the distribution, this will suggest a parameterization that can be estimated in a framework in which the non-linearities may be tested directly.

I also estimate 95% confidence bands for the smoothed estimates of offspring's earnings to describe the precision of the estimates and compare it with the graph of the ordinary least squares line. If the semi-parametric estimates are reasonably precise and the OLS line lies within the confidence interval, then one cannot necessarily say that this approach offers a better depiction of the relationship between parent and child earnings.

To account for age effects, I compute an age-adjusted log earnings measure. Separate OLS regressions of log earnings on age and age squared were estimated for fathers, sons and daughters.[28] The predicted value of log earnings at the mean age in the sample was then added to the individual-specific residual to obtain the age-adjusted earnings measure.

The results are in Figure 1. The lower set of lines is the estimated intergenerational log earnings relationship between fathers and daughters; the upper set of lines is for fathers and sons. The heavy line in Figure 1 gives the relationship between father's and son's/daughter's log earnings. The thinner lines surrounding them are the 95% confidence bands, and the straight lines are the estimated linear relations from Table 2.

[28] This same technique was used by Peters (1992). Quartic specifications in age were explored but did not predict earnings any better than the quadratic specifications.

The relationship for sons has a steady upward slope and from looking at the figure, the slope appears to get steeper where father's log earnings reaches 9.98. The relationship seems to flatten out again when father's log earnings reaches 10.7. This range corresponds with the 26th through the 80th percentile of the father's earnings distribution. Over this middle segment of the distribution, the semi-parametric estimate is steeper than the linear estimate. At the bottom and very top of the distribution, the semi-parametric estimates are flatter than the least-squares estimate. Still, the least-squares line lies within the semi-parametric estimate's confidence interval over most of the distribution, thus indicating that the semi-parametric estimates are not significantly different than the linear intergenerational earnings relationship for sons. The lack of precision in the non-linear estimates in such a small sample, however, may be interfering with the ability to distinguish between the linear and semi-parametric estimates of the intergenerational earnings relationship for fathers and sons.

For daughters, the semi-parametric estimate is flatter through the first quintile of the father's log earnings distribution, until log earnings equals 9.8, and then becomes steeper through the rest of the distribution. The semi-parametric estimate is not very smooth through the middle of the father's log earnings distribution, which makes it difficult to interpret whether there is an increase in the slope of the relationship. There is some suggestion that the slope flattens out after father's log earnings reaches 10.6, but it does not become distinctly flatter as in the case for sons. Again, the OLS line is almost always within the 95% confidence band for the semi-parametric relationship.

These semi-parametric estimates of son's and daughter's earnings as a function of their father's earnings suggest a slightly steeper slope through the middle of the distribution, but the shape is more like a piecewise linear spline rather than a cubic or quadratic relationship.[29] For both sons and daughters, the estimated relationships are not far off from those obtained from OLS regressions, but this may simply

[29] A cubic specification was estimated, however, it did not predict earnings as well at the bottom of the distribution.

reflect the lack of precision in the semi-parametric estimates. Regardless, the results are not suggestive of a poverty trap, where the slope is steepest at the bottom of the distribution.

To further test whether these differences in the degree of intergenerational mobility matter, I estimate linear splines, using where the semi-parametric graph appears to change slopes as a guide for where to set the knots. If the knots are reasonably specified, one can test whether or not the coefficients are equal across the different segments. The splines are estimated first separately for sons and daughters, and then, since the lines in Figure 1 are roughly parallel and the changes in slope at the bottom of the distribution are not too far apart, a set is estimated in which sons and daughters are pooled.

In Figure 1, the change in slope for sons appears to correspond with father's log earnings of 9.98 and 10.7 or about \$21,600 and \$44,400, respectively. For daughters, the slope appears steeper after the first quartile and father's earnings rise above \$18,000. The imprecision makes it difficult to discern whether the slope is steeper between 9.8 and 10.6, so I allow that segment to have a different slope and test to see if it is significantly different than the slope for the top half of the distribution. When pooling sons and daughters, I set the knots at 9.98 and 10.6.[30]

Table 3 gives the results from the splines for father-son pairs, the results for fathers and daughters are in Table 4, and the pooled results are in Table 5. All the regressions include controls for both the father's and the child's age and age squared, and indicators for the year in which the child's earnings were measured.

For sons, the slope coefficient on father's log earnings in the middle part of the distribution is .58, more than double the slope in the bottom half of the distribution and also larger than that for the top quintile. It is also bigger than the OLS estimate of the coefficient on father's log earnings. Since the F-test did not reject that the coefficients for fathers whose log earnings were between 9.98 and 10.7 and those whose earnings were greater than 10.7 were equal, spline estimates from a regression in which

[30] Using either 9.8 and/or 10.7 instead, both the point estimates on father's log earnings and the tests for non-

these two groups were combined are in the second column of Table 3. In both specifications, the F-tests for equality of the coefficients indicate that the slope at the bottom of the distribution of father's earnings is significantly lower than the coefficient for the middle and upper portions of the distribution.

The results in Table 4 indicate that the effect of father's earnings on daughter's earnings is also not the same across the distribution. In the bottom quintile, the coefficient on father's log earnings is not significant and is less than one-half the size of the coefficients on the other two segments. The coefficient for the bottom of the distribution is much lower than the OLS estimate. The coefficients for the segments where father's log earnings are between 9.8 and 10.6 and greater than 10.6 are close at .50 and .55, respectively, and are larger than the least squares estimate of .42.

The F-tests indicate that the intergenerational earnings relationship for daughters is significantly different at the 5% level over the distribution of father's earnings. As in the case of sons, the pairwise F-test for the upper two segments of the distribution indicated that the coefficients on father's log earnings were not significantly different, so they were combined and the second set of spline estimates are in the right-hand column of Table 4. Again, at the bottom of the distribution, father's earnings have no effect on daughter's earnings, but in the upper portion of the distribution there is a strong effect.

The results in Table 5, where sons and daughters are pooled, corroborate the findings in Tables 3 and 4. An indicator for female is included to shift the intercept down for daughters. The effect of father's earnings at the bottom of the distribution is .19 in column 1 and .17 in column 2, less than half the degree of intergenerational earnings transmission observed in the middle and upper parts of the distribution. The slope on the bottom quartile of the distribution is estimated precisely enough in this larger sample to be significantly different from zero. The larger sample also yields more precise estimation of the segment at the top of the distribution. The F-tests in column 1 indicate that there is weak evidence of father's earnings having less impact on children's earnings in the top quintile of the distribution (rejecting

linearities produce similar results.

equality of the coefficients at 10%). In both columns 1 and 2, the estimates strongly reject that the degree of intergenerational earnings transmission is the same in the bottom quartile as in the rest of the distribution.

The spline estimates provide some evidence that the relationship between father-child earnings in the United States is not constant, whereas the semi-parametric estimates in Figure 1 did not. One concern is that the locally weighted regressions from which the relationship in Figure 1 was derived were estimated on a very small sample and as a result, are imprecise. While no larger sample is available, the graphs and splines were re-estimated for a number of alternative samples and with alternative earnings definitions and produced largely similar results. Using non-recession years to measure sons and daughters' earnings (cutting off the sample with the 1989 wave), using family earnings instead of father's earnings, using only observations where 3 years of children's earnings and 5 years of father's earnings were available, and excluding the oversample of poor households did not appreciably change the coefficients on father's log earnings or the test results for non-linearities.[31]

As noted by Corak and Heisz (1999), the U.S. has less intergenerational earnings mobility for sons than Canada as measured by OLS, and as described in Gottschalk and Smeeding (1997), more inequality. So why does the U.S. relationship in Figure 1 appear more linear? In Corak and Heisz's graph of the non-linear relationship between Canadian father's and son's earnings (see their Figure 3a), the least-squares estimate is outside of the non-linear estimate's confidence interval over the majority of the distribution—rejecting a linear specification. Yet despite the results in Tables 3-5, Figure 1 does not indicate significant non-linearity. This difference may be due to the data used in each analysis. Corak and Heisz have access to linked father and son earnings from tax records for an extremely large and representative sample of Canadian males.[32] No such administrative, large, representative data are available for the United States.

[31] Available from the author upon request.
[32] Corak and Heisz (1999) use 334,018 father-son pairs for their transition matrix analysis and a random subsample of 33,660 of these pairs for their semi-parametric and regression analyses.

The PSID provide the best available data for such an intergenerational analysis in the United States, but yield a much smaller sample of father-child pairs. The precision of the graphical estimates in a larger sample may reveal these differences to be significant.

The relative differences in scale and the way the coefficients change is consistent with there being greater within-generation earnings inequality in the U.S. Although children whose fathers were at the bottom of the earnings distribution have less earnings transmission in both countries, Corak and Heisz's estimate of the degree of earnings transmission at the bottom of the Canadian distribution is .1, indicating more mobility than in the U.S. where the estimate from this analysis is .2.

Middle class families in the United States also have a much higher degree of intergenerational earnings transmission from parents to children—and less mobility—than in Canada. In Canada, the maximum estimated degree of earnings transmission is .3, which is lower than the U.S. estimates of .5 to .6. What also differs is where the relationship becomes steepest and the proportion of the distribution with a high degree of earnings transmission. In Corak and Heisz's sample, families just below the median have the greatest degree of persistence in earnings followed by increasing mobility at high levels of father's earnings. For both women and men in the U.S., the shift to less intergenerational mobility (more transmission) occurs around the bottom quarter of the father's earnings distribution and persists well beyond the middle of the father's earnings distribution. One possible explanation is that costs of human capital investment constrain U.S. parents in the middle of the earnings distribution more than in Canada.

VI. Conclusion

This paper aimed to document whether intergenerational earnings transmission differed across the distribution of father's earnings in the U.S. The semi-parametric techniques used in this paper are an improvement over previous work that had analyzed differences in intergenerational earnings mobility because they were not subject to the floor and ceiling bias of transition matrices and because they did not impose a particular functional form for non-linearities in the relationship.

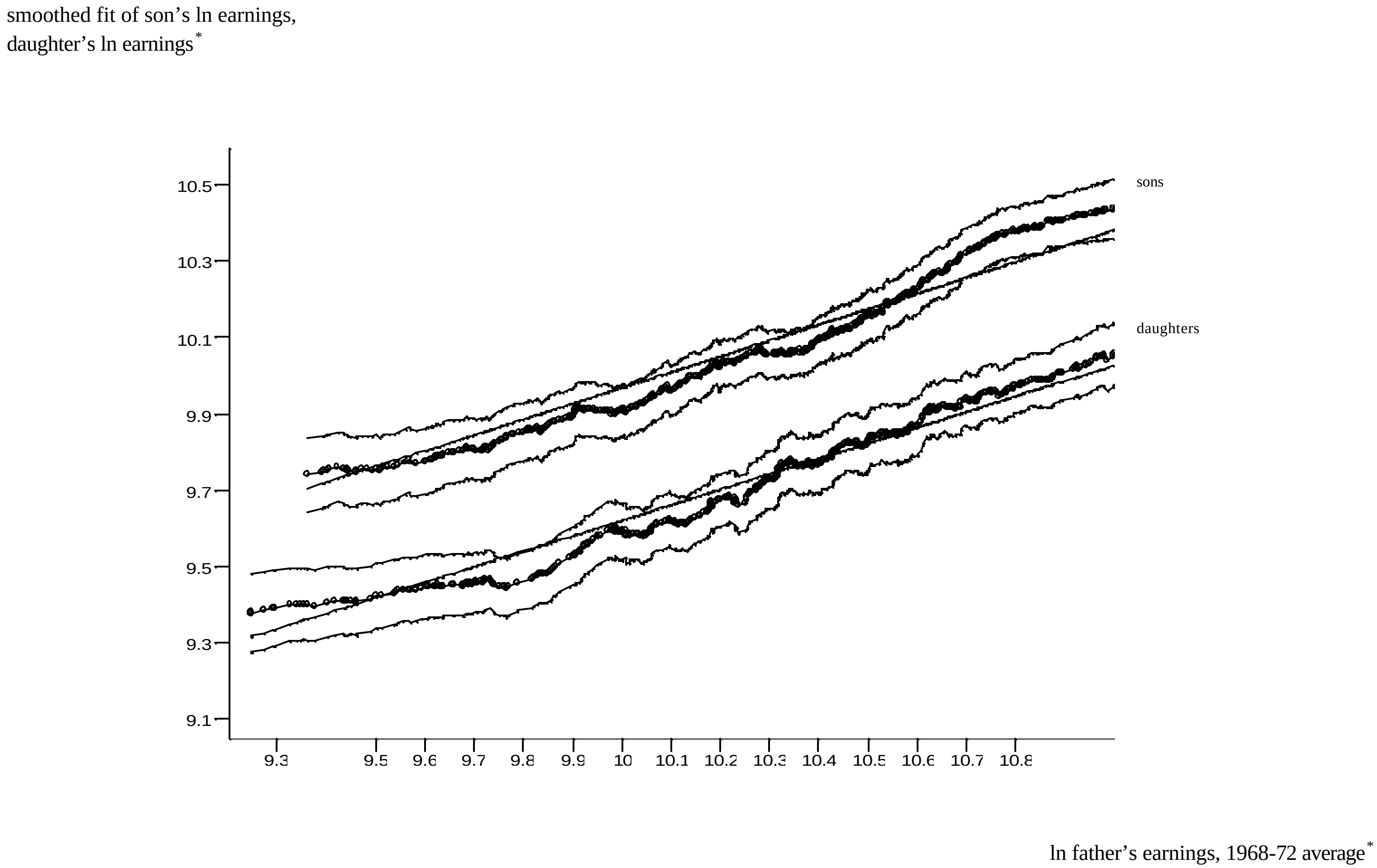
While the results in Figure 1 cannot reject linearity, this may be the result of a lack of precision from such a small sample. More direct tests for linearity in the spline regressions indicate that the degree of intergenerational transmission of earnings is lower at the bottom of the father's earnings distribution. In comparison, the results from using a linear specification to estimate the degree of intergenerational mobility results in understating the degree of mobility for the bottom of the distribution and overstating the degree of earnings mobility for those above the 25th percentile of the earnings distribution.

As mentioned in Section 2, there are other explanations for finding less earnings mobility in the middle and upper parts of the distribution. One is that the effect of increased endowments at higher levels of earnings on the demand for human capital investment is greater than the reduction in liquidity constraints. Therefore, the parents of the poorer child will be less constrained in making the lower optimal level of human capital investment for their child, while those from the median household will be more constrained.

Another possible explanation may be due to the increase in disparity between the wages of more highly skilled and less skilled workers. Earnings of less skilled workers have remained fairly flat over the past two decades, while earnings of more highly skilled workers have grown rapidly. If parents failed to foresee these relative changes in the returns to various levels of human capital investments, then parents at the bottom of the earnings distribution may have underinvested in their children's human capital. If these children are more likely to do worse than their fathers, then the regression estimates will show a weaker relationship between father's and children's earnings for this portion of the distribution.

If a larger data set containing earnings for both parents and children were available, perhaps the graphical estimates would have provided more definitive evidence. Nonetheless, the regressions presented strong evidence of less earnings transmission at lower levels of father's earnings. Further investigation of differences in intergenerational mobility that attempt to examine the human capital investment component separately, as described in Han and Mulligan (2001), might shed more light on these differences and their implications.

Figure 1: Semi-parametric estimates of the father-son and father-daughter intergenerational earnings relationship



* earnings data are adjusted for age, see text for details

Table 1
Sample Statistics for PSID Fathers, Sons and Daughters

	mean	median
Father-son sample (n=896)		
father's earnings	33,812	31,441
	(568)	
log father's earnings	10.28	10.34
	(.019)	
age of father	40	40
	(.24)	
proportion of fathers with 5 years of earnings data	.67	
	(.016)	
son's earnings	30,147	26,791
	(564)	
log son's earnings	10.12	10.17
	(.020)	
age of son	33	33
	(.14)	
proportion of sons with earnings from 1990-92	.68	
	(.016)	
Father-daughter sample (n=793)		
father's earnings	34,455	32,172
	(641)	
log father's earnings	10.29	10.37
	(.020)	
age of father	41	40
	(.25)	
proportion of fathers with 5 years of earnings data	.71	
	(.016)	
daughter's earnings	21,134	18,483
	(453)	
log daughter's earnings	9.76	9.79
	(.022)	
age of daughter	33	32
	(.15)	
proportion of daughters with earnings from 1990-92	.62	
	(.017)	

Note: Standard errors are in parentheses.

Table 2
OLS Regressions of Log Children's Earnings on Log Father's Earnings

	log father's earnings, 1968-72 average
Sons	
log father's earnings	.40 (.033)*
adjusted R^2	.24
n=896	
Daughters	
log father's earnings	.42 (.035)*
adjusted R^2	.21
n=793	

Notes: Standard errors are in parentheses. An asterisk denotes coefficient significance at 5%.

Table 3
Spline Regressions of Log Son's Earnings on Log Father's Earnings

	Two changes in slope (1)	One change in slope (2)
Coefficient on log father's earnings:		
log earnings ≤ 9.98	.21 (.091)*	
9.98 < log earnings ≤ 10.7	.58 (.088)*	
log earnings > 10.7	.36 (.13)*	
log earnings ≤ 9.98		.23 (.086)*
log earnings > 9.98		.51 (.054)*
adjusted R^2	.24	.24
sample size	896	896
F-test: coefficients on log father's earnings are different from zero	F(3,874)=44.94 (.00)	F(2,875) = 67.37 (.00)
F-test: coefficients on log father's earnings are equal	F(2,874)=5.19 (.006)	F(1,875) = 10.20 (.002)
F-test: equality of coefficients in 1st and 2nd segments	F(1,874)=7.50 (.006)	
F-test: equality of coefficients in 2nd and 3rd segments	F(1,874)=0.20 (.66)	

Notes: An asterisk denotes coefficient significance at 5%. Bootstrapped standard errors for the coefficients are in parentheses. The parentheses under the F-test statistics contain the p-value. Additional covariates in these regressions include father's age, son's age, father's age squared, son's age squared, and indicators for the year the son's earnings were measured.

Table 4
Spline regressions of Log Daughter's Earnings on Log Father's Earnings

	Two changes in slope (1)	One change in slope (2)
Coefficient on log father's earnings:		
log earnings ≤ 9.8	.17 (.12)	
9.8 < log earnings ≤ 10.6	.50 (.086)*	
log earnings > 10.6	.55 (.12)*	
log earnings ≤ 9.77		.16 (.12)
log earnings > 9.77		.52 (.051)*
adjusted R^2	.21	.21
sample size	793	793
F-test: coefficients on log father's earnings are different from zero	F(3,771)=54.86 (.00)	F(2,772) = 82.11 (.00)
F-test: coefficients on log father's earnings are equal	F(2,771)=7.79 (.00)	F(1,772) = 15.11 (.00)
F-test: equality of coefficients in 1st and 2nd segments	F(1,771)=12.16 (.00)	
F-test: equality of coefficients in 2nd and 3rd segments	F(1,771)=0.47 (.49)	

Notes: An asterisk denotes coefficient significance at 5%. Bootstrapped standard errors for the coefficients are in parentheses. The parentheses under the F-test statistics contain the p-value. Additional covariates in these regressions include father's age, daughter's age, father's age squared, daughter's age squared, and indicators for the year in which daughter's earnings are measured.

Table 5
Spline regressions of Log Children's Earnings on Log Father's Earnings

	Two changes in slope (1)	One change in slope (2)
Coefficient on log father's earnings:		
log earnings ≤ 9.98	.19 (.066)*	
9.98 < log earnings ≤ 10.6	.60 (.075)*	
log earnings > 10.6	.47 (.078)*	
log earnings ≤ 9.98		.21 (.062)*
log earnings > 9.98		.54 (.040)*
adjusted R^2	.29	.29
sample size	1689	1689
F-test: coefficients on log father's earnings are different from zero	F(3,1666)=129.40 (.00)	F(2,1667) = 191.98 (.00)
F-test: coefficients on log father's earnings are equal	F(2,1666)=11.63 (.00)	F(1,1667) = 19.58 (.00)
F-test: equality of coefficients in 1st and 2nd segments	F(1,1666)=20.10 (.00)	
F-test: equality of coefficients in 2nd and 3rd segments	F(1,1666)=3.65 (.056)	

Notes: An asterisk denotes coefficient significance at 5%. Bootstrapped standard errors for the coefficients are in parentheses. The parentheses under the F-test statistics contain the p-value. Additional covariates in these regressions include father's age, child's age, father's age squared, child's age squared, female, and indicators for the year in which daughter's earnings are measured.

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