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**Mincer's Overtaking Point
and the Lifecycle Earnings Distribution**

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Very preliminary version – For comments only

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Introduction: Mincerian Labor Economics

When I first contemplated graduate school, I visited Columbia University just the day Reuben Gronau presented his Ph.D. dissertation research. His topic entailed a time-allocation model to estimate SST travel demand based on saving hours from faster speed. The Economics Department was in Fayerweather Hall, but the seminar took place a half dozen blocks away in a dingy drab second floor room of an old building on 114th Street. Gronau was seated at the head. Perpendicular to him on each side were the leaders of the pack, Gary Becker and Jacob Mincer. Becker and Mincer were both brilliant, but with different. And the differences were stark.

Becker was outgoing, asking lots of questions and continually calling on students. By comparison, Mincer seemed taciturn, relatively reserved and introspective, questioning Gronau only sparingly and picking on students infrequently. I believe also at the seminar were Linda Edwards, Isaac Ehrlich, Victor Fuchs, Gill Ghez, Mike Grossman, Gioria Hanoch, Marjorie Honig, John Claude Koeune, Masatoshi Kuratani, Arleen Liebowitz, Bob Michael, Dave O'Neill, June O'Neill, Beth Niemi (now deceased), John Owen, Mike (Carl) Rahm, and possibly Finis Welch. I realized those present were the world's best, brightest and most talented young labor economists, whose brand labor economics differed from the simple institutional approach I had seen and dismissed as an undergraduate. Obviously exciting major changes were occurring in labor economics and they were happening at Columbia University. Columbia was a place where labor economists ate, breathed, and dreamt economics. That's all they talk about; it was total emersion. By the time the seminar finished I was convinced that I wanted to be apart of that group. I knew Columbia was for me, so I enrolled; and I am glad I did.

Indeed, over the next year or two it got even better. Barry Chicwick and Bill Landes returned with Bill bringing his new wife Lisa. Jim Heckman arrived with immense curiosity and boundless energy. Soon Anne Bartel, Andrew Beller, George Borjas, Nori Hashimoto, Cynthia Lloyd, Margaret Ludlum, Cordelia Reimers, Mark Rosenzweig, Jacob Paroush, Fredericka Pickford Santos, Carmel Ulman, Harriet Zellner among others, joined the labor seminar. Columbia had the very best, all in one place. I

could see that Becker's and Mincer's advocacy of the price theoretic approach as a tool to understand many social problems attracted the best of Columbia's students to labor economics. Anyone that was anyone in labor was at Columbia during the 1960's and early 1970's. I was lucky to arrive just at the peak.

Mincer was a perfectionist. Both in his own work and in guiding others. He professed solid theory with an eye toward rigorous empirics. As I'll mention later, Mincer's notion of rigorous empirical research was not necessarily sophisticated multi-equation, non-linear maximum likelihood estimation, but instead to apply a sound specification to a number of data sets to assess what you might call robustness, Mincer style. He was reluctant to let a student finish until he was convinced no stone was left unturned to verify a thesis' assertions.

Students, on the other hand, had another idea of rigor. They would bring Mincer their wife and kids to somehow convince him they needed a job to support their family, hoping to get his approval for a dissertation defense, in order to get on with their life. Perhaps then would he consider consenting that yet another additional regression with another dataset might not really be necessary for the degree, "even though surely, it would be mandatory for publication". Thus, even the paper Jacob and I did together didn't satisfy him until he completely redid the entire draft and reran the entire set of regressions stratified by three different educational groups. For the extra work, I owe deep gratitude to George Borjas, who served as the final research assistant for this latter stage of analysis.

But especially in his own work, Mincer was a perfectionist. When I first got to Columbia I took the typical core courses: Jacob's statistics course, Gary Becker's micro-theory course and Albert Hart's macroeconomics course and Philip Cagan's monetary theory course. During that first year, I attended a faculty student reception and asked Jacob about labor economics. He said, "It's simple. There're supply and demand." Well I took his course, and the first semester we studied labor supply, the second we studied how employees supply the market with human capital, but we never did get to labor demand. Finally, at Jacob's Columbia University retirement party in May 1990, I got the courage to ask him about labor demand. He said "wait, there's still time." Well I'm happy

to say that in Jacob's 1997 paper on changes in wage inequality (Mincer, 1997), he finally deals with how technology affects the demand for human capital. All I can say is that Jacob is such a perfectionist that it took him over 30 years to get supply in good enough shape to ultimately pursue demand.

Indeed Mincer was a perfectionist like no other. As I mentioned, his brand of perfection was to devise a theory then rigorously test it empirically. He thought that you really didn't have a viable theory unless you could see its implications *strongly* from *OLS* estimation. Thus he didn't use fancy non-linear estimation of the type that made Heckman famous, but instead he tested and re-tested his theory in as many ways as possible. Take School, Experience and Earnings as an example, not only did he derive an earnings function and fit it with data using a multitude of specifications (e.g. linear and exponential decay functions), but he looked at the theory's further implications regarding earnings distribution. For this reason, every Mincer theory is *robust*. Indeed probably the most frequently estimated equations in the history of economics are the Mincer-earnings equation and the Mincer female labor supply function. Both form the basis of all wage and employment studies.

To me, one of Mincer's most illuminating articles was his "Market Prices, Opportunity Costs, and Income Effects". The paper dealt with five topics (transportation costs, labor supply, the demand for domestic servants, fertility and search). Not only did each become a major field of labor economics research, but also when viewed more generally the paper could be construed as the impetus for much of the empirical labor economics literature. This is especially true regarding all serious research on gender. As such, it would not be unreasonable to consider Mincer a founding father of modern labor economics. As father of modern labor economics, Mincer himself concentrated primarily on two major areas: labor supply and human capital. But within these major branches of labor economics he also wrote about education, on-the-job training (which he sometimes called post-school investment), wage floors, labor turnover, economic developments, technology, unemployment, and even on the accuracy of economic forecasting models. His important work on human capital and labor supply is put together in a two-volume set, Studies in Human Capital: Collected Essays of Jacob Mincer Volume I and Studies in Labor Supply: Collected Essays of Jacob Mincer, Volume II (Cambridge: Edward

Elgar), 1993. But since then, he wrote additional articles, two of which are published in Research in Labor Economics.

Because today's panels break up Mincer's work into two parts, I concentrate on Mincer's path breaking contributions how human capital theory explains earnings distribution.

The Topic: Mincing the Earnings Distribution -- A Human Capital Approach

Mincer was not the first scholar to examine the distribution of earnings. But he *was* the first to use the analytical techniques of capital theory in an extremely innovative way. His discoveries clearly contributed more to understanding economic wellbeing than probably the work of any other individual. By developing a very parsimonious model employing only schooling, age, and weeks worked per year as variables, he was able to account for about 60 percent of the variation in U.S. earnings. His resulting functions have been applied in literally dozens of countries with the same resounding success achieved with US data. Invariably schooling rates of return are in the 5-15% range, exactly the same range as high-grade commercial investments. Similarly all cross-sectional earnings profiles proved concave, just as he predicted.

To understand worker earnings, as Mincer did, gets at the very core of economics. Indeed comprehending the determinants of earnings helps policy makers develop tactics to help ease poverty. Mincer's work shows that luck or decree do not that lessen poverty, but instead concerted individual investments in human capital raise earnings and ease hardship. Even the less able low ability workers can benefit from training. Mincer's insights led to viable policies increasing overall wealth. As such, Mincer's insights have strong implications for growth, as many have shown. (e.g. Barro and Sala-i-Martin, 1999).

Early economists looked at the functional distribution of income i.e., labor's share. But how labor's share is divided is also crucially important. Before 1958 (when Mincer published his first article on human capital based on his Columbia University dissertation), the reigning earnings distribution theories relied mostly on stochastic chance to determine who succeeded financially, and who did not. As such, theory offered

no economic insights into the distribution process.² As Victor Fuchs states, "... The subject [of Mincer's classic Schooling, Experience, and Earnings] is earnings inequality, but the reader will look in vain for references to unions, monopsonists, minimum wage laws, discrimination, luck and numerous other institutional factors that are frequently introduced in such studies" (Fuchs, in J. Mincer (1974): xiii). Adopting notions of Adam Smith's theory of compensating differentials coupled with Friedman's notions of "tastes for risk and hence to choices among alternative [work options] differing in the probability distribution of the income they promise" [Mincer, 1974: 6], Mincer was able to come up with an entirely new theory. His innovation was to realize that these choices produced income streams easily evaluated using capital theory. As such, treating schooling and occupation as investment opportunities, he modeled the outcome of individual investment choices.

Although Mincer came up with these innovations in the late 1950's, human capital's roots go back to Sir William Petty who considered labor "the father of wealth" (Kiker, 1971, p. 61). Indeed according to Kiker, "Human capital was somewhat prominent in economic thinking until Marshall discarded the notion as 'unrealistic' (ibid., p. 51) ... since human beings are not marketable" (ibid., p. 60). The very early human capital studies (e.g., Say, Senior, List, von Thünen, Engell, Walras, Fisher (according to Kiker, p. 51), and de Jovellanos (not to be forgotten according to Street, 1988)) dealt primarily with the capitalized value of labor. Of particular concern was applying the concept to measure national wealth and the changes in national wealth caused by war (e.g., Guyot, 1914 and Boag, 1916). Not considered were life cycle aspects, though in 1924, S. G. Strumlin calculated (without appropriate discounting) returns to education and on-the-job training for a group of (Russian) metal trade workers, and in 1935 J. Walsh produced tables essentially containing age-earnings profiles for law, engineering and medicine.

² Perhaps most well known was Gibrat's theory modified by Kalecki and Rutherford. These theories point out that a log-normal income distribution results when individuals are bombarded annually with random percent income augmentations, perhaps as a result of 'luck' or 'chance.' The distribution's overall variance is preserved over time/stays constant either "if there is "a negative correlation between the size of the random shock and the level of income (Kalecki)" [Mincer p. 5] or if the random shock is applied "without restriction separately to age cohorts throughout their life histories"[Mincer p.5]

The Mincer Earnings Function

Mincer in his quest to devise econometric techniques to estimate these returns, is the first to model human capital investment using capital theory's mathematical tools. By realizing that opportunity costs constitute the bulk of training costs and by making use of the fact that the internal rate of return emerges when individuals invest up to the point where investment costs just equal the present value of schooling gains, he obtained a simple and tractable econometric specification leading to the now famous log-liner earnings function. The so-called Mincer school model was published in 1958 and the more general model encompassing on-the-job training in 1970.

Not only did this formulation provide a measure of private returns to schooling, but it generalized to get at post-school on-the-job training, as well Mincer's measures of on-the-job training are contained in his 1962 article updated in Mincer (1993).³ On-the-job training accounts for between 11 and 15% of total worker compensation (ibid., p. 279).

³ In his earnings function derivation Mincer ingeniously formulates investment in "time equivalent" terms because dollar investments are not easily observed. As such he defines k_j to be the ratio of dollar invest C_j to earnings capacity E_j . Thus

$$C_j = k_j E_j$$

and

$$E_j = E_{j-1} + rC_{j-1} = E_j (1 + rk_{j-1})$$

By recursion,

$$E_j = E_o \prod_{t=0}^{j-1} (1 + r_t k_t)$$

If $k \leq 1$ and r is relatively small

$$\ln Y_j = \ln E_o + \sum_{t=0}^{j-1} r_t k_t$$

Since

$$Y_j = E_j (1 - k_j)$$

we get

$$\ln Y_j = \ln E_o + \sum_{t=0}^{j-1} r_t k_t + \ln(1 - k_j)$$

If $r_j = r_p$,

$$\ln Y_j = \ln E_o + r_s S + r_p k_j + \ln(1 - k_j)$$

Assuming a linear declining k_j , implies the familiar quadratic specification used for estimation

$$\ln Y = a_0 + r_s S + a_1 t + a_2 t^2 + e.$$

For an alternative derivation, see Becker and Chiswick (1966).

Mincer's empirical work also showed that a worker's wages consistently rise over the life cycle at a decreasing rate, yielding a concave earnings profile for most individuals. Not only does human capital theory explain this concavity, but human capital theory has strong implications concerning the rate at which earnings rise at each phase of the life cycle. Human capital theory also explains gender, race, and ethnic differences in earnings, geographic and job mobility, occupational choice as well as labor turnover, unemployment and other labor market issues. But these applications came later in the development of human capital theory.

Before going on, let me note that other theories of earnings are now becoming popular. The most recent approaches involve incentive based compensation schemes. In these models, firms provide an earnings contract to maximize effort and hence productivity. Whereas, some argue that these contract models complement human capital in explaining wages and other labor market phenomena; others argue that contract models substitute for the human capital model. In the Contemporary Labour Market Issue of the Scottish Journal of Political Economy, I laid out a unified framework nesting both type models in order to determine the relative merits of each. In that article, I also surveyed tests of Mincer's human capital model along with extensions of the model. Now, in the next section of the paper I update part of that survey. Then, in the section after, I turn to new interesting unexplored international evidence testing implication of Mincer's "overtaking" age concept.

Proving Mincer Right: Tests of the Human Capital Model⁴

Education

By now all take for granted the positive correlation between earnings and schooling. Indeed there are so many empirical studies on the topic that it would be too difficult to do justice surveying even a subset. However, in a recent special edition of Labor Economics devoted to the topic, Ashenfelter *et. al.* (1999) note that "these studies provide us strong evidence that schooling is a powerful investment in a wide variety of

⁴ This section updates part of the literature review contained in Polachek (1995).

settings” (Ashenfelter *et. al.*: viii).⁵ Chiswick, Lee and Miller (2002) confirm this using data from the 1996 Australian Survey of Aspect of Literacy by in essence showing that “education is a value added process in which skills, including literacy and numeracy, are improved...” Further, though there are different interpretations, data indicate that school directly enhances real output. For example, Griliches (1963, 1964) used aggregate state (and regional) data to find far higher farm production in states with higher education levels. More recently, utilizing more appropriate micro-level information on 296 household farms in West Bengal, India, Kumbhakar (1996:188) showed “that education increases [actual] productivity” and that such effects increased farmer wages. Generalizing these results to economic growth, Barro and Sala-i-Martin (1999) find that the higher a population’s education, the higher its GDP and GDP growth per capita. Also educated immigrants assimilate far more quickly into the U.S. economy (Borjas, 1993, 1994). Thus education has direct measurable effects on productivity and labor market success.

Race, Education and Black-White Earnings Differences

Prior to ‘Brown vs. the Board of Education,’ blacks in the U.S. were relegated to separate but ‘equal’ schools. Welch (1974) argued that at least a portion of the black-white earnings gap is attributable to black school quality deficiencies. Using data from several age groups, he shows dramatic increases in educational rates of return to ‘newer’ vintage black cohorts. Welch attributes these greater schooling returns to increases in black school quality relative to whites. He proceeds to make a case that school quality is an important aspect of the black-white earnings gap. Despite its persuasiveness, the Welch study is limited because it contained no direct measures of per capita inputs for black compared to white schools. However, going back to state data, Card and Krueger (1992) rectified this deficiency by comparing direct measures of school quality. These include pupil-teacher ratios, annual teacher pay, and length of school term, all of which are linked to U.S. Census data. Changes in school quality explain at least 50-80% of the relative increase in black educational rates of return and at least 15-25% of the narrowing of the

⁵ Other recent work on this includes card (1998) and Heckman *et al* (1995).

black white earnings gap between 1960 and 1980. In addition, Card and Lemieux (1996) use changes in rates of return to explain black-white differences over the 1980s. While some might offer explanations other than human capital, there is a striking consistency with human capital predictions: education positively enhances labor market success, and better schools do the same.

Earnings Function Concavity

Turning back to the earnings function and post school investment, there is one finding that is virtually universal. This widespread result is "earnings function concavity". Earnings consistently rise at a decreasing rate throughout one's life.⁶ Early studies (Mincer, 1974) tested this proposition using OLS regression with cross-sectional data. But the results hold when one adjusts for selectivity biases (Hartog, et. al., 1989; Kiker and Oliveira, 1992; or Baldwin, Zeager and Flacco, 1994) and individual specific heterogeneity (Mincer-Polachek, 1978; Licht-Steiner, 1991; Kim-Polachek, 1994; Light-Ureta, 1995).

Earnings of Women

More interestingly, as the human capital model (Polachek 1975) predicts, female earnings profiles are lower and flatter (less concave). Further these age-earnings profile differences vary by marital status. Married women have 55% lower earnings profiles than married men. Additionally, married women's profiles are best fit by a cubic equation rising initially at a slow rate, then falling until the mid-thirty age group, finally rising at about the same rate as males (Mincer-Polachek, 1974, Mincer-Ofek 1982). In contrast to these stark differences for the married, single men and women have roughly comparable profiles. Were discrimination the prime explanation for gender wage differences, one would need an alternative explanation why discrimination the model applies to married but not to single men and women. Thus discrimination cannot explain these marital status patterns, but human capital theory does.

At least in the past, the average woman exhibited intermittent labor force behavior, dropping out on average over ten years to bear and raise children. Such labor

⁶ Some exceptions are in panel data, but one can question how to adjust for price changes. Another exception is in executive pay late in some individuals' career paths.

market patterns have implications for human capital investment. Discontinuous workers invest less, and their investments need not decline monotonically (Polachek, 1975, Weiss-Gronau, 1981, and Goldin-Polachek, 1987). As a result the simple quadratic earnings function should be “segmented” into various work and non-work time periods to capture the appropriate investment patterns. But even then, expectations aren’t fully taken into account (Polachek, 1975a and Goldin-Polachek 1987) leading to potential biases estimating male-female discriminate (Polachek, 1975b). This bias is evidenced by the rapid restoration of female earnings upon reentering the labor market after completed home time (Mincer-Polachek, 1974, Mincer-Ofek, 1982).

Heterogeneous Human Capital and Matching

Modifying the above segmented earnings function further to account for various depreciation rates enables one to apply the human capital model to predict gender differences in occupational choice (Polachek, 1979, 1981). Such a framework implies that occupations differ from each other in skill content. Some skills depreciate more quickly when not used (atrophy), while others become obsolete as technology changes. As such human capital is heterogeneous. In this framework, individuals select a type human capital (occupation) to best match his or her attributes.⁷ Although initially applied to occupations, the same framework holds for types of school major (Paglin-Rufolo, 1990), geographic and job mobility (Polachek-Horvath, 1978) turnover declines with tenure on-the-job (Jovanovic-Mincer, 1981), as well as to performance related pay attracting high quality workers (Booth, 1999). Becker (1974) even carries this type matching one step further by considering assortive mating, thereby getting more generally at family investments in human capital.⁸

The Human Capital Earnings Function and Incomplete Employee and Employer Information

In a sense the whole matching process is a form of search. Labor force participants search for the best job matches and employers search for employees with the

⁷ See Autor (2001) for implications regarding new labor market institutions that might evolve from this matching process.

⁸ See Fernandez & Rogerson (2001) for a recent generalization and Nakosteen and Zimmer (2001) for an empirical analysis of marital section.

best skills. Search and matching models developed independent of human capital (Stigler, 1961), but in reality information is a valuable resource in which employees and employers both invest. The more information each party obtains, the better the match and the higher are worker wages and productivity.

Search strategies have two implications: First, there is incomplete information because efficient search entails stopping rules that lead searchers to compromise by sufficing instead of ending up in the *best* job possible. (The same can be said for employers searching for the best possible employee.) Second, incomplete information likely results in eventual job turnover because imperfect information on both sides likely leads to some bad matches.

One can apply frontier estimation (Aigner, Lovell and Schmidt, 1977) to Mincer earnings functions to separate observed wage dispersion into purely random variation (noise in the data), variation due to incomplete employee information, and variation due to incomplete employer information (Polachek-Yoon, 1987). To get at these facets, simply estimate Mincer's earnings function with a three component error term such that $-u < v$, $-v < w$, and $0 < w < u$, as indicated below:

$$\ln Y = a_0 + a_1 S + a_2 t + a_3 t^2 + u + v + w$$

The error component u represents the typical two-sided error term representing pure noise. The negative error term v represents a worker's incomplete information since it represents the difference between the wage a worker receives and the wage that could have been attained given knowledge of a higher paying firm. The positive error term w represents a firm's incomplete information since it represents the difference between the wage a firm pays and the wage it could have paid had it known of workers willing to work at lower wages. By introducing independent direct measures of workers' knowledge of the *World of Work*, Polachek and Robst (1998) verify that this generalization of Mincer's earnings function can be used to actually measure incomplete market information, thus illustrating yet another application of the Mincer earnings function.

Mincer's Overtaking Age Revisited

Perhaps one of the more unique, interesting, but rarely explored concepts to emerge from Mincer's earnings function formulation is the "overtaking point." The overtaking point is the point in one's lifecycle when observed earnings just equals one's potential earnings at graduation, were there no post-school investment. As illustrated in Figure 1 (Mincer, 1974:17), the concave curve $Y_0 Y_j Y_p$ plotted over the lifecycle reflects observed earnings, which are potential earnings (E_j depicted by curve $Y_s E_j Y_p$) minus (net) human capital investments C_j .⁹ At the overtaking point $\hat{j}$, observed earnings $Y_{\hat{j}}$ equal potential earnings upon graduation, i.e., $Y_{\hat{j}} = E_0 = Y_s$.

MINCER FIGURE 1.2 – PAGE 17

As the case for many profound discoveries, the overtaking point should have been obvious. Early in one's career, the typical person takes a job below Y_s , say Y_0 , to finance post-school investment. Eventually earnings grow higher than Y_0 surpassing Y_s as one reaps returns from investments C_j . Figuring out the overtaking point merely implies solving for the age at which this occurs.

Mincer's Derivation of the Age at Overtaking

To derive the overtaking point, Mincer rigorously specifies the experience-level at which observed earnings just equals one's earnings-potential at graduation. This is point $\hat{j}$ when $Y_s = Y_{\hat{j}}$ (again refer to Figure 1 taken from Mincer, Figure 1.2, p.17). Recall, that upon graduation, one invests a portion of potential earnings Y_s in on-the-job training lowering one's observed earnings to $Y_0 = Y_s - C_0$ which rises as one begins to accumulate the returns from investments C_t . Thus according to Mincer,

$$Y_{\hat{j}} = Y_s + r \sum_{t=0}^{\hat{j}-1} C_t - C_{\hat{j}} = Y_s$$

⁹ Net investment equals *gross* human capital investments minus *depreciation*. See Polachek and Siebert (1993) Chapter 2 for an exposition and diagrams contrasting gross and net investment.

occurs when $r \sum_{t=0}^{j-1} C_t = C_j$. If human capital investment (C_t) from $t = 0$ through $t = \hat{j}$ is constant, then $r\hat{j}C_j = C_j$ implying $\hat{j} = \frac{1}{r}$. If C_t declines between time 0 and $\hat{j}$ then $\hat{j} \leq \frac{1}{r}$.

The overtaking point is important because it enables one to observe what one would have earned upon graduation at each level of schooling. This knowledge facilitates computing schooling rates of return. Simply compare Y_j at each schooling level S_i . Percentage earnings differences reflect the impact of schooling and define rates of return (assuming all schooling costs are opportunity costs). Indeed at $\hat{j}$ the Mincer “Schooling Model” should work best. Empirical tests (Brown, 1980) somewhat (but not completely) corroborate this.

But, the overtaking point is also important for another reason. Mincer uses it to get at some interesting implications regarding earnings distribution.

Implication Regarding Earnings Distribution

Define $s^2(Y_j)$ to be the variance of earnings, and define $s^2(\ln Y_j)$ to be the *relative* earnings variance. According to Mincer, $s^2(Y_j)$ and $s^2(\ln Y_j)$ must vary over the life cycle. The pattern of variation depends on the dispersion in post-school investments and the correlation between post-school investment and earning capacity (Mincer, 1974: 98-103). “If ... the correlation between (dollar) schooling and post-school investment is positive ... dollar variances must rise from overtaking to peak earnings. In addition, dollar variances will rise throughout if $s^2(Y_0) < s^2(Y_j) \dots$ ” (Mincer, 1974:98). In contrast, $s^2(\ln Y_i)$ is more likely U-shaped (Mincer, 1974:103).

To see this more rigorously, Mincer defines earnings (Y_{si}, Y_{ji} , and Y_{pi}), and the log of earnings ($\ln Y_{si}, \ln Y_{ji}$, and $\ln Y_{pi}$) as well earning variance at three points in the life lifecycle: (1) at graduation, point S; (2) at the overtaking point; and (3) at point p, when the earnings profile peaks. Accordingly, as depicted in equation (2) below, for any

individual i , earnings upon graduation (Y_{si}) are earnings potential (E_{si}) minus investments first year out in the labor force (C_{oi}). Earnings at the overtaking point Y_{ji} depicted in (3) are simply (E_{si}). Finally earnings at the profile peak (Y_{pi}) depicted in (4) are initial earnings potential upon graduation (E_{si}) plus the returns to all past post-school investments (rC_T). Equations (5) - (7) give comparable definitions for relative earnings ($\ln Y$):

$$(2) \quad Y_{si} = E_{si} - C_{oi} \Rightarrow s^2(E_s) + s^2(C_o) - 2r(C_o, E_s)s(E_s)s(C_o)$$

$$(3) \quad Y_{ji} = E_{si} \Rightarrow s^2(Y_j) = s^2(E_s)$$

$$(4) \quad Y_{pi} = E_{si} + rC_T \Rightarrow s^2(Y_p) = s^2(E_s) + r^2s^2(C_T) + 2rr(C_T, E_s)s(E_s)s(C_T)$$

and

$$(5) \quad \ln Y_{si} = \ln E_{si} + \ln(1 - k_{oi})$$

$$\Rightarrow s^2(\ln Y_s) = s^2(\ln E_s) + s^2(\ln(1 - k_o)) + 2r(\ln E_s, \ln(1 - k_o))(s(\ln E_s), s(\ln(1 - k_o)))$$

$$(6) \quad \ln Y_{pi} = \ln E_{si} \Rightarrow s^2(\ln Y_j) = s^2(\ln E_s)$$

$$(7) \quad \ln Y_{pi} = \ln E_{si} + rK_{ti} \Rightarrow$$

$$s^2(\ln Y_p) = s^2(\ln E_s) + r^2s^2(K_T) + 2rr(\ln E_s, K_T)s(\ln E_s)s(K_r).$$

Variances of earnings (and relative earnings) across all i individuals at each of these three points are also given in equations (2) - (7). Note, as just indicated above, the variances (or standard deviations) depend on the correlation between school and post school investments. For dollar earnings, these are generally positively correlated leading to the possibility that earnings distribution widens throughout life (or more specifically from graduation, to the overtaking point, and finally to the point where the earnings profile peaks). But changes over the working life in logarithmic earnings variances depend on the correlation between $\ln E_s$ and $\ln(1 - k_0)$. As Mincer states, “If the correlations are weak, $r_1 = r_2 = 0$ and the profile of log variances is U-shaped, with the

bottom at overtaking” (Mincer, 1974:103). Mincer illustrates the validity of these conjectures in two Figures, reproduced below as Figures 2 and 3.

Figures 2 and 3: Mincer’s Charts 6.1 and 6.3

Given the uniqueness of these results, it might be worth examining whether these patterns generalize to the U.S. economy today, so many decades after Mincer’s original contribution in this area. Examining these earning distributions is the point of the remainder of this paper. But, in addition to exploring the United States, I utilize the Luxembourg Income data to also examine a random set of 7 of that data’s 26 countries, thereby testing whether the results generalize internationally.

Earnings Distribution in the United States, 1980 and 1990

I use the 1980 and 1990 Census to examine U.S. earnings variations over the life cycle. To avoid confounding earnings distribution with gender and race, I concentrate on white males. And to circumvent labor supply issues, I examine hourly earnings (computed as annual earnings divided by a measure of hours worked per year). The final graphs are given in Figures 4-7.¹⁰ Two figures are presented for each decade: one for the variance (actually the standard deviation) of dollar hourly earnings over the life cycle and another for the standard deviation in relative hourly earnings $s(\ln Y)$.

Several interesting observations are apparent. First, the standard deviation of the log wage profile is U-shaped, whereas the lifecycle pattern for the standard deviation in dollar earnings is not. Second, the trough in 1980 is about at age 19, while the trough in 1990 is about at age 12 ½ Both observations are consistent with Mincer’s expectation. That the log variance profile is more U-shaped is in tune with a lower correlation between time-equivalent investment and initial earnings. And, that one observes an earlier 1990 than 1980 over-taking point $\hat{j}$ is consistent with rising human capital rates of return. (See Table 1 containing U.S. earnings profile parameters including the rate of return to schooling for 1980 and 1990.) Third, and perhaps inconsistent, is the exact age when overtaking takes place. According to Mincer, the 1980 experience level at overtaking should be less than 13.9 years [$\hat{j} < (1/.061) = 16.4$], and the 1990 experience

level should be less than 10.5 [$\hat{j} < (1/.095) = 10.5$]. Both are lower than the troughs just observed in Figures 5 and 7. While bothersome, a number of factors can explain this incongruity. Most likely, the finding results from difference in rates of return between schooling and on-the-job training. On the one hand, schooling is subsidized which normally would imply higher investment levels and possibly lower rates of return. On the other hand, subsidization lowers costs and raises returns. Thus it is conceivable that schooling rates of return exceed on-the-job training rates of return, thereby leading to downward biased estimates of the overtaking age. Obviously other issues are also involved. For example, using cross-sectional rates of return estimates for a lifecycle phenomenon might bias rates of return, but the whole econometric issue that evolved on how to appropriately estimate Mincer's earnings functions is not the focus of this paper.

International Data

The Luxembourg Income Study (LIS) is a collection of household data compiled from ongoing statistical surveys in 26 countries.¹¹ The database provides statistics on demographic, income and expenditure variables on three levels: households, persons and children. I concentrate on extracting education, age, and earnings data for white males from the person file of the countries, at least half contain information on hourly earnings¹². Of those, I concentrated on eight countries chosen randomly.

For each of these countries, I first ran an earnings profile for the entire sample. These are reported in Table 1. Then I stratified by education and age to compute age-specific earnings variations. As such, I computed $s(Y_{s,A})$ where S equals schooling level and A equals age. To get at non-linearities, I plotted an age-specific earnings variation profile (both in log and dollar formats), and for each profile I fit a sixth degree polynomial in age. (These are available on request.) To preserve space, I re-calibrated each profile with experience level (rather than age) and graphed them on one diagram. I followed the same procedure for each country. Finally, I fit a quadratic equation for the

¹⁰ The regression results underlying the figures are available upon request.

¹¹ See Appendix A for a list of each represented country and year. Appendix B contains the particular country surveys comprising the data.

¹² Those countries with no reported hourly wages have annual earnings. These data could have been used to compute earnings variance. But in order to be consistent with the computations done for the U.S., I limited the analysis to countries reporting hourly earnings.

final re-calibrated age-specific $s(Y_{S,A})$ points. The predicted values from these equations along with the original data points are contained in Figures 8-27.¹³ For each country, there are two figures: one for the variance of earnings (Figures 8, 10, 12, 14, 16, 18, 20, 22, 24, and 26 with vertical axes denoted as stdh) and the other for the variance in *relative* earnings (Figures 9, 11, 13, 15, 17, 19, 21, 23, 25, and 27 with vertical axes denoted as stdl) .

A number of patterns emerge. First, *relative earnings* standard deviation profiles tend to be U-shaped. *Dollar* standard deviation profiles are not. Second, the troughs of the U-shaped profiles tend to hover around twenty-five years of experience. (Twenty-three when including Sweden, the one country with a rising log-variance experience profiles). Figure 28, which graphs each country's rate of return against trough experience levels, implies a negative correlation between these troughs (i.e., the experience levels at these troughs) and rates of return, just a Mincer predicted given. Third, as Mincer finds, *dollar* variance profiles rise as schooling increases. However, while *relative* variances tend to rise with schooling, this is not the case for every country.

As with the U.S., the experience levels associated with each trough are somewhat larger than expected, given estimated rates of return. Of course, one reason may be that schooling returns overstate post-school investment returns. Another may be that underlying earnings function parameters vary across members of the population. This heterogeneity adds to earnings dispersion, making the overtaking point less discernable. Still another reason may be rates of return that depend on investment level which could alter the shape of the earnings-dispersion-experience profile. Clearly, these possibilities need be explored in future work.

Conclusions¹⁴

An individual's labor market success is probably the most important indicator of individual welfare. As such, how earnings are distributed across the population is of paramount importance. In 1958 Jacob Mincer pioneered an important approach to understand earnings distribution. In the years since this seminal work, he, his colleagues,

¹³ To save space, only Figures 8,9,12 and 13 are presented here. The others are available upon request.

and his students extended the original model reaching important conclusions about a whole array of observations pertaining to worker wellbeing. The line of research proved powerful and robust because it explained many important earnings related phenomena. For example, it explained why education enhances earnings so that an extra year of school provides approximately 5 to 15% higher earnings. It explained why earnings rise through one's life cycle at a diminishing rate. It explained how earnings power atrophies with intermittent labor force participation. It explained why earnings growth is smaller for those anticipating intermittent labor force participation. It explained why men earn more than women, why married women earn less than single women, and why whites earn more than blacks. It explained why occupational distributions differ by gender. It explained why geographic and job mobility predominates for the young more than the old. It explained why on-the-job tenure reduces turnover. It explained why unemployment is lower among the skilled. And, it explained many more phenomena, as well.

However, also in the years since Mincer's ground-breaking work, a number of alternative theories were developed to explain *some* of the patterns mentioned above. For example, screening models look at why education raises earnings. Occupational segregation models attempt to get at why the male occupational distribution differs from the female occupational distribution. Efficiency wage models explain unemployment, but not necessarily its distribution across the population. And, effort enhancing contract models emerged to offer an alternative explanation to upwardly sloped earnings profiles though it's not obvious they account for the specific concave shape.

Only one theory – the human capital theory – seems to explain *each* phenomenon. The human capital theory is well grounded in standard neoclassical economic theory and subject to much econometric testing. This paper surveys human capital theory related to Mincer's earnings function. In addition it provides new empirical work regarding the overtaking age. Its main substantive contribution is to reexamine one implication of this concept as it relates to the earnings distribution, particularly Mincer's prediction of a U-shaped lifecycle log-variance of earnings profile. In this vain, the paper not only replicates Mincer's original findings using U.S. Census 1980 and 1990 data, but also

¹⁴ This section extends the conclusions reached in Polachek (1995).

using seven other countries.¹⁵ As Mincer predicted, U-shaped variance profiles for relative earnings but not nominal earnings is found.

¹⁵ Australia, Belgium, Canada, Czech Republic, France, Mexico, Republic of China (Taiwan), Spain and Sweden.

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Table 1

Earnings Function Paramters By Country and Year

<u>Country</u>	<u>Year</u>	<u>cnst</u>	<u>t-value</u>	<u>school</u>	<u>t-value</u>	<u>experience</u>	<u>t-value</u>	<u>experience-squared</u>	<u>t-value</u>	<u>R-squared</u>
Australia	1981	8.26	175.6	0.062	18.6	0.058	26.7	-0.0011	-25.5	0.11
Australia	1994	7.86	97.4	0.095	16.3	0.11	25.1	-0.0021	-21	0.24
Belgium	1997	4.66	65.3	0.096	26.2	0.041	10.2	-0.0005	-6.4	0.33
Canada	1997	0.636	13.9	0.09	27.6	0.072	41.2	-0.0012	-30.1	0.19
Canada	1998	1.099	51.3	0.082	52.6	0.05	57.9	-0.0008	-39.5	0.34
Czech Republic	1996	-2.051	-92.9	0.091	55.2	0.038	33.2	-0.0007	-30.2	0.2
France	1994	2.087	28.2	0.089	24.1	0.063	13.6	-0.00089	-9.9	0.14
Mexico	1984	-3.752	-86.8	0.116	35.6	0.065	20.4	-0.001	-16.4	0.3
Mexico	1998	0.22	7.1	0.139	56.1	0.0606	26.8	-0.0009	-20.2	0.32
ROC-Taiwan	1995	11.21	329.3	0.087	37.9	0.083	61.5	-0.0017	-72.6	0.42
Spain	1980	11.55	313.1	0.121	56.1	0.044	56.1	-0.0008	-24.7	0.25
Spain	1990	11.76	421.1	0.111	59.4	0.077	50.1	-0.0012	-38.7	0.31
Sweden	1995	3.519	49.3	0.057	14.7	0.0316	6.8	-0.00066	-6.7	0.05
United States	1980	0.681	16.1	0.061	18.5	0.0552	31.24	-0.001	-17.6	0.13
United States	1990	0.709	30.1	0.095	61.6	0.047	44	-0.0007	-31.7	0.2

Source: Luxembourg Income Study (LIS) Data and 1980 and 1990 U.S Census

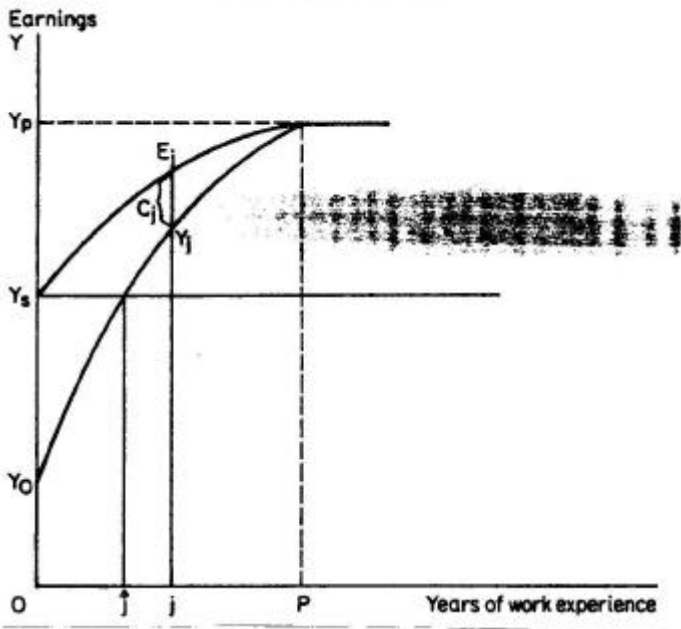
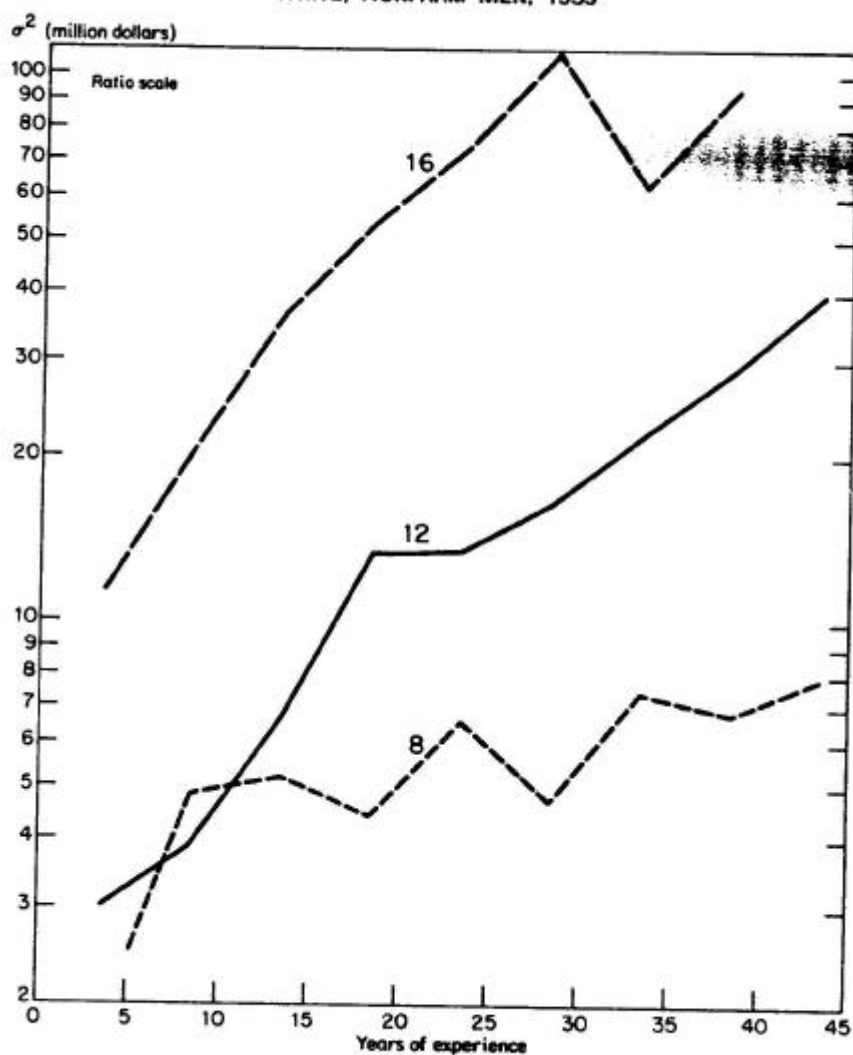


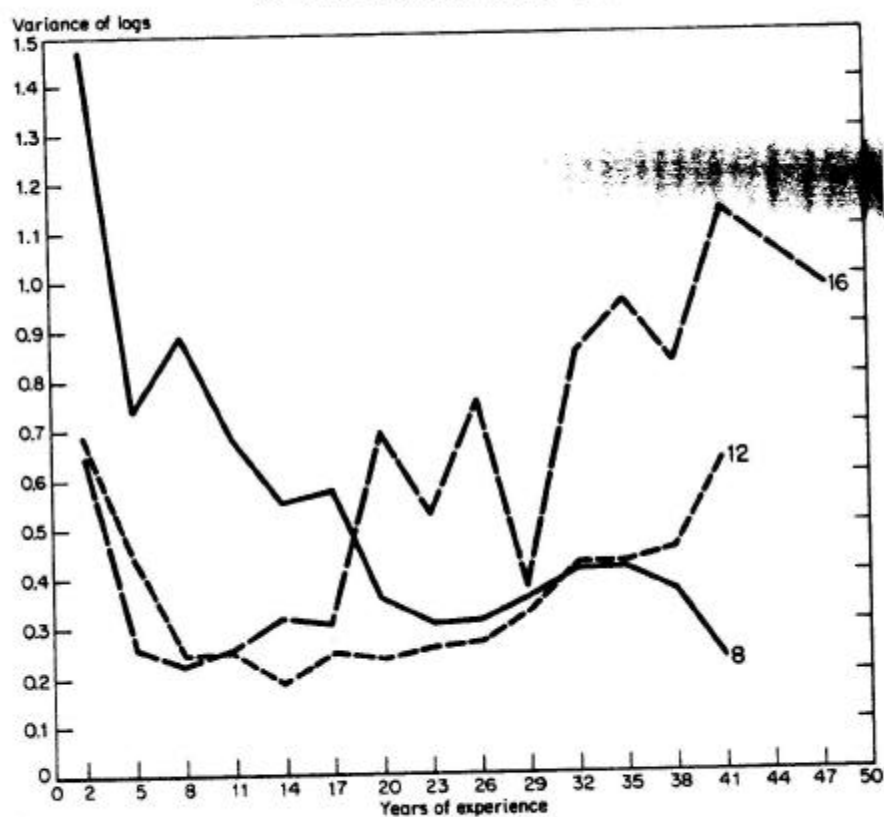
CHART 6.1
EXPERIENCE PROFILES OF VARIANCES OF ANNUAL EARNINGS OF
WHITE, NONFARM MEN, 1959



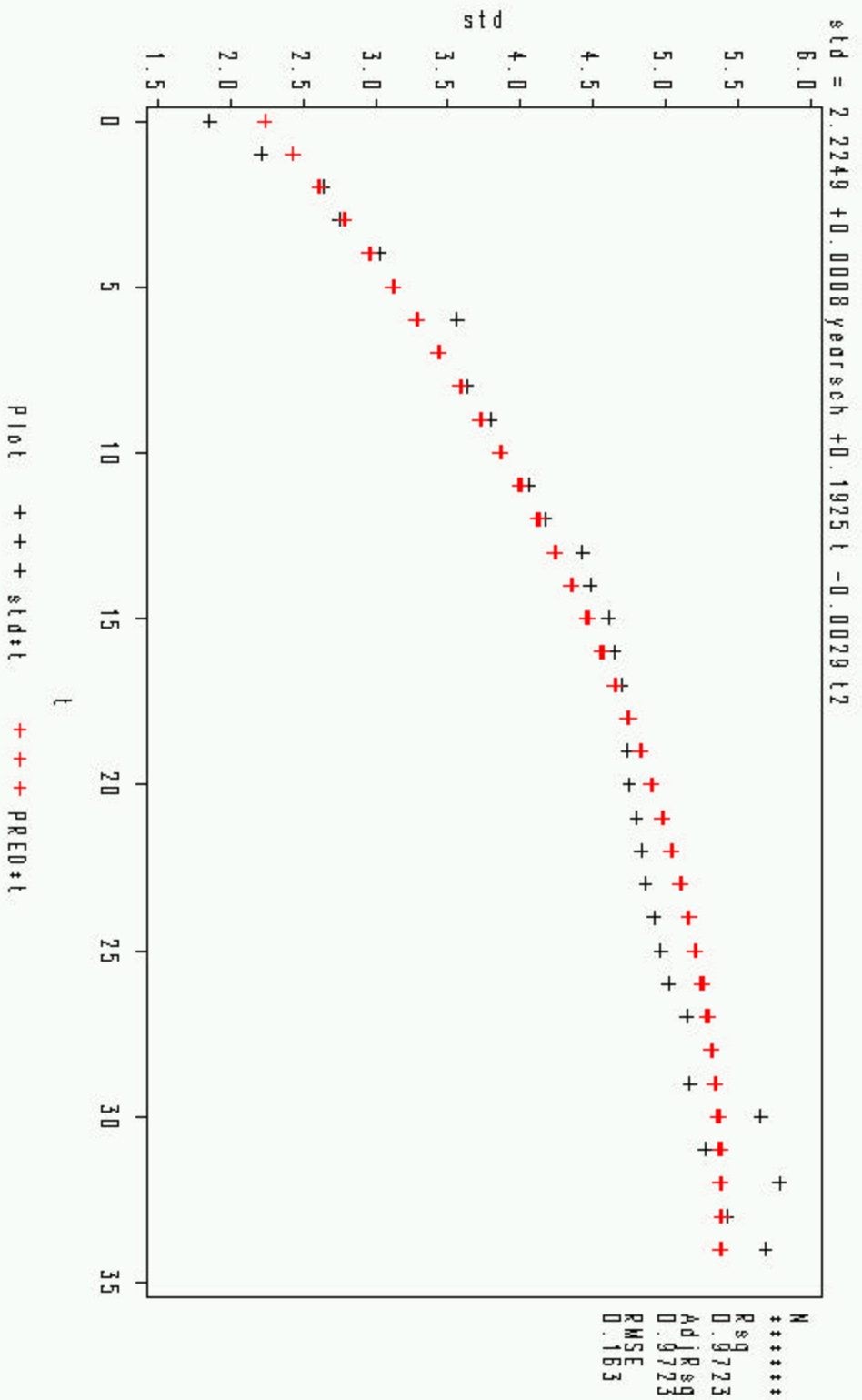
NOTE: Figures on curves indicate years of schooling completed.

SOURCE: 1/1,000 sample of U.S. Census, 1960.

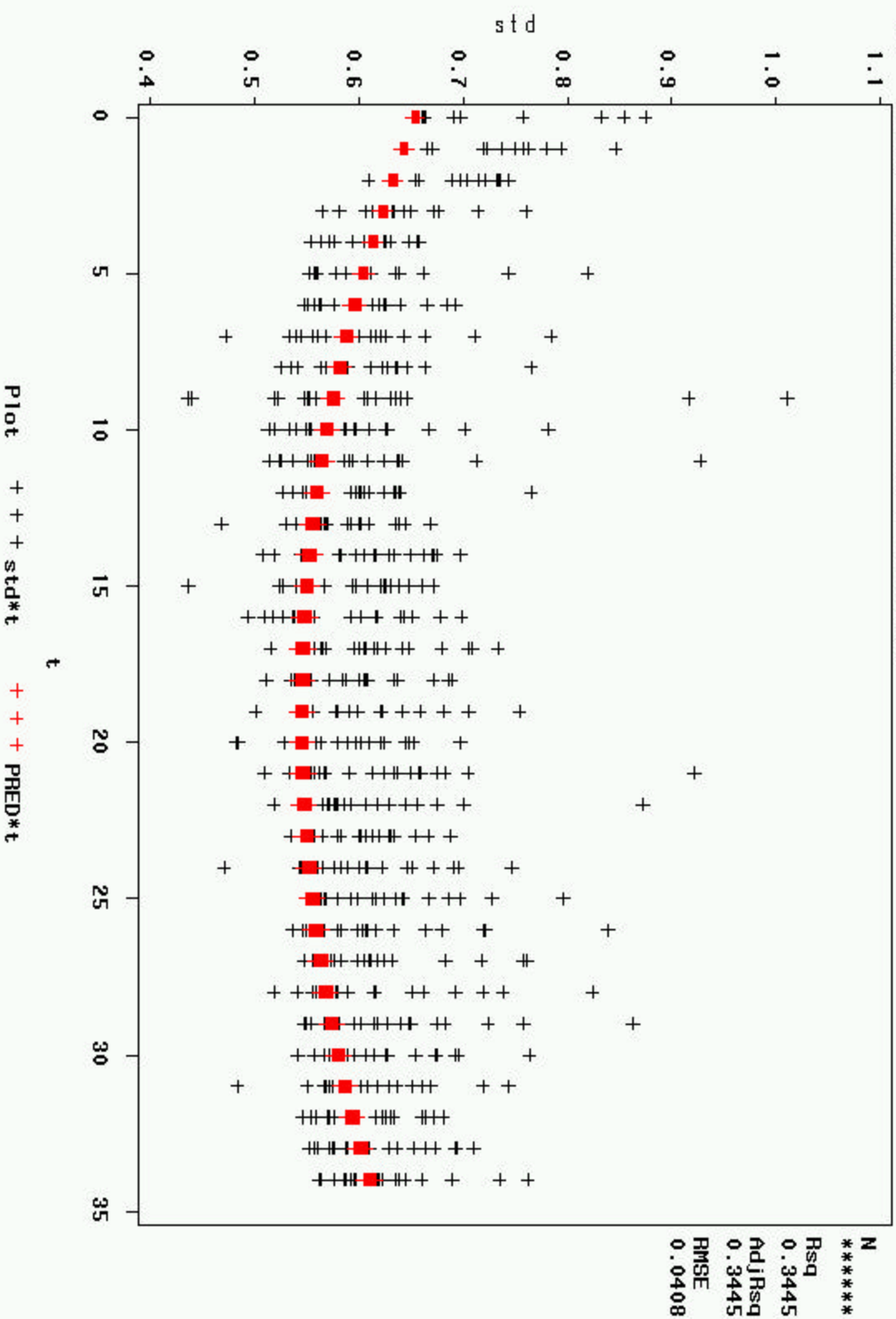
CHART 6.2
EXPERIENCE PROFILES OF LOG VARIANCES OF ANNUAL EARNINGS
OF WHITE, NONFARM MEN, 1959



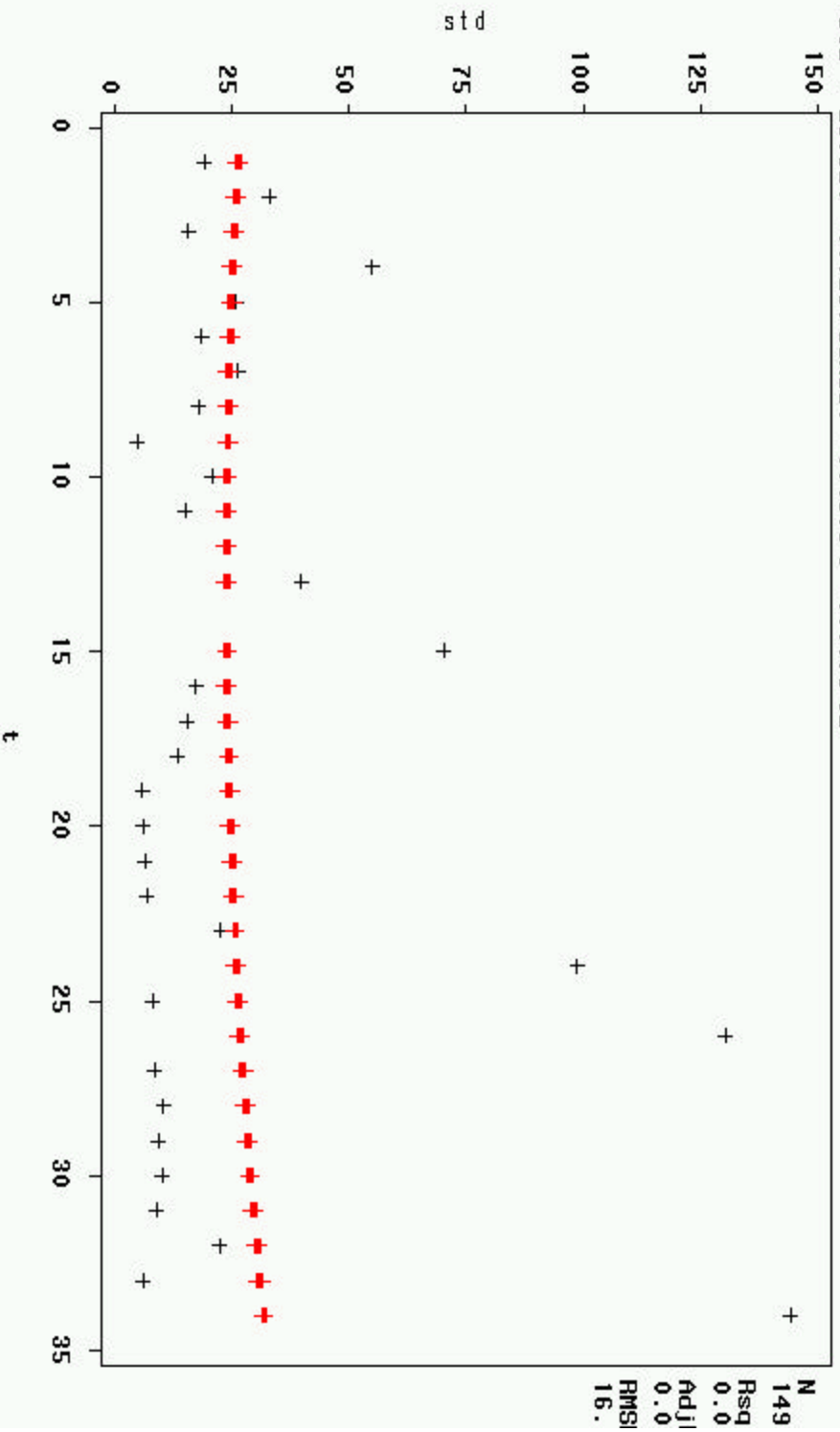
NOTE: Figures on curves indicate years of schooling completed.
SOURCE: 1/1,000 sample of U.S. Census, 1960.



$$\text{std} = 0.6442 + 0.0006 \text{ yearsch} - 0.0111 t + 0.0003 t^2$$

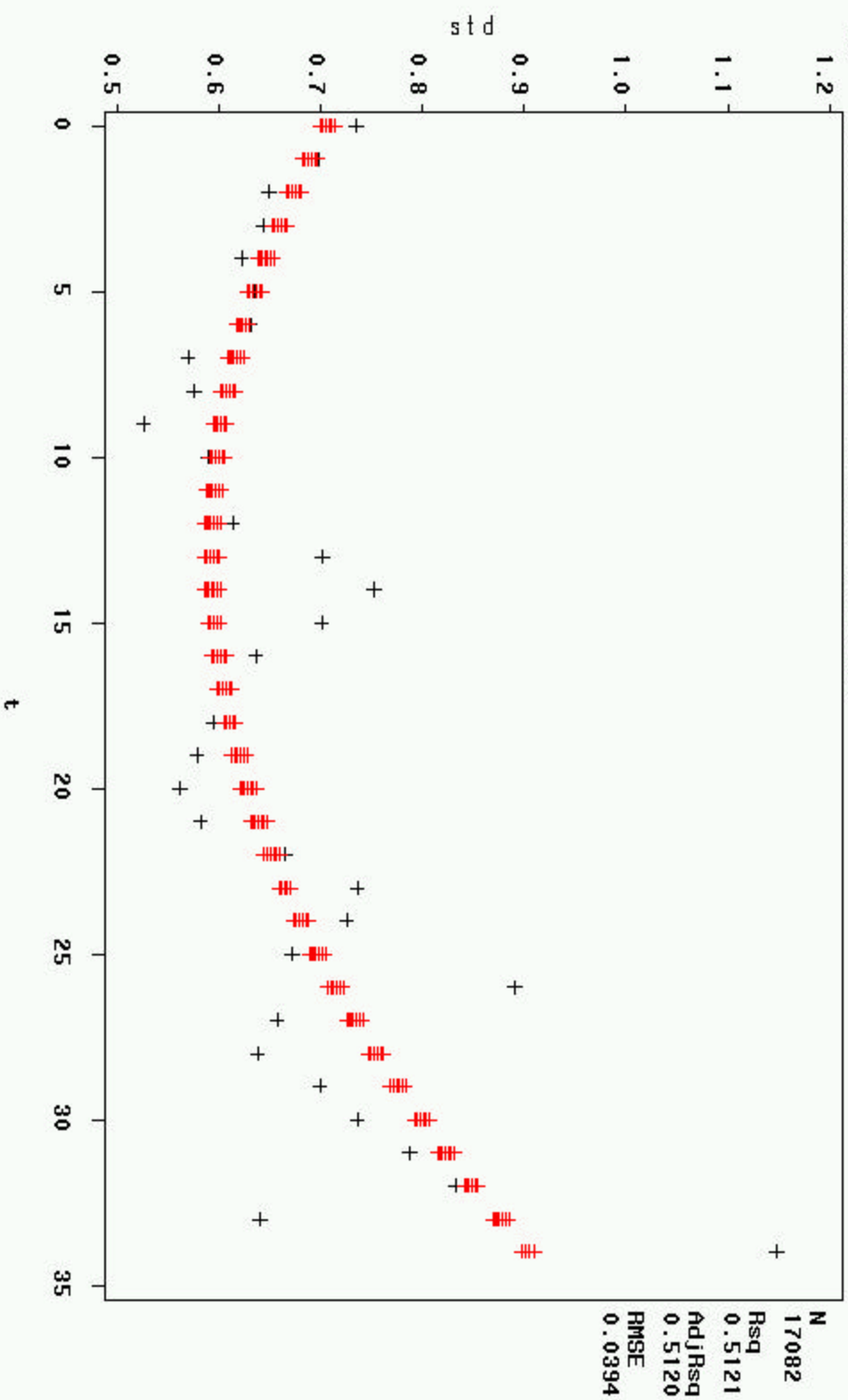


$$\text{std} = 28.624 - 0.1261 \text{ school} - 0.4516 t + 0.0176 t^2$$



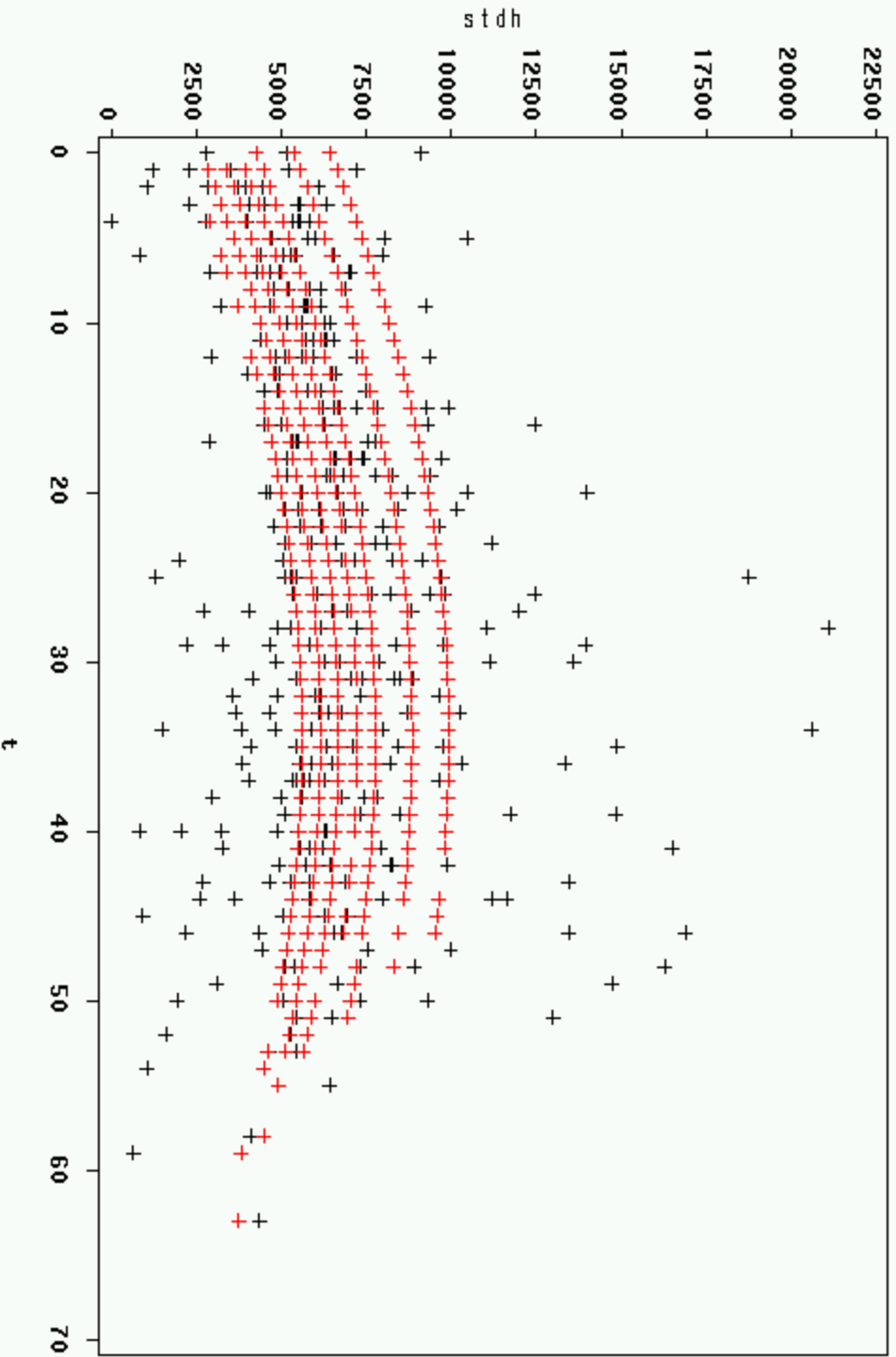
Plot + + + std*t + + + PRED*t
1990 U.S. Census (standard deviation hourly earnings)

$$\text{std} = 0.6833 + 0.0015 \text{ school} - 0.0178 t + 0.0007 t^2$$

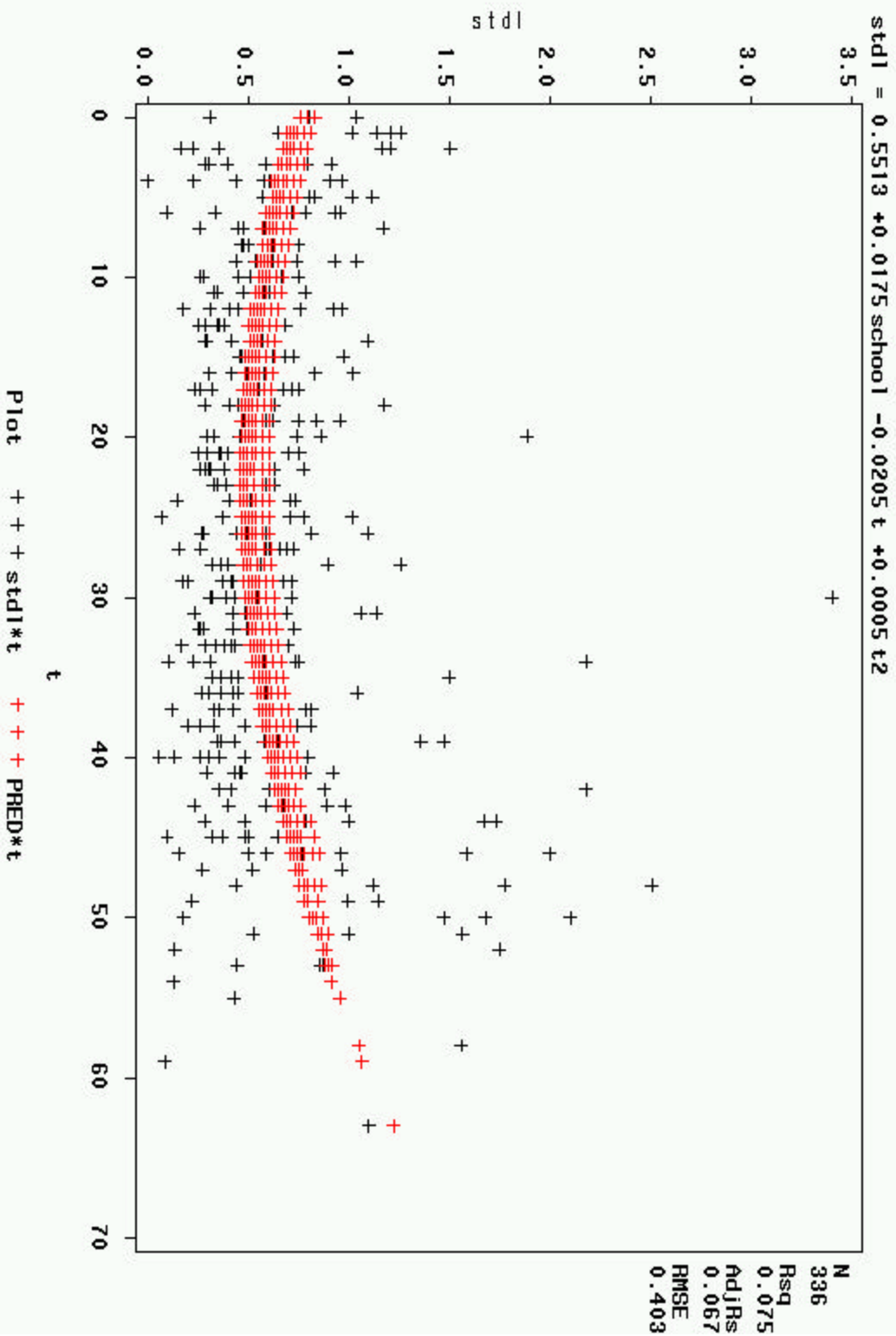


stdh = -2218.2 +541.07 school +202.69 t -2.9423 t^2

N
336
Rsq
0.296
AdjRsq
0.290
RMSE
2529.

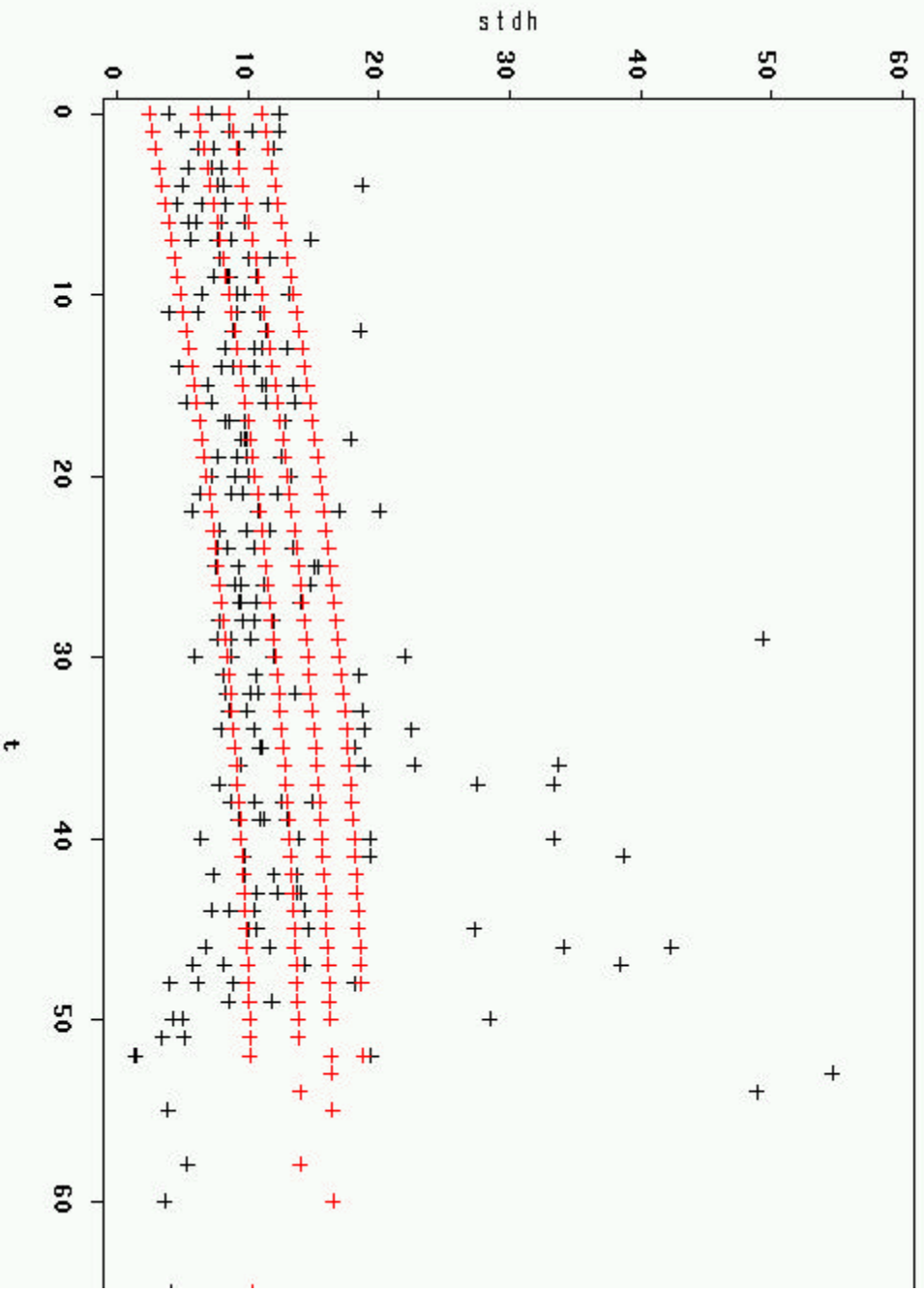


Australia 1981 (Standard Deviation Hourly Earnings)



Australia 1981 (standard deviation ln hourly earnings)

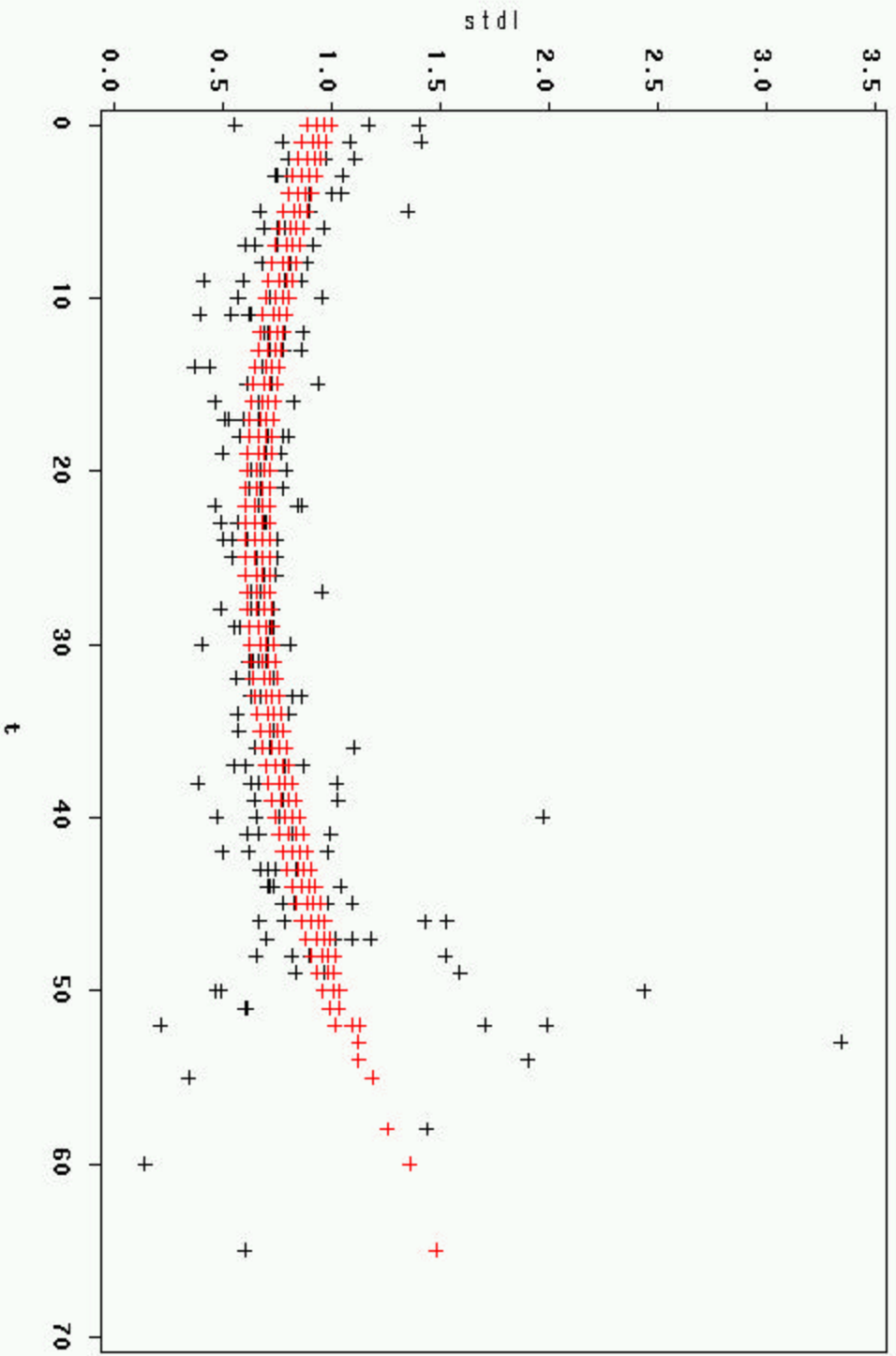
$$\text{stdh} = -8.6158 + 1.2315 \text{ school} + 0.2652 t - 0.0022 t^2$$



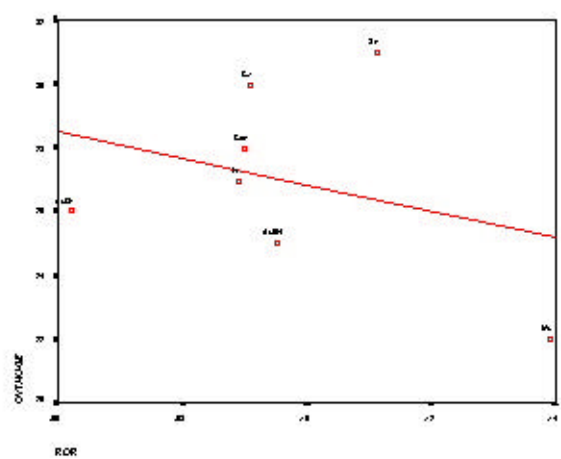
Plot + + + stdh*t + + + PRED*t
Canada 1997 (standard deviation hourly earnings)

$$\text{stdl} = 0.7476 + 0.0156 \text{ school} - 0.0241 t + 0.0005 t^2$$

N
 213
 Rsq
 0.167
 AdjRs
 0.155
 RMSE
 0.313



Canada 1997 (standard deviation ln hourly earnings)



APPENDIX B



Data Information

LIS Survey List

COUNTRY CODE	SURVEY NAME
AS81-AS85-AS89-AS94	Australian Income and Housing Survey
AT87-AT95	Austrian Microcensus
BE85-BE88-BE92- BE97	Panel Survey of the Centre for Social Policy
CN71-CN75-CN81-CN87-CN91-CN94-CN97	Survey of Consumer Finances
CN98	Survey of Labour and Income Dynamics
CZ92-CZ96	Microcensus
DK87-DK92-DK95-DK97	Income Tax Survey
FI87-FI91-FI95	Income Distribution Survey
FR79-FR84A	The French Survey of Income from Income Tax
FR84B-FR89-FR94	Family Budget Survey
FR81	CERC Survey of Women with Children
GE73-GE78-GE83	Income and Consumer Survey (EVS)
GE81	The German Transfer Survey (Transferumfrage 1981)
GE84-GE89-GE94	German Social Economic Panel Study (GSOEP)
HU91-HU94	Hungarian Household Panel
IR87	ESRI Survey of Income Distribution, Poverty and Usage of State Services
IS79-IS86-IS92-IS97	Family Expenditure Survey
IT86-IT91-IT95	The Bank of Italy Survey (Indagine Campionaria sui Bilanci Delle Famiglie)
LX85-LX91-LX94	The Luxembourg Social Economic Panel Study "Liewen zu Letzebuerg"
MX84-MX89-MX92-MX94-MX96	National Household Survey on Income and Expenditure (Encuesta Nacional de Ingresos y Gastos de los Hogares)
NL83-NL87	Additional Enquiry on the Use of (Public) Services (AVO)
NL86-NL91-NL94	Socio-Economic Panel (SEP)
NW79-NW86-NW91-NW95	Income and Property Distribution Survey

PL86-PL92-PL95-PL99	Household Budget Survey
RC81-RC86-RC91-RC95	Survey of Personal Income Distribution, Taiwan Area
RL92-RL95	Russian Longitudinal Monitoring Survey
SV92	Slovak Microcensus
SP80-SP90	Expenditure and Income Survey
SW67-SW75-SW81-SW87-SW92-SW95	Income Distribution Survey (Inkomstfördelningsundersökningen)
CH82	Swiss Income and Wealth Survey
CH92	Swiss Poverty Survey
UK69-UK74-UK79-UK86-UK91-UK95	The Family Expenditure Survey
UK94	The Family Resources Survey
US69-US74-US79-US86-US91-US94-US97	March Current Population Survey
US9567	Combined File of Three CPS ('95,'96,'97)

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