Volume Title: The Allocation of Time and Goods over the Life Cycle

Volume Author/Editor: Gilbert Ghez and Gary S. Becker

Volume Publisher: NBER

Volume ISBN: 0-870-14514-2

Volume URL: http://www.nber.org/books/ghez75-1

Publication Date: 1975

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Chapter Author: Gilbert Ghez, Gary S. Becker

Chapter URL: http://www.nber.org/chapters/c3745

Chapter pages in book: (p. 83 - 132)

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The Allocation of Time Over the Life Cycle

In this chapter the allocation of time by men over their lifetime is analyzed. As in Ghez's study of consumption in Chapter 2, information on different cohorts at a given time is used because information on a single cohort at different ages is lacking. The main source of information is the 1960 Census, in particular, the 1/1,000 sample. For each of the over 180,000 persons in this sample, information is given about the respondent's sex, race, weeks worked in 1959, hours worked in the census week of 1960, earnings and other income in 1959, years of schooling completed as of 1960, the family size in 1960, and family income in 1959. For the empirical work in this chapter a subsample of some 34,000 employed men has been used. The appendix to this chapter contains more detailed information on the nature of the subsample. Total hours worked in 1959 of each person in this subsample are estimated as the product of his weeks worked in 1959 and his hours worked in the census week. Weekly and hourly wage rates in 1959 are estimated respectively as the ratio of his annual earnings to his weeks worked and to my estimate of his hours worked in 1959. Errors in the estimates of weeks and hours

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NOTE: Becker is solely responsible for this chapter.

worked cause errors in the opposite direction in these estimates of weekly and hourly earnings. The different variables were averaged arithmetically for all men of the same age, race, and years of schooling.

Five-year moving averages of average annual hours worked and average hourly earnings are plotted in Figures 3.1 to 3.8, separately for white and nonwhite men of different ages and four schooling classes. Consistent with the substantial evidence on age-earnings profiles, these age and wage rate profiles rise relatively rapidly up to about age 40 and later taper off. One surprise, however, is that wage rate profiles, unlike earnings profiles, do not really fall before age 65 for whites. Either they reach a plateau (see Figure 3.1 for all male whites) or they continue to rise (see Figure 3.4 for male whites with 13 years or more of schooling).

Annual hours worked also rise quite rapidly at young ages and then more slowly. Instead of continuing to rise, however, they peak at a relatively early age, generally in the late thirties, and then decline gradually. This explains why earning profiles, unlike wage rate profiles, generally do peak and begin to decline before age 65. Clearly almost all the evidence in the figures confirms the prediction of the theory in Chapter 1 that hours of work reach a peak (hours of consumption reach a trough) earlier than wage rates.

A finding of some studies is that young persons not enrolled in school have much "unexplained" time; that is, time when they are not employed, looking for work, in training, or sick.[1] They may be traveling, plotting the revolution, or most commonly simply "hanging around." The importance of "unexplained" time is consistent with the evidence in the figures of relatively few hours worked at young ages. Both the "unexplained" time and the relatively few hours worked are explained in our theory by the incentive to use time in nonmarket activities when wage rates are low; that is, to use relatively time-intensive methods of producing consumption commodities. This allocation away from work and toward consumption at young ages makes it difficult to estimate the earnings forgone of those persons who remain in school.[2]

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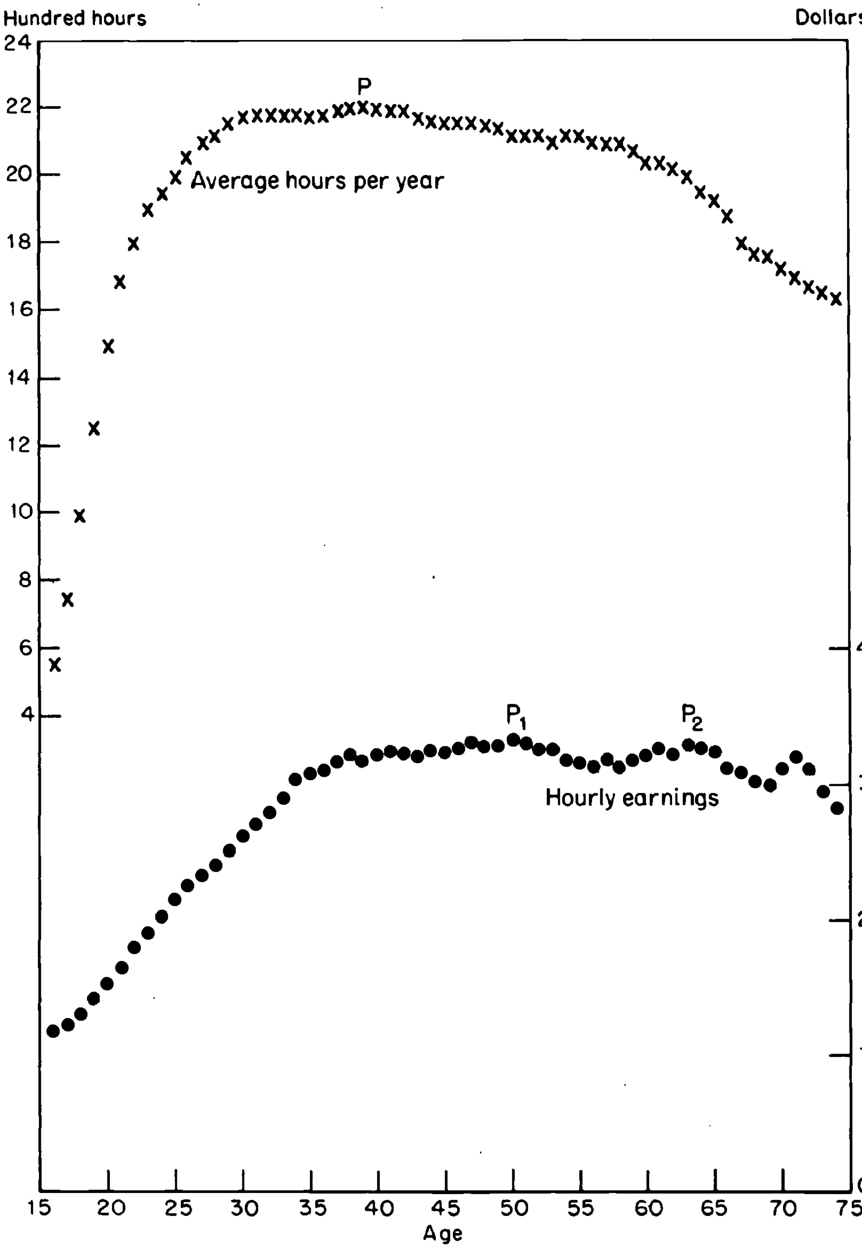
1. See *School and Early Employment Experience of Youth: A Report on Seven Communities, 1952–57,* BLS Bull. 1277, 1960, especially Table 20.

2. See the discussion of this problem in Gary S. Becker, *Human Capital,* 1st ed. (New York: NBER, 1964), pp. 169–172.

FIGURE 3.1

HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED WHITE MEN, ALL EDUCATION LEVELS COMBINED

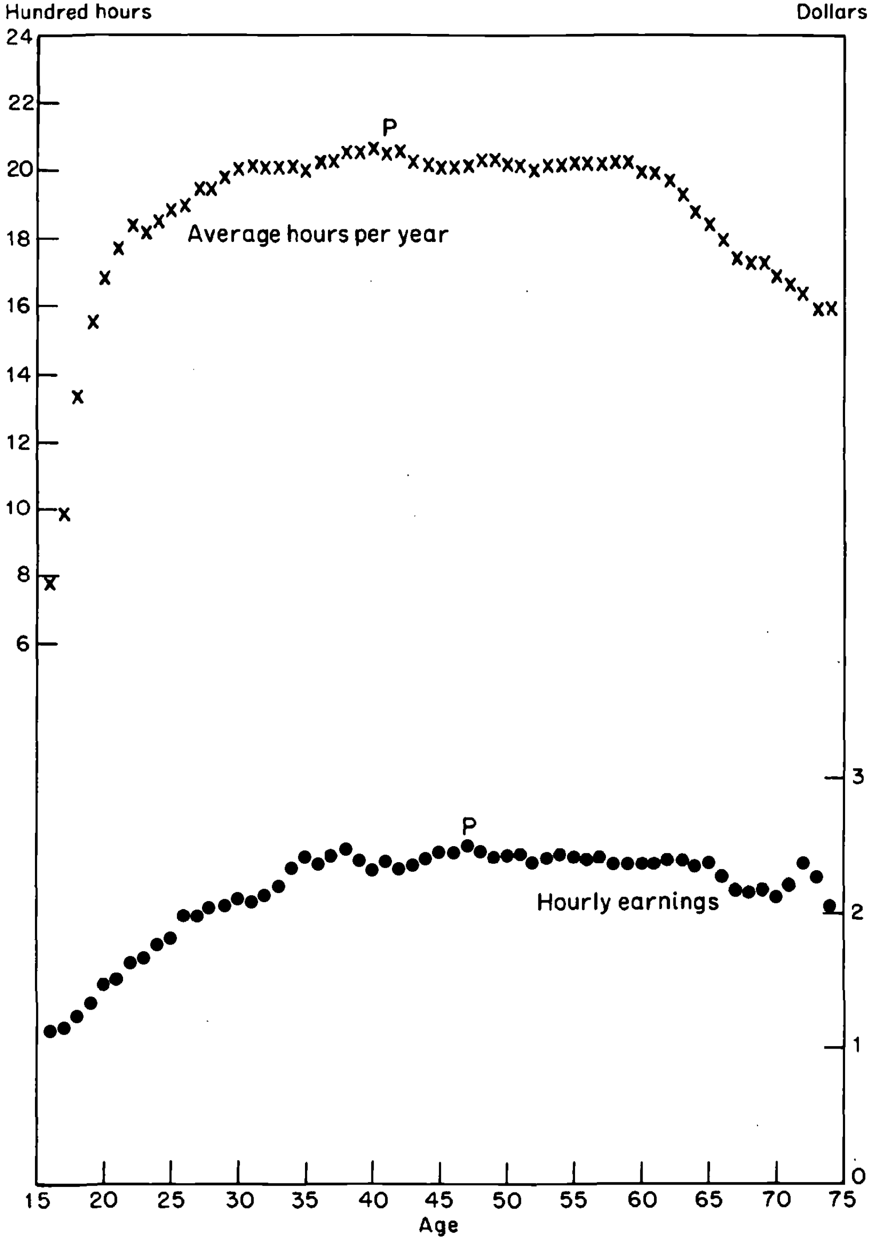
(five-year moving average)



P = peak in hours or earnings.

SOURCE: See Appendix to this chapter.

FIGURE 3.2
HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED WHITE MEN, GRADE SCHOOL LEVEL
(five-year moving average)

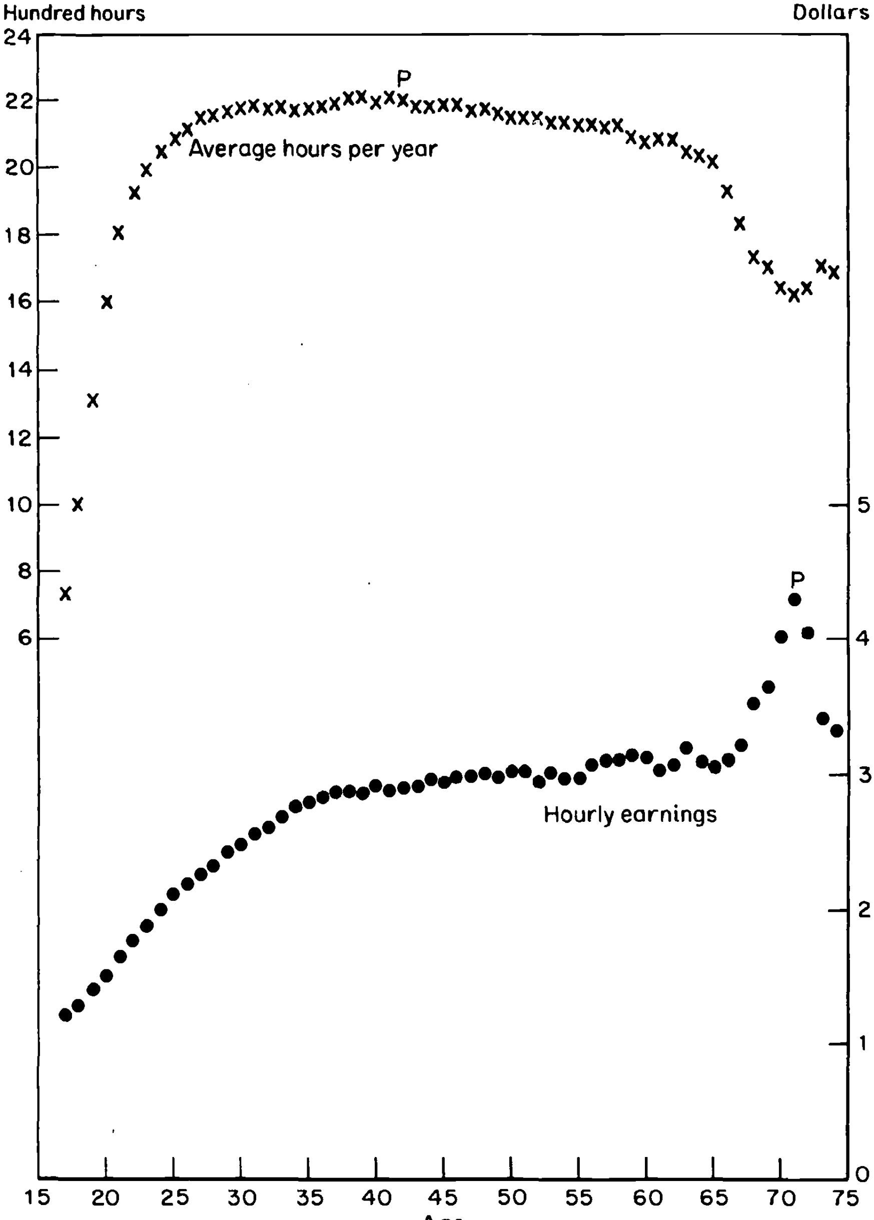


P = peak in hours or earnings.
SOURCE: See Appendix to this chapter.

FIGURE 3.3

HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED WHITE MEN, HIGH SCHOOL LEVEL

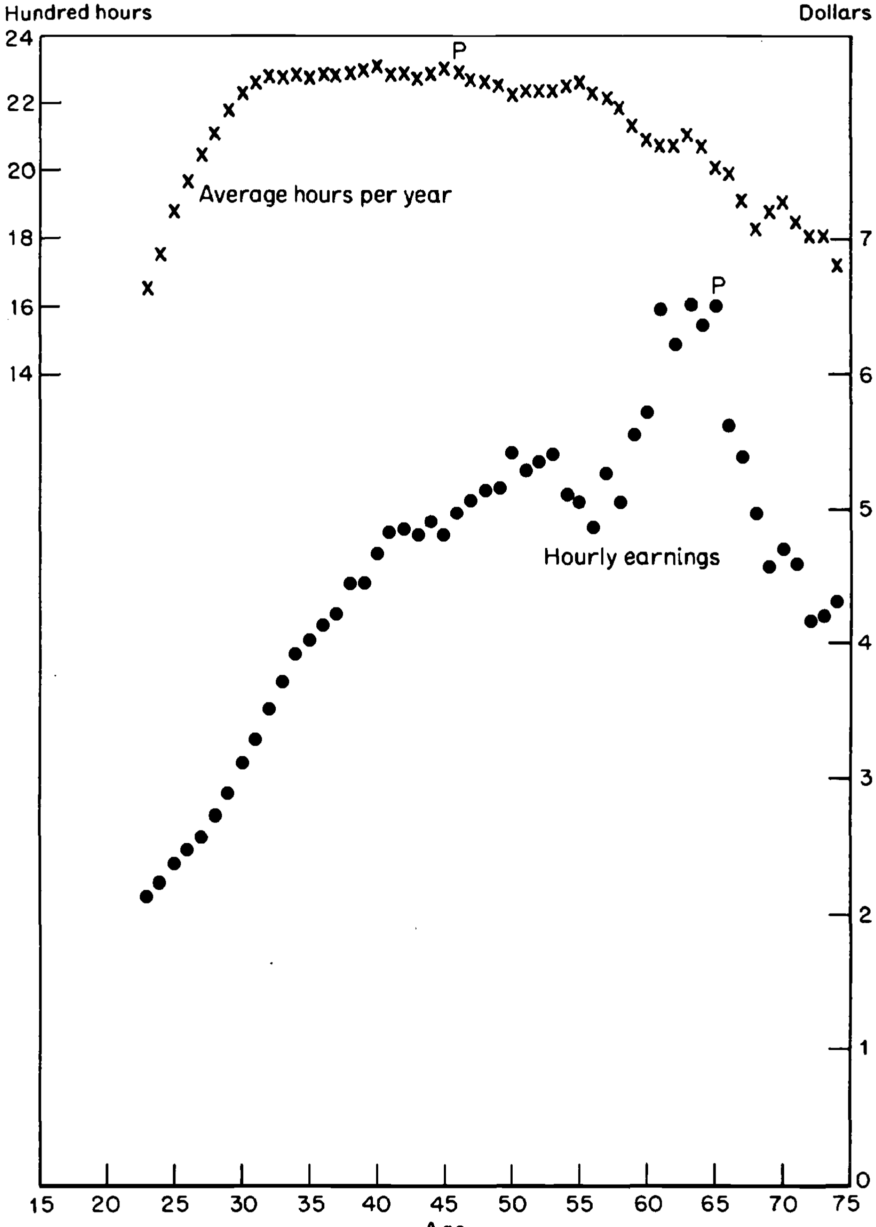
(five-year moving average)



P = peak in hours or earnings.

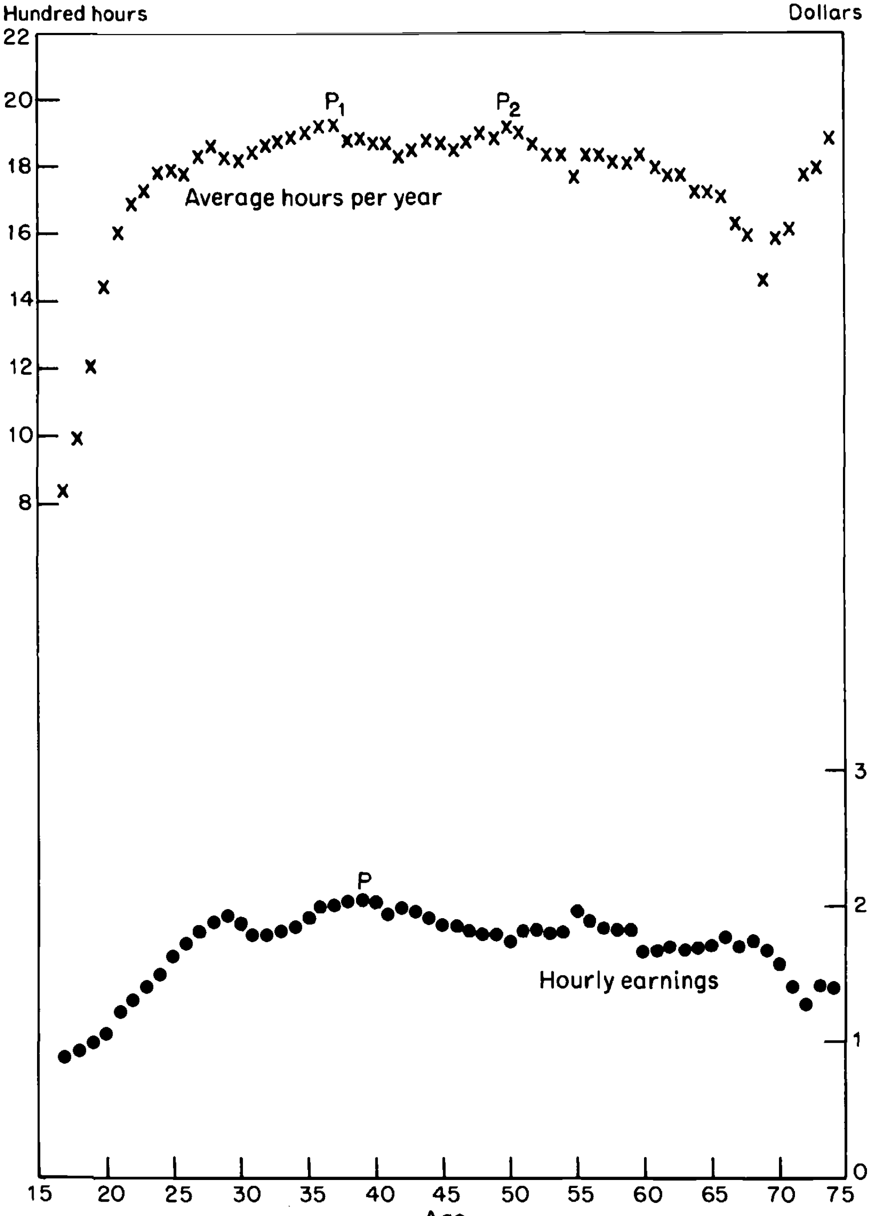
SOURCE: See Appendix to this chapter.

FIGURE 3.4
HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED WHITE MEN, COLLEGE LEVEL
(five-year moving average)



P = peak in hours or earnings.
SOURCE: See Appendix to this chapter.

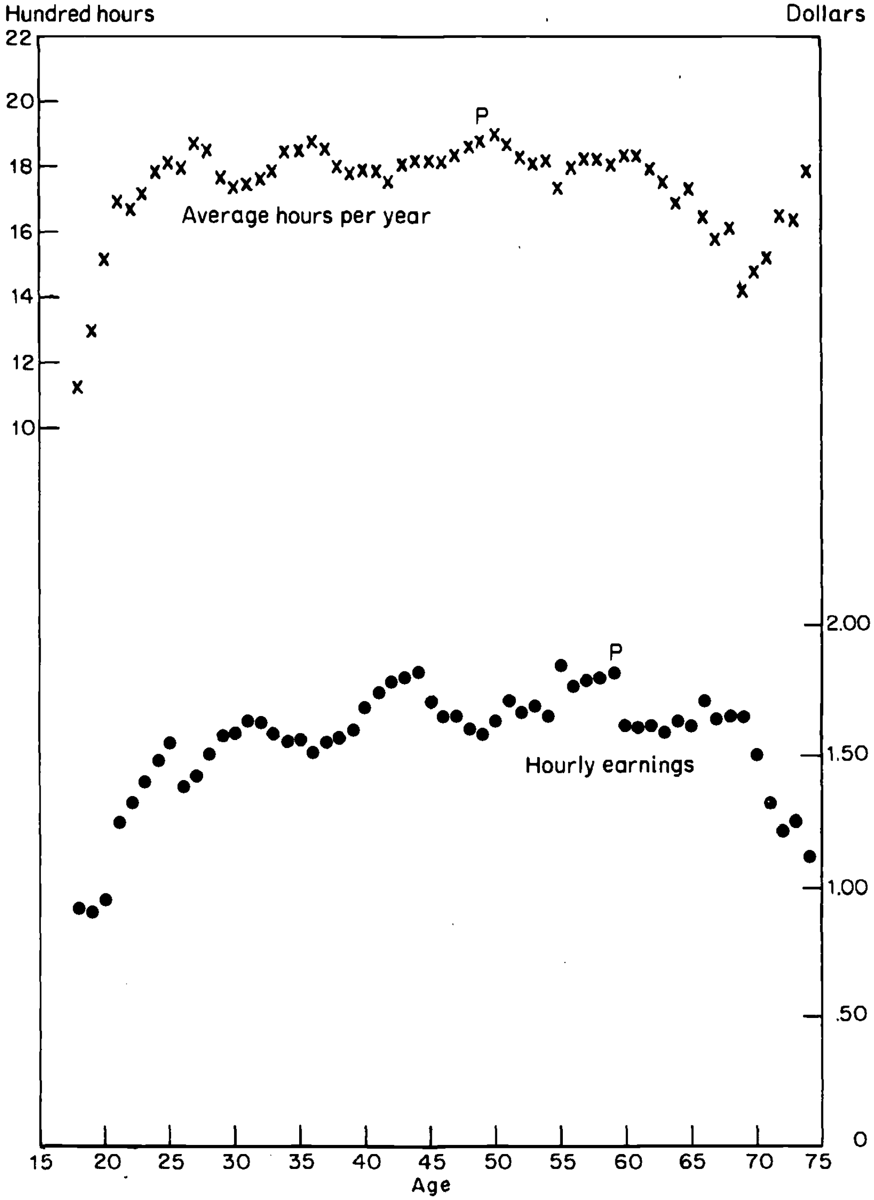
FIGURE 3.5
HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED NONWHITE MEN, ALL EDUCATION LEVELS COMBINED
(five-year moving average)



P = peak in hours or earnings.
SOURCE: See Appendix to this chapter.

FIGURE 3.6

HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED NONWHITE MEN, GRADE SCHOOL LEVEL
(five-year moving average)

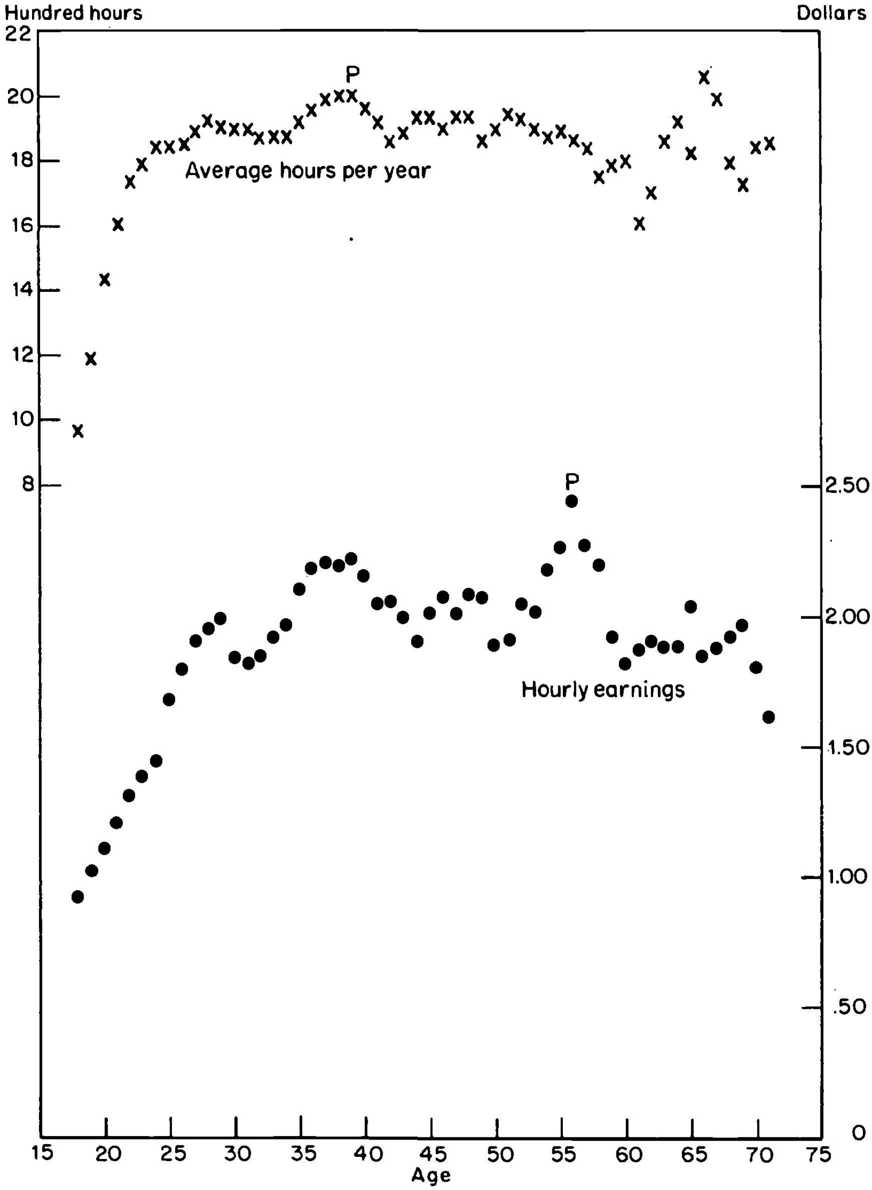


P = peak in hours or earnings.
SOURCE: See Appendix to this chapter.

FIGURE 3.7

HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED NONWHITE MEN, HIGH SCHOOL LEVEL

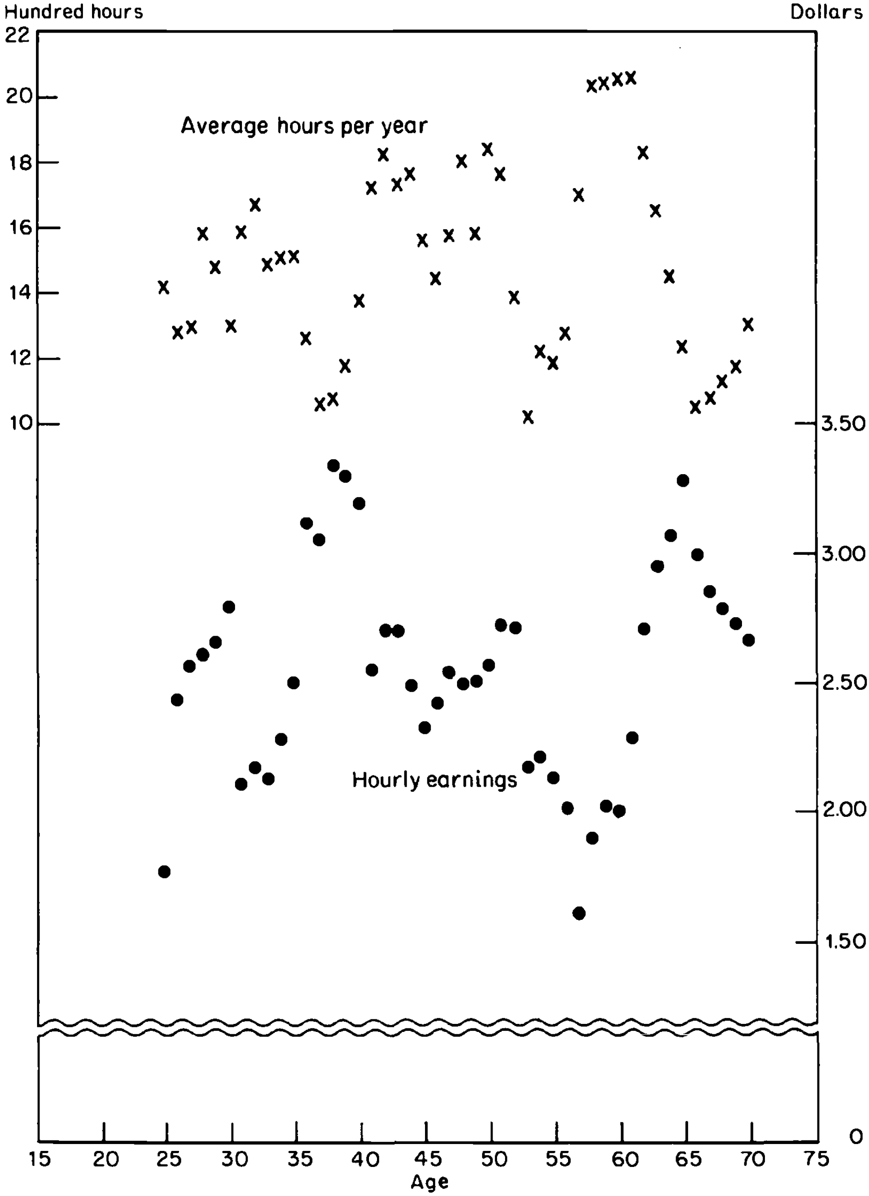
(five-year moving average)



P = peak in hours or earnings.

SOURCE: See Appendix to this chapter.

FIGURE 3.8
HOURLY EARNINGS AND AVERAGE HOURS PER YEAR, TOTAL UNITED STATES, ALL EMPLOYED NONWHITE MEN, COLLEGE LEVEL
(five-year moving average)



P = peak in hours or earnings.
SOURCE: See Appendix to this chapter.

The theory developed in Chapter 1 predicts a relation between the allocation of time, wage rates, and other variables at different ages that can be tested with the data in the 1/1,000 sample. The prediction is that:

$$\log L_{tt'} = a_0 + a_1 \log w_{tt'} + a_2 \log w^0_{tt'} + a_3 \log Z_{tt'} + a_4 t + a_5 \log v_{tt'}, \tag{3.1}$$

where

$L_{tt'}$ = average number of hours allocated to consumption activities at time t' by the male cohort aged t;

$w_{tt'}$ = average wage rate at time t' of the male cohort aged t;

$w^0_{tt'}$ = average wage rate at time t' of other family members of the male cohort aged t;

$Z_{tt'}$ = average family size at time t' of the male cohort aged t;

$v_{tt'}$ = average income other than earnings at time t' of the male cohort aged t.

I have already indicated how the average wage rate, income other than earnings, and family size can be measured for men of different ages from the 1/1,000 sample. Since the information available for men does not give the average hours worked of other family members, I did not measure their wage rates, but instead used the difference between the average family income and own income of men as a measure of the total earnings of other family members.

The dependent variable in equation (3.1), hours spent at consumption, is very difficult to measure accurately. One simple approach follows the theory developed in the first part of Chapter 1 in assuming that time can be allocated only to work or consumption. Then the hours spent at consumption during any year would equal the difference between the total hours in a year and the hours spent at work:[3]

$$L_{tt'} = (52 \times 7 \times 24) - N_{tt'} = 8{,}736 - N_{tt'}. \tag{3.2}$$

Although used in many of the following regressions, this measure has several obvious shortcomings. Some time, especially for younger persons, is generally spent neither producing nor consuming but investing in human capital (see the discussion in section 1.5, above).

3. Although there are 8,760 hours in a typical year, the figure 8,736 (= 52 × 168) is more consistent with the way hours worked are estimated.

The information available for each person in the 1/1,000 sample gives his years of schooling completed and whether he was enrolled in school (as of April 1960), but not how many hours he spent in school, in on-the-job training, or investing in other kinds of human capital. The errors in the estimates of consumption hours from the neglect of time spent in school can be reduced only if persons in each schooling class who are at least several years older than those typically completing that class are included: they must be at least age 18 if they have eight years or fewer of schooling, at least age 22 if they have nine to twelve years, and at least 26 if they have more than twelve.

In several studies it has been shown that a significant amount of time is usually spent in formal or informal on-the-job training, especially during the first ten years of labor force participation after completion of schooling.[4] Since the time spent in such training is generally reported to the Census as work, the estimates of hours worked are biased upward, especially at young ages. If, however, all training time were reported as work, the estimates of consumption hours spent derived from equation (3.2) would not be biased; if only some training time were not reported as work, estimated consumption hours would be biased upward, presumably especially at young ages. Since wage rates are estimated by dividing earnings by reported hours of work, they are biased downward, again especially at young ages.

A further problem is time lost due to ill health: this time and the time spent investing in health both tend to rise with age.[5] Hence, the estimates of consumption time derived from equation (3.2) would be biased upward, especially at older ages since, as Grossman shows, at least some of the time spent on health should be included along with time spent investing in human capital. The increase in the bias with age is usually small, however, below age 60.[6]

Time spent sleeping and in other "personal care" probably should be distinguished from other consumption time because

4. See especially Jacob Mincer, *Schooling, Experience, and Earnings* (New York: NBER, 1974).

5. See Michael Grossman, *The Demand for Health: A Theoretical and Empirical Investigation*, NBER Occasional Paper 119 (New York: NBER, 1972), Chap. 5.

6. An average of about 4.8 working days a year are spent in ill health between ages 17 and 24, 4.9 days between ages 25 and 44, and 6.3 days between ages 45 and 64 (U.S. Public Health Service, *Time Lost from Work Among the Currently Employed Population*, Series 10, no. 71, April 1972).

presumably goods cannot easily be substituted for time in the production of personal care, nor can other commodities easily be substituted for personal care itself. One piece of evidence supporting these presumptions is that sleeping time, a major part of personal care time, averages a little over 7½ hours per day in very different countries.[7] Another piece of evidence is that time spent on personal care by women working in the market sector is only slightly less than the approximately 75 hours a week spent by women not working there at all.[8]

A somewhat extreme assumption of no substitution possibilities in the production and consumption of personal care implies that the time spent producing personal care would be fixed, say at 70 hours per week or approximately 3,640 hours per year. The time spent producing other household commodities could be estimated from the equation,

$$L'_{tt'} = 8{,}736 - 3{,}640 - N_{tt'} = 5{,}096 - N_{tt'}; \tag{3.3}$$

and this estimate can be used in equation (3.1).

The theory developed in Chapter 1 predicts that if equation (3.1) is estimated from cross-sectional data of the kind found in the 1/1,000 sample, the parameter values would be, aside from sampling errors and measurement biases,

$$a_1 = -[(1 - s_1)\sigma_f + s_1\sigma_c] < 0;$$

$$a_2 = s_2(\sigma_f - \sigma_c) \gtreqless 0;$$

$$a_4 = r'\sigma_c - [s_3 + (1 - s_3)\sigma_c]g_w; \tag{3.4}$$

where

σ_c = elasticity of substitution in consumption between commodities in different time periods;

σ_f = elasticity of substitution in production between any two inputs at a particular time;

r' = difference between current rate of interest and time preference;

7. See A. Szalar, "The Multinational Comparative Time Budget Research Project," *American Behavioral Scientist* (December 1966); Table 6 contains data for eleven countries, including the United States, the U.S.S.R., Bulgaria, France, Yugoslavia, and Germany.

8. See, for examples, ibid., Table 9.

s_1 = share of husband's time in cost of producing commodities;
s_2 = share of wife's time in cost of producing commodities;
s_3 = share of goods in cost of producing commodities: $s_3 = 1 - s_1 - s_2$;
g_w = rate of growth over time in real wage rate at given age.

Tables 3.1 and 3.2 give the results of running a wide variety of regressions with the 1/1,000 sample. Three-year moving averages of all the variables are used to reduce the effects of the large measurement errors in the original data. For purposes of comparison, however, some results using original data are also included in each table. Moving averages can be expected to introduce positive serial correlation into the residuals, and they clearly do here: the Durbin-Watson statistics are generally much lower for the regressions with moving averages than for those with original data. Moving averages can also result in spuriously high t statistics, and for this reason levels of significance are not given for the regression coefficients.

3.1 WHITES

Table 3.1 contains the results for all white males, and separately for those with eight years or less of schooling, nine–twelve years, and more than twelve years, when consumption time is estimated by equations (3.2) and (3.3). Almost all the regression coefficients for the own hourly wage rate are negative. The three positive coefficients, for college graduates, have low t values, whereas all the negative coefficients in the moving average regressions have very high t values. As would be expected since the coefficients are elasticities, the magnitudes estimated from consumption time net of the time spent on personal care are about two to three times larger than those estimated from all consumption time. Also, the coefficients estimated from moving averages are several times larger, in absolute value, than those estimated from original data.

Family size always has a negative coefficient for the three separate education classes, and these have t values exceeding 2.5 in more than half the cases. For all classes combined, two coefficients are positive but have very low t values; one is negative with a t value close to 2. The preponderance of negative coefficients suggests that an increase in family size results in an increase in time spent working by men.

In all cases but two, other family income, which is used as a measure of wage rates of other family members, have positive coefficients. The t values are negligible for the two negative coefficients and high for most of the positive ones. The preponderance of positive coefficients suggests that an increase in the wage rates of other family members reduces the time spent working by men.

The coefficients for age are positive for the three education classes when only age and the man's wage rate are included, and negative when all the variables are included. The coefficients are positive for all classes combined when moving averages are used. Most of the negative coefficients have low t values, whereas most of the positive ones have sizable t values. Over-all, there is no clear indication of the nature of the effect of age on the allocation of time.

Income other than earnings always has a positive coefficient. However, most of the t values are small, and more importantly, practically all the coefficients are themselves small: five are 0.01 or less, and only one is above 0.025. In contrast, five coefficients for the male wage rate are above 0.20.

The negative coefficient for the own (i.e., male) wage rate is predicted by the theory developed in Chapter 1. An increase in own wage at any age reduces own time allocated to consumption at that age because of substitutions toward goods and other person's time in the production of commodities and substitution toward commodities at other ages. The elasticity of response of own time—i.e., the regression coefficient for own wage—is predicted to be a weighted average of the elasticities of substitution in production and consumption, the weights being the shares of own time and other inputs in production costs [see equation (3.4)].

The coefficient for own wage rate is about -0.12 in the regression combining all education classes when total consumption time is included, and it more than doubles (to about -0.27) when estimated time spent on personal care is excluded. Although the sizable difference between these coefficients is arithmetically necessary, I believe it also reflects the much smaller elasticity of substitution in production and consumption for personal care than for other commodities. The estimate of 0.27 suggests that the average of the elasticities of substitution in production and consumption is significantly greater than zero and smaller than 1.

The true average of these elasticities may be even larger than

TABLE 3.1

REGRESSIONS FOR CONSUMPTION TIME OF WHITE MEN: LEVEL EQUATIONS

Form of Dependent Variable[a] (in logs)	Independent Variables (t values in parentheses)						Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
	Intercept	Age	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size			
All Education Levels; Ages 22–65; Three-year Moving Average									
5,096 − HW/YR	8.176 (643.0)	0.002 (11.27)	−0.260 (15.81)				.92	.85	0.45
5,096 − HW/YR	7.881 (79.95)	0.002 (2.03)	−0.275 (4.09)	0.017 (1.26)	0.024 (2.27)	0.038 (0.81)	.94	.87	0.49
8,736 − HW/YR	8.978 (1520.)	0.001 (11.10)	−0.118 (15.66)				.93	.85	0.45
8,736 − HW/YR	8.743 (192.9)	0.001 (0.13)	−0.128 (0.14)	0.007 (1.20)	0.011 (2.24)	0.020 (0.91)	.94	.87	0.49
All Education Levels; Ages 22–65; Original Data									
5,096 − HW/YR	7.925 (65.79)	−0.001 (0.52)	−0.083 (1.31)	0.007 (0.67)	0.035 (2.79)	−0.089 (1.91)	.89	.77	1.20
Grade School; Ages 18–65; Three-year Moving Average									
5,096 − HW/YR	8.216 (469.4)	0.001 (3.60)	−0.266 (9.45)				.83	.68	0.79
5,096 − HW/YR	7.828 (36.76)	−0.001 (0.76)	−0.167 (3.01)	0.016 (1.05)	0.045 (2.25)	−0.021 (0.56)	.86	.70	0.68
8,736 − HW/YR	8.900 (1075.)	0.0004 (3.58)	−0.126 (9.48)				.83	.69	0.78
8,736 − HW/YR	8.709 (86.64)	−0.0003 (0.081)	−0.081 (3.09)	0.008 (1.06)	0.022 (2.29)	−0.007 (0.42)	.86	.70	0.68

Grade School; Ages 18–65; Original Data									
5,096 − HW/YR	7.937	−0.003	−0.001	0.0002	0.053	−0.123	.74	.49	1.40
	(46.42)	(3.21)	(0.01)	(0.02)	(3.10)	(2.97)			
High School; Ages 22–65; Three-year Moving Average									
5,096 − HW/YR	8.139	0.003	−0.253				.92	.85	0.55
	(785.5)	(11.7)	(15.21)						
5,096 − HW/YR	7.995	−0.001	−0.167	0.040	0.006	−0.042	.95	.89	0.68
	(104.3)	(0.84)	(3.19)	(4.26)	(0.69)	(1.77)			
8,736 − HW/YR	8.861	0.001	−0.114				.92	.84	0.54
	(1890.)	(11.6)	(15.16)						
8,736 − HW/YR	8.796	−0.0004	−0.077	0.018	0.003	−0.018	.95	.89	0.67
	(252.2)	(0.76)	(3.24)	(4.21)	(0.67)	(1.66)			
High School; Ages 22–65; Original Data									
5,096 − HW/YR	7.889	−0.002	−0.046	0.022	0.027	−0.079	.85	.69	1.66
	(83.83)	(1.72)	(0.87)	(2.61)	(2.67)	(2.87)			
College; Ages 26–65; Three-year Moving Average									
5,096 − HW/YR	8.106	0.004	−0.225				.79	.61	0.60
	(374.6)	(6.71)	(7.94)						
5,096 − HW/YR	8.265	−0.004	0.050	0.022	−0.006	−0.224	.91	.80	0.64
	(85.50)	(2.68)	(0.73)	(2.10)	(0.55)	(4.59)			
8,736 − HW/YR	8.845	0.002	−0.100				.79	.61	0.60
	(913.4)	(6.66)	(7.89)						
8,736 − HW/YR	8.916	−0.002	0.022	0.010	−0.003	−0.100	.90	.79	0.64
	(205.2)	(2.67)	(0.72)	(2.10)	(0.55)	(4.54)			
College; Ages 26–65; Original Data									
5,096 − HW/YR	8.205	−0.004	0.063	0.013	0.004	−0.214	.81	.60	1.39
	(71.25)	(2.90)	(1.16)	(1.37)	(0.29)	(4.89)			

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

a. Total hours in a year = 8,736 (= 52 × 168); total hours net of time spent in personal care = 5,096 (= 52 × 70); HW/YR = hours of work per year. For further clarification, see equations (3.2) and (3.3).

0.27 because random errors of measurement in the own wage rate bias its regression coefficient toward zero and even toward positive values. Measurement errors in total earnings bias the wage rate estimates but presumably not hours. The consequence is that the regression coefficient is biased toward zero. Random errors of measurement in hours worked bias the estimates of wage rates and consumption hours in the same direction; hence, the regression coefficient is biased toward a positive value. The importance of measurement error can be seen by comparing the results using moving averages with those using the original data. Presumably a moving average reduces the importance of measurement error because positive and negative errors are averaged together. The own wage coefficient is much higher in all the regressions using moving averages than in those using the original data (except for the college-educated group, where they are about equal).[9] Some independent evidence that errors of measurement reduce (in absolute value) the own wage coefficient is found in the regressions using hours of work as the dependent variable (see the discussion of Tables 3.5, 3.6, and 3.7).

Systematic errors in the own wage rate bias its regression coefficient, with the major bias probably due to the inclusion in measured working hours of time spent in on-the-job training. Since more time is spent in such training at younger ages (relative to working time), the rate of increase in the measured wage rate exceeds that in the true wage rate;[10] therefore, its coefficient would be biased toward zero. Moreover, if actual working time enters into the production of human capital,[11] the true wage rate would understate the shadow price of time, again especially at younger ages. Hence, even the regression coefficient for the true wage rate would be biased toward zero relative to the coefficient for the shadow price of time.[12]

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9. Of course, the bias in the own-wage coefficient depends not only on its measurement error, but also on those in other independent variables, on the partial correlation between these variables and the own wage, and on the true values of the other regression coefficients—see E. Malinvaud, *Statistical Methods of Econometrics* (Chicago: Rand McNally, 1966), Chap. 10. The difference between values of the coefficients based on moving averages and those based on original data suggests that the net effect of *all* the errors is to bias the coefficient for own wage toward zero.

10. In other language, the increase in the "net" wage rate exceeds the increase in wage rate "capacity."

11. See the formulation in section 1.5, above.

12. Other biases result from the inclusion in consumption time of some time spent in school, job search, portfolio management, and investment in health. Their net effect is probably to bias the own wage coefficient away from zero.

The own wage coefficient is very similar in all the regressions in Table 3.1 when age and own wage are the only independent variables; there is a slight tendency for it to decline with increases in education. When the other independent variables are entered, the own wage coefficient for each of the separate education classes is reduced substantially (but not the one combining all classes). It remains about the same for persons with elementary and high school education, and becomes positive and with a very low *t* value for persons with a college education.

The positive coefficient for my measure of the wage rates of other family members implies according to the theory [see equation (3.4)] that the elasticity of substitution in production exceeds the elasticity of substitution in consumption, which is consistent with the evidence on consumption analyzed by Ghez in Chapter 2. The coefficients are always rather small, never above +0.06, but their size cannot be taken seriously since this measure of other wage rates has large random and even systematic errors.[13]

An increase in family size apparently reduces the consumption time of men (increases their working time); the elasticity of response, although generally small, is positively related to education. Ghez finds that the consumption of goods is strongly and positively related to family size (section 2.5, above); moreover, a finding of many studies is that the labor force participation of married women, perhaps especially college-educated women, is significantly reduced if the household includes young children.[14] One plausible interpretation of these results (see section 1.7) is that child care uses a woman's time much more intensively than a man's, perhaps especially among the college educated.[15]

All the age coefficients are positive when only age and the own wage rate are entered in the regressions; this is also shown graphically in Figures 3.1–3.8, where hours worked peak at an earlier age

13. Note, however, that James Smith, using other data and a much better measure of the wage rate of wives, also finds small positive coefficients; see his, "The Life Cycle Allocation of Time in a Family Context" (Ph.D. diss., University of Chicago, 1972).

14. See, for example, Smith, ibid., and Arleen Leibowitz, "Women's Allocation of Time to Market and Non-Market Activities" (Ph.D. diss., Columbia University, 1972). Ghez finds only a weak relation between education and the elasticity of response of the consumption of goods to a change in family size.

15. This interpretation is elaborated in Smith, "Life Cycle Allocation," Chap. IV, to explain why the working time of men actually increases as family size increases.

than own wage rate. When the other independent variables are entered, however, the age coefficients become negative (but with low t values) in the regressions for the separate education classes, but not for all classes combined. According to the theory developed in Chapter 1, the age coefficient in a regression using observations of a given cohort over its life cycle would equal the product of the elasticity of substitution in consumption and the difference between the rate of interest and the time preference for the present. The coefficient in a regression using observations across successive cohorts, such as those found in the Census, would be "biased" downward by a growth in real wage rates between cohorts (see the discussion by Ghez in section 2.3); the bias would be sizable if the growth in wage rates and the share of goods in commodity production costs were sizable [see equation (3.4)]. Therefore, the mixture of positive and negative signs for the age coefficient does not necessarily imply that age has little systematic effect on the allocation of time. Indeed, the analysis in Chapter 4 suggests that the consumption of both time and goods rises significantly with age.

An increase in income other than earnings appears to increase consumption time, although the elasticity of response is small. For all schooling levels combined and for grade school men, it is only one-tenth of the elasticity of response of consumption time to an increase in the own wage rate; for high school men, it is about one-fourth. These results are generally consistent, therefore, with the implication of our theory that life cycle variations in wage rates have a more important effect than life cycle variations in other income. Indeed, the theory implies that if each cohort accurately foresees the future, life cycle variations in other income have *no* effect on the allocation of time. Since the regression coefficients for other income are small and generally have low t values, these results are not grossly inconsistent with accurate *cohort* forecasts of other income. On the other hand, since the coefficients are always positive even though the large errors of measurement in other income presumably bias them toward zero, and since Ghez finds sizable coefficients for other income in his regression for goods (see Chapter 2), cohorts may be systematically adapting their forecasts of income to unexpected changes in observed values.[16]

16. If the wealth elasticity of consumption time equals 1, and if nonhuman wealth is about one-quarter of all wealth, the true value of the regression coefficient of other income would equal $+(1/4)a$, where a is the percentage increase in expected nonhuman

3.2 NONWHITES

Corresponding regression results for all male nonwhites and for those with an elementary school, high school, and college education are presented in Table 3.2. Since the number of nonwhites in the 1/1,000 sample is only about one-tenth the number of whites, some nonwhite cell sizes are quite small. For example, an average of only 7 observations of nonwhites with a college education and 25 observations of nonwhites with a high school education are found at each age (see Table 3A.1, below). One would expect, therefore, random errors of measurement and other "noise" to have an even greater effect on the results for nonwhites than they do for whites, which is apparently true. For example, all the correlation coefficients are considerably smaller for nonwhites than for whites. In the original data, where noise is more important, the coefficient of determination for all nonwhite men is only about one-fifth, whereas for all whites it is almost four-fifths.[17]

In spite of the importance of measurement error and other noise, the results for nonwhites are qualitatively very close to those for whites and to the predictions of the theory. In Table 3.3, to facilitate comparison I show each coefficient for nonwhites alongside the corresponding coefficient for whites. The own-wage-rate coefficients for both nonwhites and whites are negative (except for college persons), have reasonably high t values, and are about the same for all elementary and high school men for both whites and nonwhites. The nonwhite coefficients are considerably smaller than the white ones, possibly because of the greater measurement error in the nonwhite data.[18]

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wealth adapted from an observed 1 per cent increase in other income. If the values generally observed for this coefficient (less than +0.02) were close to the true values, a would be less than 0.08, a very small adaptation coefficient.

Moreover, note that other income is not exogenous: its lifetime pattern is partly a consequence of the optimal lifetime patterns for goods and time operating through the effect of the latter two on savings and the accumulation of nonhuman capital. In these regressions, therefore, other income may pick up the effect of omitted determinants of the lifetime allocation of time. Even the direction of the resulting bias in the coefficient of other income is not obvious, however, partly because there is usually not even a monotonic relation between the optimal path of consumption time and that of nonhuman capital.

17. I cannot explain why the serial correlation for the residuals in the regressions for nonwhites is much less than for the residuals for whites.

18. The importance of measurement error is further emphasized by the regressions for nonwhites using the original data. Although these own-wage coefficients are also negative, they are negligible and have negligible t values.

TABLE 3.2
REGRESSIONS FOR CONSUMPTION TIME OF NONWHITE MEN: LEVEL EQUATIONS

Form of Dependent Variable[a] (in logs)	Independent Variables (t values in parentheses): Intercept	Age	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
All Education Levels; Ages 22–65; Three-year Moving Average									
5,096 – HW/YR	8.144	0.0002	−0.106				.61	.34	0.94
	(612.9)	(0.76)	(4.88)						
5,096 – HW/YR	8.008	−0.001	−0.051	0.003	0.033	−0.087	.78	.55	1.24
	(64.11)	(1.98)	(2.25)	(0.89)	(2.42)	(3.42)			
8,736 – HW/YR	8.865	0.0001	−0.050				.61	.34	0.94
	(1412.)	(0.77)	(4.90)						
8,736 – HW/YR	8.802	−0.003	−0.025	0.002	0.015	−0.041	.78	.55	1.23
	(149.2)	(1.97)	(2.28)	(0.88)	(2.40)	(3.42)			
All Education Levels; Ages 22–65; Original Data									
5,096 – HW/YR	8.104	−0.001	−0.008	0.010	0.018	−0.107	.53	.19	2.17
	(41.01)	(2.00)	(0.21)	(1.97)	(0.85)	(2.46)			
Grade School; Ages 18–65; Three-year Moving Average									
5,096 – HW/YR	8.150	0.0000	−0.110				.52	.24	0.83
	(553.5)	(0.12)	(3.23)						
5,096 – HW/YR	7.791	−0.0004	−0.048	−0.005	0.054	−0.016	.68	.39	0.99
	(51.87)	(0.40)	(1.35)	(0.74)	(3.65)	(0.26)			
8,736 – HW/YR	8.869	0.0000	−0.054				.53	.24	0.83
	(1242.)	(0.14)	(3.29)						
8,736 – HW/YR	8.695	−0.0002	−0.024	−0.002	0.026	−0.007	.68	.39	0.99
	(119.1)	(0.36)	(1.41)	(0.75)	(3.61)	(0.23)			

			Grade School; Ages 18–65; Original Data						
5,096 – HW/YR	7.706	−0.001	−0.012	0.001	0.048	−0.063	.43	.09	2.14
	(46.32)	(1.38)	(0.26)	(0.19)	(2.68)	(0.99)			
			High School; Ages 22–65; Three-year Moving Average						
5,096 – HW/YR	8.117	0.0002	−0.079				.48	.20	1.04
	(528.9)	(0.40)	(3.20)						
5,096 – HW/YR	7.923	−0.001	−0.042	0.011	0.027	−0.040	.60	.28	1.22
	(66.03)	(1.18)	(1.55)	(2.17)	(1.96)	(1.22)			
8,736 – HW/YR	8.852	0.0001	−0.038				.49	.20	1.05
	(1244.)	(0.44)	(3.26)						
8,736 – HW/YR	8.764	−0.0003	−0.020	0.005	0.013	−0.019	.61	.28	1.23
	(157.4)	(1.16)	(1.61)	(2.17)	(1.93)	(1.23)			
			High School; Ages 22–65; Original Data						
5,096 – HW/YR	8.137	−0.001	−0.003	0.001	−0.005	−0.008	.16	−.11	1.82
	(76.67)	(0.73)	(0.06)	(0.14)	(0.54)	(0.17)			
			College; Ages 26–65; Three-year Moving Average						
5,096 – HW/YR	8.140	−0.004	0.046				.45	.14	0.69
	(122.7)	(2.63)	(0.67)						
5,096 – HW/YR	7.705	−0.004	0.105	0.006	0.078	−0.148	.80	.57	1.22
	(41.12)	(4.33)	(2.00)	(0.63)	(3.39)	(3.05)			
8,736 – HW/YR	8.868	−0.002	0.021				.45	.15	0.68
	(284.9)	(2.63)	(0.66)						
8,736 – HW/YR	8.660	−0.002	0.049	0.003	0.037	−0.070	.80	.57	0.22
	(98.92)	(4.36)	(2.00)	(0.63)	(3.40)	(3.08)			
			College; Ages 26–65; Original Data						
5,096 – HW/YR	7.830	−0.003	0.265	0.001	0.047	−0.187	.70	.35	2.15
	(26.93)	(1.37)	(3.78)	(0.10)	(1.54)	(1.93)			

SOURCE: Same as Table 3.1. See also section 2 of the appendix to this chapter.
a. See Table 3.1, note a.

TABLE 3.3
COMPARISON OF REGRESSION COEFFICIENTS FOR WHITES AND NONWHITES[a]

Dependent Variable[b] (in logs)	Age	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size
All Education Levels; Ages 22–65; Three-year Moving Average					
5,096 − HW/YR	.002	−.260			
	.0002	−.106			
5,096 − HW/YR	.002	−.275	.017	.024	.038
	−.001	−.051	.003	.033	−.087
8,736 − HW/YR	.001	−.118			
	.0001	−.050			
8,736 − HW/YR	.001	−.128	.007	.011	.020
	−.003	−.025	.002	.015	−.041
All Education Levels; Ages 22–65; Original Data					
5,096 − HW/YR	−.001	−.083	.007	.035	−.089
	−.001	−.008	.010	.018	−.107
Grade School; Ages 18–65; Three-year Moving Average					
5,096 − HW/YR	.001	−.266			
	.0000	−.110			
5,096 − HW/YR	−.001	−.167	.016	.045	−.021
	−.0004	−.048	−.005	.054	−.016
8,736 − HW/YR	.0004	−.126			
	.0000	−.054			
8,736 − HW/YR	−.0003	−.081	.008	.022	−.007
	−.0002	−.024	−.002	.026	−.007
Grade School; Ages 18–65; Original Data					
5,096 − HW/YR	−.003	−.001	.0002	.053	−.123
	−.001	−.021	.001	.048	−.063
High School; Ages 22–65; Three-year Moving Average					
5,096 − HW/YR	.003	−.253			
	.0002	−.079			
5,096 − HW/YR	−.001	−.167	.040	.006	−.042
	−.001	−.042	.011	.027	−.040
8,736 − HW/YR	.001	−.114			
	.0001	−.038			
8,736 − HW/YR	−.0004	−.077	.018	.003	−.018
	−.0003	−.020	.005	.013	−.019

TABLE 3.3 (continued)

Dependent Variable[b] (in logs)	Age	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size
High School; Ages 22–65; Original Data					
5,096 − HW/YR	−.002	−.046	.022	.027	−.079
	−.001	−.003	.001	−.005	−.008
College; Ages 26–65; Three-year Moving Average					
5,096 − HW/YR	.004	−.225			
	−.004	.046			
5,096 − HW/YR	−.004	.050	.022	−.006	−.224
	−.004	.105	.006	.078	−.148
8,736 − HW/YR	.002	−.100			
	−.002	.021			
8,736 − HW/YR	−.002	.022	.010	−.003	−.100
	−.002	.049	.003	.037	−.070
College; Ages 26–65; Original Data					
5,096 − HW/YR	−.004	.063	.013	.004	−.214
	−.003	.265	.001	.047	−.187

SOURCE: Same as Table 3.1.
a. Upper coefficient in each cell is for whites; lower one is for nonwhites.
b. See Table 3.1, note a.

My measure of the wage rates of other family members always has a positive coefficient that is typically almost as large (in absolute value) for nonwhites as the own wage coefficient. Therefore, nonwhite men also work less in the market sector when their wives' wage rate increases. Perhaps nonwhite men allocate less of their time and nonwhite women more of their time to the market sector than do white men and women,[19] because the difference in wage rates between men and women is smaller in nonwhite than in white families.[20]

19. Nonwhite men averaged 1,900 hours of work in 1959, whereas white men averaged 2,147 hours; similarly, nonwhite women averaged 1,385 and white women averaged 1,486 (Smith, "Life Cycle Allocation," Table 4, p. 33).

20. Similarly, married men allocate more time and married women less time to the market sector than do unmarried men and women. See *U.S. Census of Population, 1960:* vol. 2, *Subject Reports,* Part 6A, *Employment Status and Work Experience* (1963), Tables 4 and 12.

Family size consistently has a negative coefficient, with a high *t* value for all schooling levels combined and for college-educated nonwhite men. The coefficients for whites and nonwhites are about equal in the three separate education classes. Apparently, an increase in family size also induces nonwhite men to spend more time and nonwhite women less time at work.[21]

The age coefficients for nonwhites, like those for whites, are small, not consistently positive or negative, and have small *t* values. Perhaps negative values are more frequent for nonwhites, but the difference is of little significance. As mentioned earlier, the age coefficient is biased downward; therefore, a small age coefficient is not evidence that age has little effect on the allocation of time.

The coefficient for other income of nonwhites is generally positive and has a low *t* value. Its size relative to the own wage coefficient is about the same for all whites and nonwhites, and for whites and nonwhites with an elementary school education. Hence, there is a suggestion that both nonwhites and whites moderately adapt their expectations of other income to unexpected changes in observed values.

James Smith ran regressions similar to those in Tables 3.1 and 3.2 on a completely independent body of data for a different year; namely, the 1967 Survey of Economic Opportunity. A comparison of his results with mine, reported in Table 3.4, offers an important opportunity to check the validity of my findings. The coefficient of the male wage rate is always negative in his regressions; it is very similar to mine for all whites and for those with a high school education; it is (absolutely) larger than mine for all blacks[22] and for whites with a college education, and smaller than mine for whites with an elementary school education. His measure of the wage rate of wives is much better than mine, and it is reassuring to my emphasis on measurement error to note that his coefficient is also larger (except for whites with an elementary school education) than mine. The coefficient of his family size variable is more consistently negative, probably because he uses the number of children under age seven

21. Note, however, that the effect of family size on the working time of nonwhite women is considerably less than that for white women (see Smith, "Life Cycle Allocation," Chap. IV).

22. His data refer only to blacks, mine to all nonwhites; the differences between these groups are not large.

TABLE 3.4
COMPARISON OF REGRESSIONS BY SMITH AND BECKER[a]
FOR HOURLY WAGE RATES OF MEN
(t values are in parentheses)

	Hourly Wage of Men	Wages of Wife[b]	Age	Family Size[c]
All whites				
Becker	−0.128	0.011	0.001	0.020
	(4.14)	(2.24)	(2.13)	(0.91)
Smith	−0.1040	0.0202	0.00014	−0.0178
	(6.88)	(0.82)	(0.67)	(4.60)
Whites; college				
Becker	0.022	−0.003	−0.002	−0.100
	(0.72)	(0.55)	(2.67)	(4.54)
Smith	−0.0405	0.0195	−0.00002	−0.0092
	(2.24)	(1.17)	(0.041)	(1.13)
Whites; high school				
Becker	−0.077	0.003	−0.00004	−0.018
	(3.24)	(0.67)	(0.76)	(1.66)
Smith	−0.0852	0.0510	−0.00003	−0.0198
	(4.16)	(2.10)	(0.097)	(4.02)
Whites; elementary school				
Becker	−0.081	0.022	−0.0003	−0.0007
	(0.09)	(2.29)	(0.68)	(0.42)
Smith	−0.0029	−0.0415	0.009	0.0072
	(0.084)	(1.92)	(2.08)	(0.92)
All blacks				
Becker	−0.025	0.015	−0.041	−0.003
	(2.28)	(2.40)	(3.42)	(1.97)
Smith	−0.0643	0.0455	0.00001	−0.0107
	(2.16)	(1.71)	(0.031)	(1.35)

SOURCE: See accompanying text.

a. Becker's regressions include one additional variable—other nonlabor income.

b. Becker's variable is other family income.

c. Becker's variable is family size, while Smith's is number of children younger than age seven.

rather than total family size. The participation of married women in the labor force is also more sensitive to the number of children under age seven than to the total number of children.[23]

3.3 WORKING TIME

For comparability with studies that use working time rather than consumption time, I ran regressions like those in Tables 3.1 and 3.2 with working time as the dependent variable; the results are presented in Tables 3.5 and 3.6. Since the change in working time is, by definition, equal but opposite in sign to the change in consumption time, each coefficient in Tables 3.5 and 3.6 should be opposite in sign to the corresponding coefficient in Tables 3.1 and 3.3. Moreover, since average hours worked are about 30 per cent of all consumption hours and 70 per cent of consumption hours net of personal care,[24] the absolute value of a coefficient in Table 3.1 should be about three-tenths of the corresponding coefficient in Table 3.5[25] for all consumption time and seven-tenths for consumption time net of personal care.[26] The signs and magnitudes of the coefficients in Tables 3.5 and 3.6 generally do follow this pattern.

Since all the coefficients in Tables 3.1 and 3.2 were discussed earlier, I now consider only those for earnings in Tables 3.5 and 3.6. For whites, the coefficient of hourly earnings is positive and has a high t value except for college persons, for whom it is negative and has a low t value. Moreover, the coefficient declines as education increases. For nonwhites, the coefficient is also positive, again

23. See Smith, "Life Cycle Allocation," Chap. IV.

24. Since all white males worked about 2,100 hours in 1959 (see Table 3A.2), then $2{,}100/(8{,}736-2{,}100)=0.32$, and $2{,}100/(5{,}096-2{,}100)=.70$.

25. Since the ratios for nonwhites are $1{,}833/(8{,}736-1{,}833)=0.26$, and $1{,}833/(5{,}096-1{,}833)=0.55$, coefficients in Table 3.2 should be about one-fourth and one-half of the corresponding coefficients in Table 3.6.

26. Since $dN=-dL$, where dL is the change in consumption time and dN is the change in working time,

$$\frac{dN}{N}=d\log N=\frac{-dL}{L}\frac{L}{N}=-d\log L\,\frac{L}{N}.$$

If $r=L/N$ is treated as a constant, by integration $\log N=-r\log L$. Therefore, if $\log L=\Sigma a_i \log X_i$, then by substitution, $\log N=\Sigma a_i' \log X_i$, where $a_i'=-ra_i$.

except for college persons; is much smaller than that for whites; and does not vary systematically with education.

In most studies, a negative rather than a positive relation has been found between hours worked and the own wage rate, and the negative relation has been interpreted as evidence that the income effect is more powerful than the substitution effect.[27] I obtain a positive relation partly because the income effect is reduced and perhaps largely eliminated by using life cycle observations, and partly because errors of measurement have been reduced. Wage rates usually are not directly observed but are constructed from presumably statistically independent observations on earnings and hours worked. As pointed out earlier, random errors of measurement in earnings bias the regression coefficient between hours worked and the constructed wage rate toward zero, whereas random errors in hours worked bias it toward −1. These biases would be especially large in small samples that are analyzed in disaggregated form.[28] Although the Census sample is large, it is obtained by inexperienced interviewers. Moreover, the sample is classified into more than 250 cells, and some have few observations: for example, nonwhite males with a college education average only seven observations at each age (and their wage rate has a negative coefficient[29]).

I tried to reduce the measurement error by using three-year moving averages of all the variables. The coefficient of hourly earnings is significantly larger algebraically, especially for whites, in these regressions than in those using the original data. The effect of measurement error can be reduced even further by using annual rather

27. See, for example, James A. Morgan et al., *Productive Americans* (Ann Arbor: University of Michigan Press, 1966).

28. For example, Morgan, *Productive Americans* (p. 21, n. 4), uses a sample of 2,214 men obtained by interviews and does not aggregate at all. However, he is aware of the biasing effect of measurement error in hours of work, but considers it not of dominant importance.

29. The wage rate coefficient is also negative for male whites with a college education, although they average 165 observations at each age (a smaller number of observations, however, than at the other two education classes). The coefficient is negative for both white and nonwhite college persons perhaps also because hours of work are less accurately measured for them. Men with less than a college education are usually paid on an hourly basis and a written record is kept of their hours, whereas college-educated men are usually salaried or self-employed and do not have their hours recorded so diligently.

TABLE 3.5

REGRESSIONS FOR ANNUAL HOURS WORKED OF WHITE MEN: LEVEL EQUATIONS

(dependent variable = log annual hours worked = HW/YR)

	Independent Variables (t values in parentheses)								
Intercept	Age	Log Annual Earnings	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
All Education Levels; Ages 22–65; Three-year Moving Average									
7.391	−0.003		0.386				.92	.84	0.43
(373.4)	(10.46)		(15.06)						
7.843	−0.004		0.448	−0.020	−0.036	−0.091	.94	.86	0.50
(51.07)	(2.45)		(4.28)	(0.96)	(2.17)	(1.25)			
5.251	−0.003	0.288					.96	.92	0.43
(47.83)	(12.57)	(21.91)							
4.545	−0.004	0.424		−0.024	−0.008	−0.160	.98	.94	0.60
(13.69)	(5.23)	(10.17)		(1.87)	(0.75)	(4.12)			
All Education Levels; Ages 22–65; Original Data									
5.342	−0.003	0.317		−0.013	−0.023	−0.067	.93	.85	1.68
(11.34)	(2.46)	(5.39)		(1.04)	(1.45)	(1.19)			
Grade School; Ages 18–65; Three-year Moving Average									
7.268	−0.002		0.490				.83	.68	0.73
(223.6)	(3.46)		(9.39)						
8.131	0.001		0.345	−0.033	−0.089	−0.018	.86	.71	0.68
(20.83)	(0.31)		(3.38)	(1.13)	(2.45)	(0.26)			
4.593	−0.001	0.364					.93	.87	0.79
(25.54)	(4.83)	(16.34)							
4.508	−0.003	0.401		0.001	−0.007	−0.085	.94	.87	0.92
(8.44)	(0.40)	(8.83)		(0.04)	(0.26)	(1.95)			

Grade School; Ages 18–65; Original Data									
5.708	0.0001	0.253		−0.0002	−0.037	0.024	.82	.63	2.09
(9.55)	(0.05)	(4.03)		(0.01)	(1.29)	(0.36)			
High School; Ages 22–65; Three-year Moving Average									
7.457	−0.004		0.360				.92	.84	0.53
(496.9)	(11.40)		(14.97)						
7.662	0.001		0.236	−0.055	−0.008	0.046	.95	.88	0.64
(67.58)	(0.52)		(3.40)	(4.02)	(0.59)	(1.30)			
5.405	−0.003	0.274					.96	.92	0.53
(51.15)	(14.34)	(21.35)							
5.189	−0.002	0.308		−0.032	0.010	−0.020	.97	.93	0.64
(13.63)	(1.49)	(7.24)		(2.91)	(1.05)	(0.74)			
High School; Ages 22–65; Original Data									
6.072	−0.001	0.213		−0.020	−0.017	0.017	.89	.77	1.67
(12.82)	(0.63)	(3.88)		(1.83)	(1.31)	(0.47)			
College; Ages 26–65; Three-year Moving Average									
7.512	−0.005		0.302				.79	.60	0.59
(251.5)	(6.49)		(7.73)						
7.303	0.006		−0.068	−0.031	0.008	0.302	.90	.78	0.63
(53.71)	(2.62)		(0.70)	(2.08)	(0.51)	(4.39)			
5.564	−0.004	0.257					.88	.77	0.63
(29.86)	(8.86)	(11.51)							
5.770	−0.001	0.216		−0.038	0.025	0.058	.92	.82	0.76
(9.65)	(0.53)	(2.64)		(2.94)	(1.78)	(0.74)			
College; Ages 26–65; Original Data									
6.560	0.001	0.109		−0.021	0.013	0.132	.81	.61	1.36
(11.82)	(0.30)	(1.52)		(1.73)	(0.78)	(1.82)			

SOURCE: See Table 3.1.

TABLE 3.6
REGRESSIONS FOR ANNUAL HOURS WORKED OF NONWHITE MEN: LEVEL EQUATIONS

	Independent Variables (*t* values in parentheses)								
Intercept	Age	Log Annual Earnings	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
All Education Levels; Ages 22–65; Three-year Moving Average									
7.417	−0.0003		0.193				.62	.35	0.95
(315.7)	(0.79)		(5.02)						
7.640	0.001		0.098	−0.005	−0.056	0.153	.78	.55	1.23
(34.40)	(1.94)		(2.42)	(0.83)	(2.33)	(3.40)			
5.946	−0.0003	0.196					.76	.56	0.99
(28.64)	(1.12)	(7.56)							
6.480	0.001	0.135		−0.002	−0.034	0.126	.83	.65	1.24
(17.08)	(1.59)	(4.21)		(0.41)	(1.55)	(3.08)			
All Education Levels; Ages 22–65; Original Data									
6.173	0.001	0.149		−0.017	−0.005	0.141	.63	.32	2.20
(10.63)	(1.48)	(2.74)		(1.99)	(0.14)	(1.95)			
Grade School; Ages 18–65; Three-year Moving Average									
7.381	−0.0002		0.258				.55	.27	0.84
(233.5)	(0.24)		(3.52)						
8.151	0.0001		0.131	0.010	−0.106	−0.001	.68	.39	0.98
(24.81)	(0.06)		(1.69)	(0.78)	(3.28)	(0.01)			
5.075	−0.001	0.310					.78	.60	0.91
(16.72)	(1.84)	(7.73)							
5.874	−0.001	0.262		−0.001	−0.048	−0.038	.80	.60	0.95
(11.08)	(0.85)	(5.17)		(0.06)	(1.70)	(0.34)			

Grade School; Ages 18–65; Original Data									
5.442	0.000	0.299		−0.009	−0.055	0.069	.68	.40	2.26
(8.99)	(0.002)	(4.57)		(0.71)	(1.70)	(0.62)			
High School; Ages 22–65; Three-year Moving Average									
7.469	−0.0004		0.140				.51	.22	1.07
(297.7)	(0.60)		(3.47)						
7.775	0.001		0.081	−0.018	−0.041	0.067	.62	.30	1.24
(29.43)	(1.11)		(1.81)	(2.19)	(1.80)	(1.25)			
6.217	−0.001	0.165					.67	.43	1.14
(26.52)	(1.30)	(5.57)							
6.647	0.0003	0.129		−0.012	−0.024	0.045	.71	.43	1.25
(17.37)	(0.31)	(3.61)		(1.52)	(1.14)	(0.92)			
High School; Ages 22–65; Original Data									
5.987	−0.001	0.181		−0.002	0.014	0.003	.44	.09	2.15
(11.34)	(0.35)	(2.88)		(0.19)	(1.01)	(0.04)			
College; Ages 22–65; Three-year Moving Average									
7.396	0.006		−0.072				.46	.15	0.65
(64.55)	(2.66)		(0.61)						
8.752	0.008		−0.172	−0.011	−0.134	0.262	.81	.58	1.20
(25.55)	(4.46)		(1.98)	(0.67)	(3.42)	(3.18)			
5.352	0.003	0.249					.60	.31	0.98
(3.98)	(1.27)	(2.62)							
7.692	0.006	0.052		−0.013	−0.126	0.188	.78	.52	1.43
(8.37)	(2.55)	(0.51)		(0.76)	(2.84)	(1.91)			
College; Ages 22–65; Original Data									
7.175	0.002	0.073		−0.008	−0.050	0.064	.31	−.14	2.46
(3.99)	(0.39)	(0.36)		(0.28)	(0.68)	(0.27)			

SOURCE: See Table 3.1.

TABLE 3.7
COMPARISON OF THE COEFFICIENT OF MALE HOURLY EARNINGS ESTIMATED DIRECTLY AND ESTIMATED INDIRECTLY FROM ANNUAL EARNINGS

	Education Level			
	All	Grade School	High School	College
Whites				
Direct estimate	.448	.345	.236	−.068
Indirect estimate	.736	.669	.445	.276
Nonwhites				
Direct estimate	.098	.131	.081	−.172
Indirect estimate	.156	.355	.148	.055

than hourly earnings as an independent variable. A simple transformation[30] of the coefficient of annual earnings provides an estimate of the coefficient of hourly earnings that is biased by errors of measurement only to zero rather than −1.

Table 3.7 contains direct estimates of the coefficients of hourly earnings alongside the indirect estimates obtained from annual earnings. The indirect estimates are more than 50 per cent larger than the direct ones for all whites and nonwhites and for those with an elementary or high school education. The effect is even more dramatic for college persons: negative direct estimates are replaced by the predicted positive estimates when annual earnings are used. Even in the large Census sample, the bias toward a negative coefficient resulting from dividing earnings by a badly measured estimate of hours of work may be very large.

Certain systematic variations in hours worked may, however,

30. If $\log N_t = b_1 \log E_t + \Sigma b_j X_j$, where E_t is annual earnings at age t; then by subtracting $b_1 \log N_t$ from both sides,

$$\log N_t(1 - b_1) = b_1 \log \frac{E_t}{N_t} + \Sigma b_j X_j,$$

or

$$\log N_t = b_1' \log \frac{E_t}{N_t} + \Sigma b_j' X_j,$$

where E_t/N_t is hourly earnings, and $b_1' = b_1/(1 - b_1)$.

bias the indirect estimates upward. Assume that the true relation is given by[31]

$$\log N = a + b \log w + cz, \tag{3.5}$$

where z represents certain omitted variables that affect N, and where $\log w$ and z are uncorrelated. If w were measured without error, the least squares regression of $\log N$ on $\log w$ would given an unbiased estimate of b. Suppose instead that equation (3.5) is transformed into

$$\log N = \frac{a}{1+b} + \frac{b}{1+b} \log Nw + \frac{cz}{1+b} = a' + b' \log E + c'z, \tag{3.6}$$

where E is earnings. Then $\log E$ and z would be correlated because $\log N$ and z are, and the regression of $\log N$ on $\log E$ would give an upwardly[32] biased estimate of b', and thus of b. If errors of measurement in hours worked were large relative to the error from omitting relevant independent variables, the upward bias in the earnings regressions would be small compared to the downward bias in the hours regressions; and vice versa, if the random error were small compared to the systematic error. In any case, the estimates from regressions of the wage rate and earnings would bound the true value of the wage rate coefficient.

A still different way to reduce the error in measuring wage rates is to utilize recent work on investment in post-school training. If the wage rate is assumed to be proportional to the stock of human capital, and the latter is assumed to be a concave function of work experience when years of schooling are held constant,[33] the wage rate will be a concave function of work experience (e), say the quadratic function

$$w_t = c_1 e + c_2 e^2. \tag{3.7}$$

In a regression of hours of work on this function, c_1 would be positive and c_2 would be negative.

Calendar age is used to measure experience in the results reported in Table 3.8 (post-school age, which Mincer uses, would

31. I am indebted for this formulation to James Smith.

32. The bias would be upward as long as $c \neq 0$.

33. Mincer, *Schooling*, gets excellent results with these assumptions.

TABLE 3.8

COMPARISON OF REGRESSIONS CONTAINING AGE AS A MEASURE OF INVESTMENT OF MEN IN POST-SCHOOL TRAINING
(based on three-year moving averages of underlying data)

Dependent Variable[a] (in logs)	Intercept	Independent Variables (t values in parentheses): Age	Log Annual Earnings	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size	Age^2	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
I. Whites											
All Education Levels											
HW/YR	7.303	0.023	0.129		−0.020	−0.098	−0.241	−0.0003	.98	.96	0.81
	(9.53)	(3.24)	(1.53)		(1.82)	(3.92)	(6.14)	(3.88)			
5,096 − HW/YR	7.427	−0.026		0.107	0.011	0.100	0.124	0.0003	.98	.96	1.07
	(106.7)	(8.99)		(2.04)	(1.48)	(10.52)	(4.75)	(9.90)			
Grade School											
HW/YR	5.820	0.009	0.261		0.001	−0.044	−0.163	−0.0001	.94	.87	0.88
	(6.20)	(1.25)	(2.77)		(0.04)	(1.31)	(2.59)	(1.68)			
5,096 − HW/YR	7.572	−0.021		0.130	0.006	0.082	0.115	0.0002	.94	.87	0.78
	(51.92)	(4.39)		(2.37)	(0.60)	(5.81)	(3.72)	(7.34)			
High School											
HW/YR	6.429	0.010	0.177		−0.025	−0.028	−0.090	−0.0001	.98	.94	0.60
	(11.48)	(2.36)	(2.92)		(2.36)	(1.74)	(2.59)	(2.83)			
5,096 − HW/YR	7.741	−0.014		0.001	0.021	0.046	0.059	0.0002	.97	.94	0.82
	(103.5)	(5.47)		(0.03)	(2.70)	(4.62)	(2.25)	(5.395)			

College											
HW/YR	6.574	0.022	0.130		−0.058	−0.008	−0.067	−0.0003	.82	.83	0.75
	(8.75)	(1.59)	(1.38)		(3.35)	(0.34)	(0.63)	(1.96)			
5,096 − HW/YR	8.038	−0.032		0.124	0.045	0.035	−0.018	0.0003	.93	.84	0.73
	(74.85)	(3.88)		(1.94)	(3.98)	(2.21)	(0.24)	(0.414)			
II. Nonwhites											
All Education Levels											
HW/YR	6.423	0.000	0.142		−0.002	−0.034	0.134	0.000	.83	.64	1.23
	(11.91)	(0.01)	(2.48)		(0.35)	(1.51)	(2.01)	(0.15)			
5,096 − HW/YR	7.988	−0.006		0.002	0.004	0.031	−0.026	0.0001	.80	.57	1.24
	(65.37)	(1.96)		(0.04)	(1.23)	(2.35)	(0.61)	(1.76)			
Grade School											
HW/YR	5.164	−0.013	0.370		−0.003	−0.076	0.134	0.0002	.81	.61	0.98
	(7.33)	(1.64)	(4.23)		(0.28)	(2.26)	(0.85)	(1.50)			
5,096 − HW/YR	7.935	−0.011		0.068	−0.006	0.021	0.134	0.0001	.73	.46	1.02
	(52.29)	(2.60)		(1.21)	(1.03)	(1.13)	(1.62)	(2.57)			
High School											
HW/YR	0.794	0.003	0.109		−0.012	−0.026	0.031	−0.000	.71	.42	1.27
	(14.11)	(0.55)	(2.05)		(1.53)	(1.21)	(0.56)	(0.51)			
5,096 − HW/YR	7.945	−0.008		0.008	0.011	0.031	−0.005	0.0001	.65	.33	1.27
	(68.43)	(2.13)		(0.23)	(2.17)	(2.27)	(0.13)	(1.97)			
College											
HW/YR	7.784	0.045	−0.036		−0.007	−0.123	0.063	−0.001	.79	.53	1.46
	(8.52)	(1.37)	(0.29)		(0.41)	(2.79)	(0.44)	(1.20)			
5,096 − HW/YR	8.298	−0.042		0.162	−0.0004	0.064	−0.003	0.001	.85	.65	1.39
	(29.04)	(2.87)		(3.11)	(0.04)	(2.96)	(0.04)	(2.57)			

SOURCE: Same as Table 3.1.
a. See Table 3.1, note a.

have been better). Usually, age has a positive and age squared a negative coefficient, as predicted by the theory of post-school investment. Moreover, the introduction of age squared into the regression generally lowers the coefficient of earnings, although it remains positive; not surprisingly, the introduction of a second measure of the wage rate decreases the importance attached to the first. The signs of other coefficients are generally not changed.

3.4 WEEKS WORKED VERSUS HOURS WORKED PER WEEK

To separate the response to changes in wage rates of hours per week from the response of weeks per year, regressions similar to those in Tables 3.1, 3.3, 3.5, and 3.6 were run, using as dependent variables hours worked in the census week, consumption hours in that week, weeks worked in 1959, and weeks of consumption in 1959. The results for weeks and hours worked are shown in Tables 3.9 and 3.10.

In the regressions using weeks worked, the coefficient of the male wage rate always has the predicted sign and is generally fairly sizable, although it is typically lower than the corresponding coefficient in the regressions using annual hours. In the regressions using hours worked in the census week, however, this coefficient is not stable, and often has the "wrong" sign and low *t* values. Apparently, weeks worked respond more systematically than hours worked per week to life cycle changes in the wage rate.[34] The evidence may be spurious, however, because the estimates of hours worked per week have considerably more measurement error than the estimates of weeks worked. As I have repeatedly pointed out, this kind of measurement error biased the regression coefficient for the male wage rate in the direction opposite to my prediction.

3.5 FIRST DIFFERENCES

To reduce the amount of serial correlation in the residuals and to check on the robustness of the findings, regressions like those

34. One important exception is the regressions for all male whites, where hours respond more than weeks.

reported in Tables 3.1–3.10 were run using differences between successive ages in the observations on wage rates, hours, other income, family size, etc. Some results with differences in the log of annual hours worked as the dependent variable are reported in Tables 3.11 and 3.12.[35] As expected, the Durbin-Watson statistic is much higher, indicating that the serial correlation in the residuals has been reduced; the correlation coefficient, on the other hand, is much lower, indicating that as usual levels can be explained more adequately than differences.

Otherwise, the first-difference regressions strongly support the level ones: the signs and relative magnitudes of different coefficients are about the same. In particular, the coefficient of the difference in annual earnings is positive, sizable, and statistically significant for both whites and nonwhites in all regressions except those for college persons. This coefficient is somewhat lower for whites and somewhat higher for nonwhites than in the level regressions. Clearly, the first-difference regressions also imply that a rise in the own wage rate over the life cycle induces a reallocation of time toward work and away from consumption.

APPENDIX

1 The Subsamples

The 1/1,000 sample from the 1960 Census provides information on over 180,000 individuals.[36] My analysis is confined, however, only to nonagriculture employed men at work during the census week in 1960 who also had been working for earnings in 1959. This sample contains about 34,000 individuals of whom about 31,000 are white and 3,000 are nonwhite.

The sample is divided into eight subsamples, as shown in Table 3A.1. The data in each subsample are grouped by single years of age; the average value of a particular variable at each age is used as the basic observation. The table also contains information about the number of individuals in each subsample, the mean size of the cells, and the coefficients of variation.

35. Similar results are found with differences in the log of consumption time as the dependent variable.

36. For a detailed description of this sample, see U.S. Bureau of the Census, *Censuses of Population and Housing: 1960, 1/1,000 and 1/10,000: Two National Samples of the United States* (1969).

TABLE 3.9

REGRESSIONS FOR WEEKS WORKED AND HOURS WORKED PER WEEK OF WHITE MEN
(based on three-year moving averages of underlying data)

Dependent Variable (in logs)	Intercept	Independent Variables (*t* values in parentheses): Age	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
				All Education Levels; Ages 22–65					
HW/WK	3.660	−0.002	0.210				.92	.85	0.49
	(332.9)	(13.75)	(14.78)						
HW/WK	3.797	−0.002	0.207	−0.007	−0.012	−0.011	.93	.84	0.48
	(41.22)	(2.30)	(3.29)	(0.58)	(1.23)	(0.25)			
WK/YR	3.731	−0.001	0.175				.92	.84	0.34
	(375.0)	(5.62)	(13.63)						
				Grade School; Ages 18–65					
HW/WK	3.667	−0.001	0.170				.62	.36	0.65
	(183.9)	(4.24)	(5.30)						
HW/WK	4.030	−0.001	0.119	0.005	−0.043	−0.026	.72	.47	0.72
	(17.61)	(1.06)	(1.99)	(0.32)	(1.99)	(0.66)			
WK/YR	3.602	−0.0004	0.321				.86	.73	0.67
	(163.9)	(1.27)	(9.08)						

				High School; Ages 22–65					
HW/WK	3.807	−0.001	0.034				.73	.51	0.57
	(310.8)	(5.00)	(1.79)						
HW/WK	3.729	0.002	−0.117	−0.010	0.003	0.100	.83	.65	1.05
	(42.65)	(1.57)	(1.95)	(0.90)	(0.30)	(3.69)			
WK/YR	3.650	−0.002	0.326				.88	.77	0.47
	(189.2)	(5.78)	(10.54)						
				College; Ages 26–65					
HW/WK	3.730	−0.003	0.154				.68	.43	0.59
	(173.3)	(5.39)	(5.46)						
HW/WK	3.522	0.005	−0.137	−0.013	0.007	0.238	.85	.69	0.62
	(35.77)	(3.09)	(1.96)	(1.26)	(0.57)	(4.78)			
WK/YR	3.782	−0.002	0.148				.82	.65	0.49
	(219.5)	(5.53)	(8.08)						

HW/WK = hours worked per week.
WK/YR = weeks worked per year.
SOURCE: See Table 3.1.

TABLE 3.10

REGRESSIONS FOR WEEKS WORKED AND HOURS WORKED PER WEEK OF NONWHITE MEN
(based on three-year moving averages of underlying data)

Dependent Variable (in logs)	Intercept	Age	Log Hourly Earnings	Log Other Income	Log Other Family Income	Log Family Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
	Independent Variables (t values in parentheses)								
All Education Levels; Ages 22–65									
HW/WK	3.707	−0.001	0.052				.72	.50	1.07
	(321.4)	(6.66)	(2.73)						
HW/WK	3.834	−0.0004	0.001	−0.010	−0.021	0.052	.84	.67	1.34
	(36.07)	(1.61)	(0.03)	(3.34)	(1.79)	(2.40)			
WK/YR	3.710	0.001	0.141				.79	.60	0.77
	(250.1)	(3.93)	(5.82)						
Grade School; Ages 18–65									
HW/WK	3.699	−0.001	0.018				.25	.02	1.00
	(243.4)	(1.62)	(0.51)						
HW/WK	4.070	−0.001	−0.037	0.004	−0.046	−0.020	.50	.16	1.14
	(25.26)	(0.84)	(0.98)	(0.65)	(2.87)	(0.30)			
WK/YR	3.682	0.001	0.240				.77	.57	0.71
	(196.8)	(0.91)	(5.53)						

				High School; Ages 22–65					
HW/WK	3.779	−0.001	−0.080				.55	.27	1.01
	(224.0)	(1.14)	(2.93)						
HW/WK	3.896	0.0001	−0.104	−0.010	−0.012	0.009	.60	.27	1.10
	(28.02)	(0.17)	(3.31)	(1.73)	(0.74)	(0.24)			
WK/YR	3.690	0.0001	0.220				.81	.64	0.80
	(201.86)	(0.73)	(7.46)						
				College; Ages 26–65					
HW/WK	3.789	0.001	−0.101				.33	.04	1.15
	(68.45)	(0.81)	(1.77)						
HW/WK	3.947	0.001	−0.140	−0.021	−0.033	0.153	.76	.50	1.62
	(24.79)	(1.64)	(3.16)	(2.66)	(1.66)	(3.72)			
WK/YR	3.607	0.005	0.029				.58	.29	0.56
	(47.71)	(3.45)	(0.37)						

HW/WK = hours of work per week.
WK/YR = weeks worked per year.
SOURCE: See Table 3.1.

TABLE 3.11
REGRESSIONS FOR ANNUAL HOURS WORKED OF WHITE MEN:
FIRST-DIFFERENCE EQUATIONS
(dependent variable: year-to-year differences
in the log of annual hours worked)

	Independent Variables (*t* values in parentheses)							
Intercept	Δ Log Annual Earnings	Δ Log Hourly Earnings	Δ Log Other Own Inc.	Δ Log Other Fam. Inc.	Δ Log Fam. Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
All Education Levels; Ages 22–65; Three-year Moving Average								
−0.002	0.301					.78	.61	1.60
(1.82)	(8.10)							
−0.003	0.351		−0.032	−0.017	−0.103	.83	.66	1.84
(1.64)	(5.89)		(2.78)	(0.67)	(1.45)			
−0.002		0.282				.54	.28	1.27
(0.82)		(4.14)						
0.000		0.167	−0.026	−0.075	0.039	.66	.38	1.34
(0.20)		(1.56)	(1.59)	(2.45)	(0.40)			
All Education Levels; Ages 22–65; Original Data								
0.001	0.121		−0.010	−0.014	0.016	.36	.04	2.41
(0.41)	(1.76)		(0.92)	(0.55)	(0.17)			
Grade School; Ages 18–65; Three-year Moving Average								
−0.0009	0.288					.54	.28	2.07
(0.35)	(4.32)							
−0.0003	0.243		−0.022	−0.035	−0.043	.56	.26	2.08
(0.11)	(2.99)		(1.23)	(0.82)	(0.36)			
0.003		0.094				.01	−.02	1.10
(0.44)		(0.07)						
0.004		−0.108	−0.042	−0.121	0.003	.45	.13	1.21
(1.02)		(1.14)	(2.28)	(2.82)	(0.03)			
Grade School; Ages 18–65; Original Data								
0.004	−0.065		0.004	−0.028	0.113	.17	−.06	2.91
(0.61)	(0.78)		(0.28)	(0.75)	(0.89)			
High School; Ages 22–65; Three-year Moving Average								
−0.003	0.290					.81	.64	1.60
(2.53)	(8.72)							
−0.002	0.261		−0.026	−0.028	−0.056	.86	.72	2.03
(1.39)	(6.45)		(3.03)	(1.93)	(1.47)			
−0.002		0.293				.60	.35	1.41
(1.40)		(4.82)						
−0.0002		0.215	−0.035	−0.054	−0.031	.77	.54	2.04
(0.11)		(3.23)	(3.20)	(3.19)	(0.62)			

TABLE 3.11 (*continued*)

	Independent Variables (*t* values in parentheses)							
Inter-cept	Δ Log Annual Earnings	Δ Log Hourly Earnings	Δ Log Other Own Inc.	Δ Log Other Fam. Inc.	Δ Log Fam. Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
High School; Ages 22–65; Original Data								
−0.001	0.154		−0.016	−0.030	−0.066	.54	.22	2.70
(0.20)	(2.90)		(1.76)	(1.76)	(1.12)			
College; Ages 22–65; Three-year Moving Average								
−0.0004	0.161					.49	.21	1.13
(0.14)	(3.38)							
0.003	0.073		−0.025	−0.008	0.162	.59	.27	1.15
(0.93)	(0.86)		(1.76)	(0.36)	(1.48)			
0.003		0.065				.17	.004	0.76
(0.86)		(1.07)						
0.008		−0.160	−0.025	−0.043	0.330	.64	.34	1.18
(2.99)		(2.08)	(1.84)	(2.16)	(3.67)			
College; Ages 22–65; Original Data								
0.004	0.055		−0.015	0.002	0.008	.31	−.01	1.86
(0.87)	(0.94)		(1.40)	(0.11)	(0.07)			

SOURCE: See Table 3.1.

TABLE 3.12
REGRESSIONS FOR ANNUAL HOURS WORKED OF NONWHITE MEN: FIRST-DIFFERENCE EQUATIONS
(dependent variable: year-to-year differences in the log of annual hours worked)

	Independent Variables (*t* values in parentheses)							
Intercept	Δ Log Annual Earnings	Δ Log Hourly Earnings	Δ Log Other Own Inc.	Δ Log Other Fam. Inc.	Δ Log Fam. Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
	All Education Levels; Ages 22–65; Three-year Moving Average							
−0.001	0.165					.35	.10	2.12
(0.21)	(2.36)							
0.001	0.179		−0.009	0.008	0.157	.49	.16	1.99
(0.44)	(2.49)		(1.18)	(0.22)	(1.95)			
0.001		−0.070				.14	.004	1.83
(0.41)		(0.90)						
0.003		−0.057	−0.014	−0.004	0.093	.35	.03	1.82
(0.78)		(0.69)	(1.79)	(0.12)	(1.04)			
	All Education Levels; Ages 22–65; Original Data							
0.002	0.261		−0.022	0.021	0.212	.59	.28	2.72
(0.25)	(2.71)		(2.47)	(0.44)	(2.45)			
	Grade School; Ages 18–65; Three-year Moving Average							
−0.001	0.350					.50	.24	1.74
(0.10)	(3.90)							
0.0003	0.378		−0.022	−0.076	0.012	.59	.29	1.90
(0.04)	(4.26)		(1.88)	(1.91)	(0.10)			
0.007		−0.172				.22	.03	1.11
(1.02)		(1.50)						
0.006		−0.133	−0.009	−0.056	−0.051	.30	.003	1.20
(0.82)		(1.07)	(0.63)	(1.16)	(0.34)			
	Grade School; Ages 18–65; Original Data							
0.003	0.366		−0.025	−0.087	0.130	.60	.29	2.81
(0.19)	(4.02)		(1.94)	(2.27)	(1.28)			
	High School; Ages 22–65; Three-year Moving Average							
−0.001	0.161					.40	.14	2.05
(0.16)	(2.77)							
0.0004	0.171		−0.009	0.015	0.046	.45	.12	2.12
(0.09)	(2.73)		(1.19)	(0.63)	(0.63)			
0.003		−0.004				.01	−.02	1.78
(0.50)		(0.06)						
0.003		−0.009	−0.012	−0.003	0.012	.22	−.05	1.86
(0.61)		(0.12)	(1.38)	(0.12)	(0.15)			

TABLE 3.12 (*continued*)

Inter-cept	Δ Log Annual Earnings	Δ Log Hourly Earnings	Δ Log Other Own Inc.	Δ Log Other Fam. Inc.	Δ Log Fam. Size	Mult. Corr. Coeff.	Adj. R^2	Durbin-Watson
	Independent Variables (*t* values in parentheses)							
High School; Ages 22–65; Original Data								
−0.0003	0.148		0.004	0.022	0.012	.26	−.03	2.91
(0.02)	(1.28)		(0.40)	(1.36)	(0.11)			
College; Ages 26–65; Three-year Moving Average								
0.006	0.055					.10	−.02	1.86
(0.48)	(0.61)							
0.005	0.056		−0.014	0.000	0.026	.21	−.07	1.93
(0.39)	(0.59)		(1.06)	(0.03)	(0.18)			
0.012		−0.200				.40	.14	1.84
(0.99)		(2.60)						
0.011		−0.205	−0.010	0.000	0.101	.44	.09	1.87
(0.92)		(2.53)	(0.79)	(0.20)	(0.78)			
College; Ages 26–65; Original Data								
0.003	0.015		−0.017	0.000	−0.188	.21	−.08	2.92
(0.08)	(0.09)		(0.92)	(0.12)	(0.91)			

SOURCE: See Table 3.1.

TABLE 3A.1
SAMPLE SIZE, MEAN SIZE OF CELL, AND COEFFICIENT OF VARIATION IN EACH SUBSAMPLE

Name of Subsample	Years of Schooling	Age Group	Color	No. of Persons	Mean Cell Size	Coeff. of Var.
All-W	All	22–65	white	30,703	698	27
G.S.-W	0–8	18–65	white	8,879	185	39
H.S.-W	9–12	22–65	white	14,726	335	40
Col-W	13+	26–65	white	6,595	165	44
All-NW	All	22–65	nonwhite	2,888	66	35
G.S.-NW	0–8	18–65	nonwhite	1,593	33	36
H.S.-NW	9–12	22–65	nonwhite	1,091	25	61
Col-NW	13+	26–63[a]	nonwhite	254	7	73

SOURCE: See text note 36.
a. Ages 64 and 65 omitted because of "empty cells."

2 THE VARIABLES

Seven variables are directly available from the 1/1,000 sample, and a number of additional variables were generated by arithmetic manipulation of the averaged ones. The seven directly available are:

	1/1,000 Sample No.
1. *FS*: Family size (number of persons in the family).	50
2. *TFI*: Total family income in 1959.	60
3. *OI*: Total own income in 1959.	43
4. *RI*: Other own income in 1959.	42
5. *AE*: Annual earnings in 1959.	39
6. *HW/WK*: Hours worked during last week before the 1960 Census.	29
7. *WK/YR*: Weeks worked in 1959.	36

The generated variables are:

8. *HE*: Hourly earnings $= AE/[(HW/WK) \times (WK/YR)]$.
9. *OFI*: Other family income $= (TFI) - [(RI) + (AE)]$.
10. *HW/YR*: Hours worked per year $= (HW/WK) \times (WK/YR)$.
11. *HC/YR*: Hours consumed (not at work) per year $= 8{,}736 - (HW/YR)$.
12. $(HC/YR) - K$: Hours consumed other than on personal care $= 8{,}736 - 3{,}640 - (HW/YR) = 5{,}096 - (HW/YR)$.
13. *HC/WK*: Hours consumed per week $= 168 - (HW/WK)$.
14. $(HC/WK) - K$: Hours consumed per week other than on personal care $= 168 - 70 - (HW/YR) = 98 - (HW/WK)$.
15. *WC/YR*: Weeks consumed per year $= 52 - (WK/YR)$.

The unweighted means and standard deviation across different ages of the basic variables used are presented in Table 3A.2.

3 REGRESSION ANALYSIS: REGRESSION FORMS

The logs of the time variables numbered 6, 7, 10, 11, 12, 13, 14, and 15 are used as dependent variables; the logs of the income variables (2, 4, 5, 8, and 9), the log of family size (1), and age are used, in various combinations, as independent variables. The four basic forms used are:

Level regressions
1. Original data
2. Three-year moving averages

First differences
3. Original data
4. Three-year moving averages

All regressions are weighted by the square root of the cell sizes.

TABLE 3A.2

MEANS AND STANDARD DEVIATIONS OF EIGHT VARIABLES BY EDUCATION-COLOR CLASS; ORIGINAL DATA

	Whites				Nonwhites			
Variable	All-W	G.S.-W	H.S.-W	Col-W	All-NW	G.S.-NW	H.S.-NW	Col-NW
1. Cell size:	698	185	335	165	65	33	25	6.7
	(185)	(71)	(133)	(72)	(23)	(12)	(15)	(4.9)
2. Family size	3.53	3.79	3.51	3.41	3.92	4.37	3.68	3.30
	(0.65)	(0.73)	(0.67)	(0.69)	(0.64)	(0.99)	(0.91)	(1.08)
3. Total family income	8,232	6,303	8,105	11,806	5,027	4,328	5,617	6,908
	(833)	(705)	(910)	(2,124)	(443)	(544)	(1,132)	(2,285)
4. Total own income	6,271	4,420	6,126	9,821	3,427	2,825	3,920	4,861
	(953)	(893)	(889)	(1,951)	(423)	(583)	(945)	(1,764)
5. Other own income	282	140	250	684	164	91	381	115
	(152)	(86)	(184)	(473)	(258)	(93)	(1,117)	(163)
6. Hourly earnings	2.87	2.18	2.77	4.22	1.78	1.54	1.93	2.43
	(0.38)	(0.34)	(0.37)	(0.86)	(0.20)	(0.27)	(0.42)	(0.86)
7. Hours worked per year	2,102	1,949	2,139	2,221	1,833	1,769	1,890	1,963
	(92)	(156)	(68)	(99)	(96)	(183)	(226)	(329)
8. Hours worked per week	43.6	42.3	44.2	45.0	39.9	39.5	40.9	41.8
	(1.1)	(1.7)	(1.0)	(1.6)	(1.5)	(2.5)	(4.0)	(5.0)

NOTE: Means are unweighted; standard deviations are in parentheses. Education-color classes are identified in section 1 of this appendix. Variables are more fully described in section 2.

4 REGRESSION ANALYSIS: PROBLEMS IN ESTIMATION

Empty cells. This problem does not exist in the regressions estimated in the "level original" form, since all regressions are weighted; it does exist, however, in the three other forms, where linear processes (moving averages and first differences) are used. Fortunately, only two cells are empty: ages 57 and 65 among nonwhites with a college education (*Col.-NW*).

The entry for age 57 was estimated as a simple average of the entries for ages 56 and 58, and a cell size of 1 was assigned to this estimate. The same procedure could not be used for age 65 because ages 66 and 67 are also empty. Instead, this cell and the one for age 64 were simply eliminated.[37]

Negative figures. Negative entries create a problem for logarithmic transformations. Negative entries are found only for the variable *OFI* (other

37. Age 64 was eliminated because a three-year moving average could not be constructed for that age.

family income). Fortunately, there are only three of these entries, and they all are based on very few observations.[38]

There are several equally arbitrary ways of handling negative values in a logarithmic transformation. Here, I used the original negative value as its logarithmic value. Since the negative entries exceed 100 in absolute value, this method transforms the actual values to positive values close to zero.[39] Fortunately, any bias in this arbitrary procedure is small because the regressions are weighted, and the three cells with negative entries have small weights (each does not exceed 0.4 per cent of the relevant subsample).

38. The negative entry for 65-year-old nonwhites with a high-school education is based on only four persons; the negative entries for 60- and 61-year-old nonwhites with a college education are each based on only one person.

39. To use x_0 instead of $\log x_0$ is equivalent to replacing x_0 by e^{x_0} in the original data. If $x_0 < -10$, then $e^{x_0} < 0.00005 \sim 0$.