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Earnings, Education, and Experience

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Introduction

When the decision to obtain additional education is based on future financial gain, an individual must determine the expected return less the cost of that education versus the net return to no further education. This decision is not unlike other investment decisions requiring a person to incur a current cost in anticipation of future returns. Typically, economists measure the return to education using an empirical earnings function based on the specification in Mincer (1974). Such earnings specifications are also used to measure wage differences between occupations, races, sexes, and so on. Moreover, the estimates taken from earnings equations are often used to guide policy. Unexplained earnings differences across race or sex, for example, have spurred legislation to correct such “discrimination.” Although the general patterns that emerge are consistent for a wide variety of specifications, the individual point estimates are not. Therefore, proper specification of the earnings equation is extremely important if inferences are to be drawn from the estimates.

For more than 20 years, the Mincer-type specification has been the workhorse of labor economists studying the determinants of earnings. Not surprisingly, it has also been the object of much scrutiny aimed at uncovering any shortcomings it may have. In this article, we examine a standard Mincer empirical earnings function, concentrating on the return to education as measured by the increase in income resulting from that education. In so doing, we address several issues. The first is determining how education should enter into a statistical framework, so that the return to years of schooling can be correctly inferred from the data. The second issue is that of separating the return to education from other effects, such as experience.

In particular, we show that combining into one category individuals who have attained a college degree and those who have some postgraduate education leads to an upward bias in the measured return to a college education. Furthermore, this problem is exacerbated as the percentage of the population with more than a bachelor’s degree increases. Although it is well known that more and more people are continuing their education past the college level, earnings specifications that do not separate individuals with graduate course work from those with only an undergraduate degree are quite common; therefore, results from such studies should be used with caution. We also show that

FIGURE 1

Log of Real Median Weekly Earnings, 1993

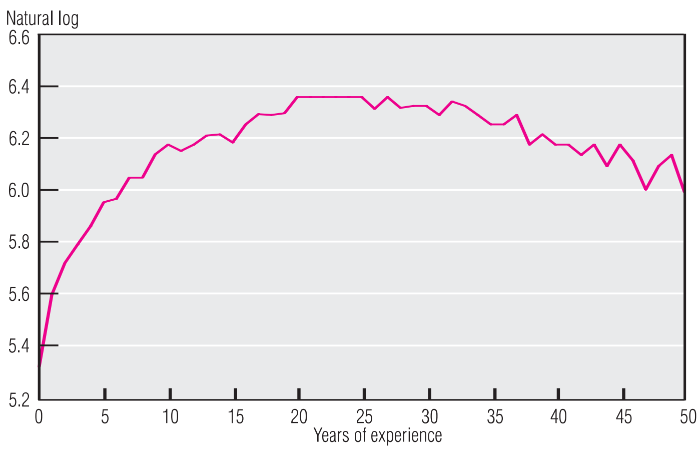
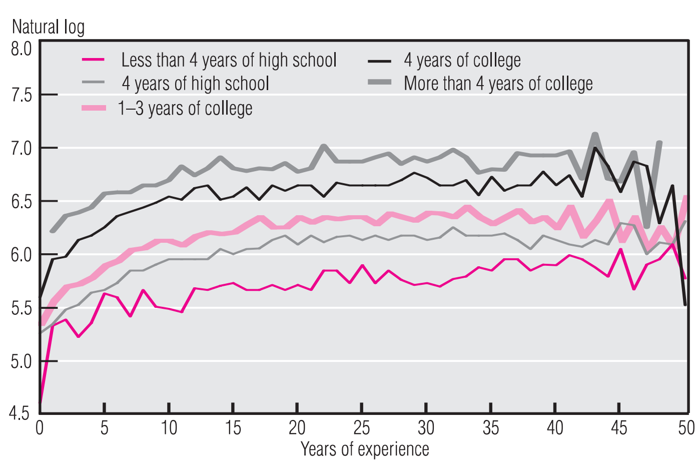


FIGURE 2

Log of Real Median Weekly Earnings by Educational Level, 1993



NOTE: Data refer to full-time U.S. workforce.
SOURCE: March Current Population Survey, 1994.

specifications using linear "years of education" may be misleading, because the largest gains in earnings come in discrete jumps upon the attainment of a degree, whether high school, college, or beyond.

Studies measuring the return to education, such as Juhn, Murphy, and Pierce (1993), show that the relative earnings of high-school- and college-educated individuals have become more disparate over time. This growing divergence arises from two effects. First, the absolute return to a college education has been increasing. Second, as mentioned above, the number of people pursuing post-graduate education has also been rising. We reiterate that failure to control for the latter (that is, combining the effect of undergraduate and post-graduate work) will lead to an overestimate of the return to a college education. Although this approach may bias the results only slightly if data from the 1960s are used (because there were relatively few post-college graduates then), the same cannot be said if more recent data are employed. We find this bias to be in the neighborhood of 12 percent.

The remainder of the paper is laid out as follows. The first section presents some basic facts concerning earnings, education, and experience. Section II describes our alternative specifications for earnings. In section III, we present our empirical results. Section IV concludes.

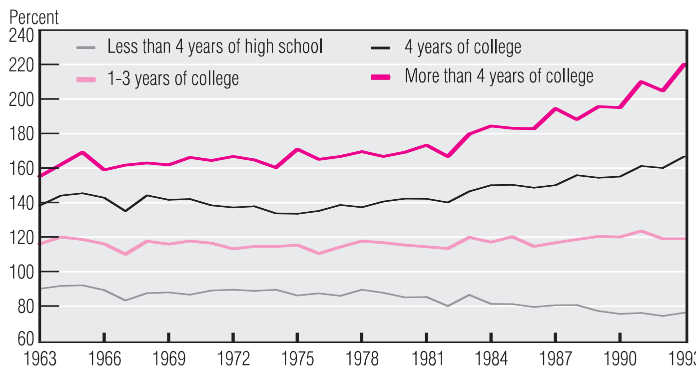
I. Earnings, Education, and Experience: The Basic Facts

Figure 1 displays the relationship between wages and experience based on the Census Bureau's March 1994 Current Population Survey (CPS), which summarizes 1993 earnings. Initially, wages rise with experience, but then begin to fall. Because the data are based on a cross-section, one reason for the profile's concave shape is that individuals with more experience are generally older and less educated than younger people. Another reason is that skills depreciate over an individual's lifespan. Thus, we see the same basic shape even within educational levels, although rates of investment and depreciation may vary across them (see figure 2). We discuss these issues in more detail below, but it should be clear at this stage that the effects of experience must be separated from those of education. Inadequate controls for experience contaminate the measured return to education.

Figure 2 shows that, on average, earnings rise with the level of education. Figure 3 presents this information in a slightly different way, graphing earnings by education level relative to those of high school graduates. Several interesting relationships are apparent. First, note that none of the lines cross, indicating that, on average, higher levels of education lead to higher earnings. Second, the lines diverge over time, meaning that the return to a college degree, relative to high school, increases throughout the years. Part of this effect occurs because the earnings of high school graduates have been falling in real terms.

FIGURE 3

Log of Real Median Weekly Earnings by Educational Level as a Share of High School Graduates' Earnings, 1963–93



NOTE: Data refer to full-time U.S. workforce.
SOURCE: March Current Population Survey, 1964–94.

Median (gross) earnings for college graduates (16 years of education) are roughly 60 percent higher than those of high school graduates (12 years of education), while high school dropouts earn about 32 percent less than individuals who have a high school diploma.[1]

II. Specification

Estimates taken from earnings regressions are often used to formulate statements that may have substantial policy relevance. Although potential biases exist in the articles mentioned below, we do not claim that such biases necessarily affect the studies' overall conclusions. Nor do we attempt to measure such biases, since their extent will depend on correlations with the education variables. Below, we show how different education specifications may affect sex- and race-based earnings estimates.

In a recent paper, Schmitz, Williams, and Gabriel (1994) examine race and sex differences in wage distributions using years of education (linear) as one of their explanatory variables. They conclude that there are differences in the distributions and attribute these differences to "... the impact of differential treatment in the labor market." Obviously, any bias in the education specification may affect the measured differences in distributions.

Dooley and Gottschalk (1984) examine trends in earnings inequality among male cohorts over the 1968–79 period. They show that earnings differences may be affected by changes in the size of the labor force. Their preferred earnings specification uses dummy variables for education levels, but combines college and post-college as one group.

Fairlie and Meyer (1996) look at several explanations for the disparity in self-employment rates across race and ethnic backgrounds. Although they find that higher education leads to a greater probability of being self-employed, their specification contains three categories for education: high school graduate, some college, and college graduate. If there are racial or ethnic differences in educational attainment, then their estimates are potentially biased.

Bar-Or et al. (1995) use Canadian data to measure the return to a university education from 1971 to 1991. They find that the return declined during the 1970s and did not rebound much during the 1980s. Throughout their paper, they use two groups: university graduates and those who have completed 11 to 13 years of education (with no post-secondary schooling).

The standard model relating education, experience, and earnings is based largely on the work of Mincer (1974). Optimal investment in human capital (formal schooling and post-school learning) is based on a maximization problem that compares the net present value of earnings for an additional year of schooling, for example, to that of no additional investment. A similar maximization problem is undertaken for post-school investment.

Mincer's model compares the present value of s years of schooling to that of $s-d$ years of schooling. First, calculate the present value of an individual's lifetime earnings at the start of formal education:

$$(1) \quad V_s = Y_s \sum_{t=s+1}^{n} \frac{1}{(1+r)^t},$$

where Y_s is the annual earnings of an individual with s years of schooling, r is the discount rate the individual uses to discount the future,[2] and n is the length of working life, which, by assumption, is independent of the amount of schooling. Next, calculate V_{s-d} to obtain the present value of $s-d$ years of schooling. Comparing V_s to V_{s-d} and applying some algebra leads to[3]

$$(2) \quad y_{it} = \alpha_0 + \alpha_1 ED_{it},$$

1 To examine the net return to education, direct and indirect costs of acquiring that education must be deducted.

2 Another way of saying this is that r represents the return necessary to delay earning in order to learn.

3 To be correct, the actual derivation is performed using the continuous-time analogue of equation (1).

where y_{it} is the log of earnings for individual *i* at time *t*, and *ED* is a measure of education. Note that in this particular specification, α_0, the constant term, can be interpreted as Y_0, $\alpha_1 = r$. If post-schooling investments are also considered, then optimization would give us a declining rate of investment in human capital over time. This result follows from the fact that there is less time to recoup investments in education as age increases; that is, as one gets older, more time is spent earning and less time is spent learning.

The conventional empirical method of capturing declining investments over time is to specify the earnings equation using a quadratic term in experience:

$$(3) \qquad y_{it} = \alpha_0 + \alpha_1 ED_{it} + \alpha_2 EX_{it} + \alpha_3 EX_{it}^2 + \gamma Z_{it} + \varepsilon.$$

Controls for other relevant factors that may influence earnings in a systematic way are also included. The matrix *Z* in equation (3) represents these other factors and includes such variables as sex and race. ε is assumed to be an independent and identically distributed error term reflecting unobservables as well as possible measurement error.

Note that a negative value of α_3 gives rise to a concave shape of the experience–earnings profile, similar to that in figure 1. This particular parametric functional form imposes strong restrictions on how investments decline over time (more flexible specifications will be examined below). The concave shape arises from the assumption of linearly declining investments (either dollar investments or the ratio of investments to earnings). If one assumes (as Mincer and nearly everyone else does) that experience is continuous and begins immediately after completion of schooling, then it can be measured as age minus years of schooling minus the age at which schooling begins.[4] Typically, experience is defined as age minus education minus six.

Perhaps more important than the specification of experience is the specification of the education variable itself. Commonly, this variable is included in an earnings regression in categorical form. More specifically, it is included as a dummy variable indicating whether an individual is a high school dropout, has a high school diploma, has completed some college, or has a bachelor's degree or more. The last category is the one typically not considered in earnings specifications. Another approach is to include a continuous variable for education, that is, years of education. However, this specification does not capture the large gains that occur at discrete points, namely, when a degree is obtained.

Equation (3) represents the most common specification used to uncover the factors explaining earnings. Although the estimating equation arises from optimizing investment behavior, several issues regarding the form of the equation do not. Specifically, how should experience and education enter the equation?

As mentioned above, if one assumes that post-schooling investment begins immediately after graduation and is continuous, then investment will decline as one ages. The question arises as to the form of this drop-off. The most commonly used is that of linearly declining investments over time, which leads to the experience-squared term in equation (3). This particular specification arises merely by assumption and is not based on any underlying theory. Obviously, imposing an incorrect functional form can lead to a misspecification of the model, in turn leading to a bias in the return to experience and possibly to other variables. Furthermore, this specification does not fit the data very well. Murphy and Welch (1990) experiment with several forms for experience and eventually find that a fourth-order polynomial (quartic) does fit the data reasonably well.

Our strategy for the experience control is to admit at the outset that we have little a priori information about its specification, so we allow it to be an arbitrary smooth function. We apply the semiparametric procedure of Robinson (1988) to the data and estimate the parameters of interest.

A potentially more important issue, however, is determining how education should enter the equation. As noted above, many studies include education as a categorical variable representing discrete levels of schooling. This specification produces the result one would expect: More education leads to higher earnings. However, as an increasing number of individuals pursue post-graduate studies, such a specification will lead to an overestimate of the return to a college education. A similar situation also exists for persons who did not complete high school. Early in the survey period, many of these noncompletions were individuals with an elementary education or less, whereas only a few workers fell into this category in the 1994 CPS.

4 Although actual work experience should be in the equation, data limitations make it necessary to use potential experience.

TABLE 1

Summary Statistics, 1963 and 1993

Variable	1963 Mean	1963 Standard Deviation	1993 Mean	1993 Standard Deviation
High school dropout	0.42	0.49	0.11	0.31
High school graduate	0.36	0.48	0.34	0.47
Some college	0.10	0.30	0.28	0.45
College graduate	0.07	0.25	0.18	0.38
Post-college graduate	0.03	0.19	0.09	0.28
Years of education	11.10	3.20	13.40	2.60
Real wage and salary earnings	$23,806	$35,612	$28,957	$19,562
Years of experience	24.10	13.60	19.80	11.70
Black	0.08	0.28	0.09	0.28
White	0.91	0.29	0.86	0.35
Other nonwhite	0.01	0.09	0.05	0.22
Female	0.28	0.45	0.42	0.49

SOURCE: Authors' calculations based on the March Current Population Survey, 1964 and 1994.

This would tend to inflate the relative wage changes of high school dropouts.

Another common specification includes earnings as a linear function of years of education. However, a large part of the return to education occurs when a degree is actually earned, so that a graph of education and earnings would resemble a step function. Another way of saying this is that the return to stopping one's formal education as a junior in college is not much different from the return to stopping as a sophomore. Below, we quantify these biases by including a separate term for various education levels.

III. Data and Results

Our data are taken from the March CPS and consist of full-time workers only. Table 1 presents summary statistics for 1963 and 1993. Note that the change in educational attainment over this time span is quite remarkable. In 1963, 42 percent of the full-time workforce consisted of high school dropouts; by 1993, that figure had fallen to 11 percent. The fraction of workers with only a high school diploma also declined over this period, from 36 to 34 percent. By contrast, the share of the workforce holding a college degree rose substantially, from 7 to 18 percent, and the fraction with some post-graduate studies shot up from 3 to nearly 9 percent. Note that the change in measured experience fell by about four years, from 24.1 to 19.8. This decline in labor market experience is at least partially explained by the additional years of schooling, since experience is measured as age minus years of education minus six.

In terms of demographics, the share of blacks in the full-time workforce did not change much, rising from 8.3 percent in 1963 to 8.8 percent in 1993. However, the fraction of whites dropped off somewhat, from 91 to 86 percent. The difference is made up by other nonwhites, whose share grew from slightly less than 1 to just over 5 percent. Females made up close to half of the labor force in 1993 (42 percent), up from 28 percent three decades earlier.

To assess the importance of the effect of rising education levels on these estimates, we next present earnings regression estimates based on several years of CPS data. Tables 2 through 5 provide results for 1993, 1983, 1973, and 1963 earnings, respectively. The same-numbered column across years represents the same specification.

As a point of departure, we report a fairly standard specification for earnings in column 1.[5] We include sex, race, and a quartic (not so standard) specification for experience. The education control is years of schooling.[6] Table 2, which presents data for 1993, shows that women earn approximately 30 percent less than men on average, and blacks earn roughly 17 percent less than whites. Each term of the experience polynomial enters significantly, and the signs indicate an "increasing-at-a-decreasing-rate" experience profile. The years-of-education coefficient implies that each additional year of schooling adds 11 percent to earnings. However, this specification masks some important information regarding education and earnings, mainly because earnings tend to increase substantially with completion of certain levels of education (high school or college, for example).

The above specification cannot accurately address the size of the return to a high school or college education. To do so requires information on the highest degree achieved by an individual. Obtaining this information allows us to measure the return to specific levels of education. Column 2 of table 2 presents the results

■ **5** In the regressions that follow, we use sampling weights to make the CPS representative of the population.

■ **6** Beginning with the 1992 survey, the Bureau of Labor Statistics altered the wording and coding of the CPS to focus on degrees rather than on years of schooling. Thus, years are not available for partially fulfilled degrees. We use the means of years for workers falling into these categories in the 1991 survey as our best estimate for years in which a specific years-of-education figure is needed. This procedure is consistent with that of Frazis, Ports, and Stewart (1995), who review the effects of the altered procedure by comparing a sample in which both questions were asked.

TABLE 2

Earnings Regression Estimates, 1993

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	4.1594	5.4917	5.5018	5.4888	5.4745	5.4905	—
	(0.0164)	(0.0113)	(0.0112)	(0.0112)	(0.0113)	(0.0112)	—
Elementary school	—	—	−0.5506	−0.5527	—	−0.5265	−0.5393
	—	—	(0.0166)	(0.0167)	—	(0.0166)	—
7 to 12 years of education	—	—	−0.2723	−0.2724	—	—	—
	—	—	(0.0085)	(0.0085)	—	—	—
High school dropout	—	−0.3217	—	—	−0.1954	−0.2241	−0.2846
	—	(0.0079)	—	—	(0.0092)	(0.0092)	—
1 to 3 years of college	—	0.1918	0.1916	0.1922	0.2318	0.2080	0.1866
	—	(0.0057)	(0.0056)	(0.0057)	(0.0056)	(0.0056)	—
4 years of college to 1 year of graduate school	—	—	0.5193	—	0.5592	0.5355	0.5267
	—	—	(0.0065)	—	(0.0065)	(0.0065)	—
2 years of graduate school	—	—	0.7311	—	0.7728	0.7476	0.7244
	—	—	(0.0083)	—	(0.0084)	(0.0083)	—
4 years of college to 2 years of graduate school	—	0.5892	—	0.5894	—	—	—
	—	(0.0058)	—	(0.0058)	—	—	—
Years of education	0.1126	—	—	—	—	—	—
	(0.0009)	—	—	—	—	—	—
Years of experience	0.0815	0.0812	0.0799	0.0814	0.0771	0.0785	—
	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0023)	(0.0022)	—
Years of experience^2	−0.0031	−0.0031	−0.0030	−0.0031	−0.0028	−0.0029	—
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	—
Black	−0.1700	−0.1560	−0.1566	−0.1600	−0.1517	−0.1574	−0.1484
	(0.0071)	(0.0071)	(0.0071)	(0.0071)	(0.0072)	(0.0071)	—
Other nonwhite	−0.0597	−0.0793	−0.0745	−0.0741	−0.0905	−0.0770	−0.0710
	(0.0111)	(0.0111)	(0.0110)	(0.0111)	(0.0112)	(0.0111)	—
Female	−0.2904	−0.2873	−0.2869	−0.2884	−0.2784	−0.2841	−0.2993
	(0.0045)	(0.0045)	(0.0045)	(0.0045)	(0.0046)	(0.0045)	—
No. of observations	50,828	50,828	50,828	50,828	50,828	50,828	50,828
R^2	0.3464	0.3444	0.3546	0.3476	0.3362	0.3491	—

SOURCE: Authors' calculations based on the March 1994 Current Population Survey.

from a specification that includes dummy variables for the highest level of schooling achieved, with high school diploma being the omitted category (so that the interpretation of the education coefficients is relative to having completed only high school). The education coefficients clearly reveal the problem with the years-of-education specification. Although completing some college increases earnings somewhat (about 20 percent over those of a high school graduate), finishing college or graduate school boosts that figure to nearly 60 percent. The years-of-education specification essentially allows for a smooth line through the data and hence makes no distinction between completing the third and fourth year of college and obtaining a bachelor's degree, for example.

As mentioned above, because more individuals are enrolling in graduate school, including only "college or more" as a dummy variable will cause the results of earnings regressions to suffer from the same problem outlined above —the return will measure the average of college and post-college. As noted previously, in 1963 only 2.7 percent of those with a college degree went on to do post-graduate work, while in 1993 that figure was roughly 9 percent. The third column in table 2 presents results from a specification that allows for two additional dummy variables—one for elementary education only and one for post-graduate work. These statistics show a large gain to a post-

TABLE 3

Earnings Regression Estimates, 1983

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	4.6163	5.6574	5.6623	5.6536	5.6465	5.6503
	(0.0147)	(0.0102)	(0.0102)	(0.0102)	(0.0103)	(0.0102)
Elementary school	—	—	−0.4500	−0.4510	—	−0.4039
	—	—	(0.0147)	(0.0147)	—	(0.0147)
7 to 12 years of education	—	—	−0.2468	−0.2475	—	—
	—	—	(0.0067)	(0.0067)	—	—
High school dropout	—	−0.2736	—	—	−0.1688	−0.1905
	—	(0.0064)	—	—	(0.0075)	(0.0075)
1 to 3 years of college	—	0.1749	0.1753	0.1755	0.2121	0.1976
	—	(0.0059)	(0.0058)	(0.0058)	(0.0058)	(0.0058)
4 years of college to 1 year of graduate school	—	—	0.4110	—	0.4468	0.4328
	—	—	(0.0061)	—	(0.0061)	(0.0061)
2 years of graduate school	—	—	0.5715	—	0.6096	0.5944
	—	—	(0.0084)	—	(0.0085)	(0.0084)
4 years of college to 2 years of graduate school	—	0.4596	—	0.4602	—	—
	—	(0.0054)	—	(0.0054)	—	—
Years of education	0.0879	—	—	—	—	—
	(0.0008)	—	—	—	—	—
Years of experience	0.0824	0.0817	0.0807	0.0824	0.0765	0.0786
	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0023)
Years of experience^2	−0.0035	−0.0034	−0.0034	−0.0035	−0.0031	−0.0032
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Black	−0.1662	−0.1648	−0.1629	−0.1639	−0.1737	−0.1676
	(0.0069)	(0.0070)	(0.0069)	(0.0069)	(0.0070)	(0.0070)
Other nonwhite	−0.0755	−0.0842	−0.0853	−0.0812	−0.0947	−0.0869
	(0.0136)	(0.0136)	(0.0135)	(0.0136)	(0.0137)	(0.0136)
Female	−0.3828	−0.3811	−0.3794	−0.3820	−0.3684	−0.3735
	(0.0043)	(0.0043)	(0.0043)	(0.0043)	(0.0044)	(0.0043)
No. of observations	50,445	50,445	50,445	50,445	50,445	50,445
R^2	0.3583	0.3562	0.3623	0.3585	0.3437	0.3534

SOURCE: Authors' calculations based on the March 1984 Current Population Survey.

graduate degree as compared to a four-year degree (approximately 20 percentage points). The measured return to a college education, however, declined about 12 percent (or about seven percentage points, from 0.589 to 0.519). This means that combining post-college graduates with those holding only a bachelor's degree leads to a substantial upward bias in the return to a college education.

Columns 4 to 6 in the tables reflect slight modifications of the education specification. For example, column 4 is similar to column 2, but includes dummy variables for elementary schooling and 7 to 12 years of education, while omitting the high school dropout category. Evidently, these changes make little difference in the return to college, post-college, race, or sex coefficients.

The results using the semiparametric experience specification are shown in the last column of table 2. Because economic theory provides no particular parametric form for the experience profile, we reran the above regression allowing that profile to be any smooth function. Estimates for the return to education and to the various demographic variables shown in table 2 were obtained using the semiparametric regression technique of Robinson (1988). This technique simultaneously solves for discrete, linear regression parameters and an arbitrary smooth-kernel regression of a continuous variable by finding the least-squares solution to this

TABLE 4

Earnings Regression Estimates, 1973

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	4.9667	5.8283	5.8264	5.8241	5.8000	5.8061
	(0.0155)	(0.0103)	(0.0103)	(0.0103)	(0.0105)	(0.0104)
Elementary school	—	—	−0.4063	−0.4068	—	−0.3361
	—	—	(0.0130)	(0.0130)	—	(0.0128)
7 to 12 years of education	—	—	−0.2012	−0.2015	—	—
	—	—	(0.0064)	(0.0064)	—	—
High school dropout	—	−0.2259	—	—	−0.0954	−0.1223
	—	(0.0062)	—	—	(0.0071)	(0.0071)
1 to 3 years of college	—	0.1468	0.1475	0.1475	0.2012	0.1838
	—	(0.0072)	(0.0072)	(0.0072)	(0.0071)	(0.0071)
4 years of college to 1 year of graduate school	—	—	0.3813	—	0.4315	0.4158
	—	—	(0.0077)	—	(0.0077)	(0.0077)
2 years of graduate school	—	—	0.4646	—	0.5187	0.5014
	—	—	(0.0117)	—	(0.0118)	(0.0117)
4 years of college to 2 years of graduate school	—	0.4025	—	0.4038	—	—
	—	(0.0069)	—	(0.0069)	—	—
Years of education	0.0729	—	—	—	—	—
	(0.0009)	—	—	—	—	—
Years of experience	0.0811	0.0805	0.0805	0.0810	0.0763	0.0778
	(0.0023)	(0.0023)	(0.0023)	(0.0023)	(0.0024)	(0.0023)
Years of experience^2	−0.0034	−0.0034	−0.0034	−0.0034	−0.0031	−0.0032
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Black	−0.1888	−0.2002	−0.1917	−0.1921	−0.2259	−0.2049
	(0.0079)	(0.0080)	(0.0079)	(0.0079)	(0.0080)	(0.0080)
Other nonwhite	−0.0941	−0.1134	−0.1099	−0.1076	−0.1172	−0.1086
	(0.0079)	(0.0203)	(0.0202)	(0.0202)	(0.0206)	(0.0204)
Female	−0.5119	−0.5049	−0.5058	−0.5072	−0.4898	−0.4969
	(0.0051)	(0.0051)	(0.0051)	(0.0051)	(0.0051)	(0.0051)
No. of observations	38,266	38,266	38,266	38,266	38,266	38,266
R^2	0.3837	0.3810	0.3857	0.3851	0.3632	0.3745

SOURCE: Authors' calculations based on the March 1974 Current Population Survey.

specification. Therefore, the parameters on the variables of interest (education, race, and sex) are conditional on the highly flexible experience profile of the nonparametric estimate.

The parameter estimates, although slightly different in actual magnitude, display almost the same pattern as the regression based on the quartic specification. The nonparametric experience profiles are similar to the column 3 estimates, confirming that the quartic specification does a reasonable job of controlling for experience. Therefore, for other years we omit column 7.

Misspecification of either experience or education may affect other variables, but for our specifications, these changes are quite small. For example, focusing on the coefficient on "black" across specifications, using just the years-of-education specification (column 1 of table 2), gives a value of –17 percent. However, allowing dummy variables for educational achievement and a nonparametric representation of experience (column 7 of table 2) increases the value on black to –14.8 percent. Therefore, misspecifying the way experience and/or education enters has consequences for the degree of race-based earnings inequality.

Because the educational attainment of the workforce has changed dramatically over time,

TABLE 5

Earnings Regression Estimates, 1963

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Constant	5.0026 (0.0237)	5.7369 (0.0183)	5.7328 (0.0182)	5.7328 (0.0182)	5.6890 (0.0185)	5.6972 (0.0184)
Elementary school	— —	— —	−0.3971 (0.0155)	−0.3971 (0.0155)	— —	−0.2892 (0.0149)
7 to 12 years of education	—	— —	−0.1983 (0.0086)	−0.1983 (0.0086)	— —	— —
High school dropout	— —	−0.2214 (0.0084)	— —	— —	−0.0426 (0.0092)	−0.0751 (0.0093)
1 to 3 years of college	— —	0.1304 (0.0122)	0.1303 (0.0121)	0.1303 (0.0121)	0.0228 (0.0119)	0.1988 (0.0119)
4 years of college to 1 year of graduate school	— —	— —	0.3059 (0.0129)	— —	0.3945 (0.0128)	0.3718 (0.0127)
2 years of graduate school	— —	— —	0.3095 (0.0215)	— —	0.4030 (0.0217)	0.3786 (0.0215)
4 years of college to 2 years of graduate school	— —	0.3065 (0.0117)	— —	0.3068 (0.0116)	— —	— —
Years of education	0.0612 (0.0012)	— —	— —	— —	— —	— —
Years of experience	0.0596 (0.0038)	0.0604 (0.0038)	0.0606 (0.0038)	0.0606 (0.0038)	0.0555 (0.0039)	0.0570 (0.0038)
Years of experience^2	−0.0022 (0.0002)	−0.0023 (0.0002)	−0.0023 (0.0002)	−0.0023 (0.0002)	−0.0020 (0.0003)	−0.0021 (0.0003)
Black	−0.3219 (0.0123)	−0.3517 (0.0123)	−0.3314 (0.0124)	−0.3314 (0.0124)	−0.3915 (0.0124)	−0.3544 (0.0125)
Other nonwhite	−0.1305 (0.0383)	−0.1753 (0.0386)	−0.1574 (0.0384)	−0.1574 (0.0384)	−0.1766 (0.0393)	−0.1529 (0.0389)
Female	−0.4962 (0.0077)	−0.4874 (0.0078)	−0.4915 (0.0078)	−0.4915 (0.0078)	−0.4663 (0.0079)	−0.4765 (0.0078)
No. of observations	18,960	18,960	18,960	18,960	18,960	18,960
R^2	0.3279	0.3182	0.3247	0.3247	0.2942	0.3080

SOURCE: Authors' calculations based on the March 1964 Current Population Survey.

we next examine specifications across years.[7] Earnings are deflated using the GNP price deflator for personal consumption. We omit the specification using semiparametric experience from the earlier years, since there is little difference between that specification and the one using a fourth-order polynomial in experience. Comparing column 1 across years shows that the return to education (measured by years of schooling) has been rising over time. In fact, compared to 1963, the return to an additional year of schooling has nearly doubled, from 6 percent in 1963 to 11 percent in 1993.

Comparing column 2 across years also shows a similar pattern for those possessing at least a college degree. Again, between 1963 and 1993 we see a near doubling of the return to a college education. The return to completing only one to three years of college did not change much. However, those who dropped out of high school fared much worse (compared to high school graduates) in 1993 than in 1963. In 1963, high school dropouts earned about 22 percent less than high school graduates; by 1993, they were earning about 32 percent less.

Comparisons using column 3 show that the gains to finishing at least two years of graduate school went from about 31 percent above a high school graduate's earnings to 73 percent.

7 We chose 10-year intervals simply for convenience; the differences we mention may be slightly affected by business cycle conditions.

On the other hand, the return to a college degree (with up to one year of graduate school) rose from 31 to 52 percent.

Comparing columns 2 and 3 in 1963 and 1993 clearly shows that the bias has been growing over time. In 1963, combining college with post-graduate work led to a 31 percent gain in earnings relative to high school graduates. In column 3, the return to college grads and those with at least two years of graduate school was also about 31 percent more. That is, separating the various educational groups in 1963 led to virtually no difference.

The results for 1993 tell a much different story. The coefficient on the combination of college and graduate school shows a gain, compared to high school graduates, of about 59 percent. Separating the different educational groups, however, reveals that those with some post-graduate work earned 73 percent more than high school graduates, while individuals with only a bachelor's degree received roughly 52 percent more.

Finally, we turn to an examination of other estimates that have changed markedly over time. Specifically, we concentrate on the race and sex coefficients. In 1963, blacks were paid roughly one-third less than whites. By 1973, that gap had narrowed to about 20 percent, and by 1993, to about 16 percent.

The pattern for females' earnings is slightly different. In 1963, women earned about half as much as men, and that figure did not change much over the ensuing 10 years. By 1983, however, the male–female earnings differential had begun to fall, with women making about 38 percent less than men. The gap narrowed again over the next 10 years, and by 1993, women were earning about 29 percent less than men.

IV. Conclusion

The general features of individual earnings are robust to a wide variety of specifications; however, the specific point estimates are not. This paper investigates two areas where the parameterization of the earnings function can alter the estimates. In the specification of both education levels and years of experience, the simplest specification could lead to substantial misestimation of the underlying model that suggests little about the exact functional form.

Evidently, the return to a college education has been rising over time. However, part of this return is due to an increasing number of individuals pursuing post-graduate schooling, a fact not typically controlled for in the existing literature. Combining both college and post-college graduates into one category leads to an overestimate of the return to college of approximately 12 percent (seven percentage points). On the other side of the earnings inequality issue, the relative wages of high school dropouts have been boosted by the rising education levels of workers within this category.

An experience profile that allows for considerable flatness in later years, after a steep initial rise, is strongly supported by the data. The simple specification of potential experience and its square fails to allow earnings to reflect this pattern. Although we favor the estimates derived using Robinson's (1988) technique, there appears to be little difference between these estimates and those obtained using Murphy and Welch's (1990) quartic specification.

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Reducing Working Hours

by Terry J. Fitzgerald

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Introduction

It has been widely reported that working hours in the United States have shown little or no decline over the past few decades, while they have fallen substantially in most other industrialized countries—usually below the U.S. average. For example, one source shows that German workers have experienced a 27 percent decrease in average annual hours worked since 1960, compared to a decline of less than 3 percent in the United States.[1]

During the same period, the U.S. unemployment rate has risen well above 7 percent several times, reaching as high as 10.8 percent in 1982. In addition, some sectors of the economy, including many manufacturing industries, have gone through prolonged periods with little or no employment growth. For example, since 1969, total employment in manufacturing has fallen by almost 2 million, or roughly 10 percent, while total civilian employment has increased by almost 50 million.

These observations have led some to conclude that working hours in the United States are now too long, and that policy steps should be taken to reduce them. As a result, several proposals have been put forth. Some of these proposals are primarily intended to increase the time available to workers for personal activities and leisure. Others are specifically intended to increase the employment level in some sectors of the economy, or in the economy as a whole, by spreading (or sharing) the work across more people.[2] That is, it is believed that if people worked fewer hours, more workers would be employed. Although the two goals of increased leisure and increased employment are distinct, proposals for attaining both of them share the same basic approach—reduce the number of hours that employed people work.

Ironically, while some in the United States are calling for a reduction in working hours, several European countries are considering

1 Data are from the Organisation for Economic Co-operation and Development.

2 For example, former U.S. Senator William Proxmire (1993) proposed reducing the length of the workweek to increase both leisure and employment. Other proposals with similar objectives have been made by Shorr (1992) and Rifkin (1995). Examples of government policies intended to give workers more personal time include the Family and Medical Leave Act of 1993 and the recently proposed Family Friendly Workplace Act of 1996. An example of a policy intended to increase employment by reducing weekly hours is the Full Employment Act of 1994, which was introduced in the House of Representatives but never enacted.

TABLE 1

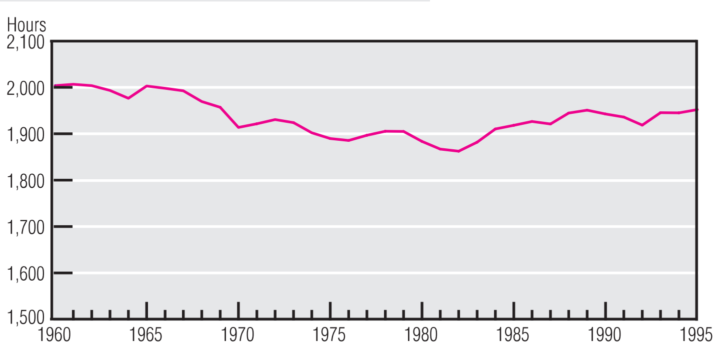
Annual Hours per Worker in All U.S. Industries

Year	Annual Hours
1870	2,964
1890	2,789
1913	2,605
1929	2,342
1938	2,062
1950	1,867
1960	1,795

SOURCE: Angus Maddison, *Dynamic Forces in Capitalist Development.* New York: Oxford University Press, 1991.

FIGURE 1

Average Annual Hours Worked in All U.S. Industries



SOURCE: Organisation for Economic Co-operation and Development.

proposals for an increase. It is sometimes argued that the relatively short working hours of many workers in Europe put firms there at a competitive disadvantage compared to firms in the United States and Japan, where working hours are longer. Proposals for longer weekly hours and shorter vacations are intended to increase productivity and thereby boost economic growth and employment.

Key considerations for plans to decrease—or increase—working hours are the interactions between hours per worker, employment, productivity, and output, as well as the effect on workers' wages. For example, a reduction in hours per worker may lead to a decline in output because of a fall in labor productivity, possibly due to the difficulty of coordinating production across a larger workforce, and/or because employment increases are curtailed by the costs of hiring and training additional workers.[3] Furthermore, a reduction in working hours would almost certainly lower workers' total earnings.[4]

In this article, I examine the issue of reducing working hours in the United States. I begin my analysis by presenting some historical facts that help explain the appeal of policies to reduce hours. I then explore a standard labor-demand model's predictions about how reducing weekly working hours would affect employment, output, and productivity. While shedding light on the potential effects of reducing hours in the United States, these predictions also provide information on the possible effects of increasing hours in European countries.

I find that the impact of a policy which effectively reduces the number of weekly hours per worker by five depends crucially on the trade-offs in production between hours per worker, employment, and output, and on how the policy affects wages. Unless the reduction in hours is associated with a large increase in the productivity of a fixed number of workers and/or a substantial decline in weekly wages, the model used in this paper predicts that the policy will have little, if any, positive impact on employment and a substantial negative effect on output. This suggests that policymakers and economists should examine these issues carefully before legislating policies that would affect working hours.

I. Some Facts about Working Hours

While it is difficult to obtain economywide data on working hours prior to the 1950s, available evidence indicates a substantial decline in the average annual hours of workers throughout the industrialized world from the late 1800s through 1960. Table 1 presents data from Maddison (1991), which show that average annual hours per worker in the United States fell steadily over that period, from almost 3,000 in 1870 to about 1,800 in 1960. Other industrialized countries experienced similar declines.

There is evidence, however, that the downward trend in annual working hours has slowed substantially or stopped in the United States

3 It has been argued that productivity may increase with a reduction in hours per worker. This possibility will also be considered.

4 Although unions sometimes propose reduced working hours with no wage decline, a reduction in hours is generally traded off—explicitly or implicitly—against a wage increase, job security, or some other benefit.

TABLE 2

Annual Hours per Worker in All Industries, 1960–1994

Country	Earliest Observation	1994	Percent Change
United States	2,003.9[a]	1,945.3	–2.9
Canada	2,025.8[b]	1,734.6	–14.4
Finland	2,061.3[a]	1,771.4	–14.1
Germany	2,151.9[a]	1,574.6	–26.8
Great Britain	1,945.3[c]	1,728.2	–11.2
Japan	2,228.0[d]	1,898.0	–14.8
France	1,962.5[c]	1,635.2	–16.7
Sweden	1,802.0[a]	1,532.2	–15.0

a. Data begin in 1960.
b. Data begin in 1961.
c. Data begin in 1970.
d. Data begin in 1972.
SOURCE: Organisation for Economic Co-operation and Development.

TABLE 3

Annual Hours per Worker in Manufacturing, 1960–1994

Country	1960	1994	Percent Change
United States	1,939.3	1,993.6	2.8
Canada	1,932.6	1,898.4	–1.8
Japan	2,477.2	1,959.8	–20.9
Denmark	2,080.1	1,573.3	–24.4
France	1,994.0	1,637.5	–17.9
Germany	2,096.1	1,541.3	–26.5
Italy	2,045.9	1,803.6	–11.8
Netherlands	2,109.2	1,598.8	–24.2
Norway	1,945.9	1,548.7	–20.4
Sweden	1,853.0	1,627.2	–12.2
United Kingdom	2,134.0	1,825.4	–14.5

NOTE: The data relate to all employed persons (employees and self-employed workers) in the United States, Canada, Japan, France, Germany, Norway, and Sweden, and to all employees (wage and salary earners) in Denmark, Italy, the Netherlands, and the United Kingdom. Hours are those actually worked, including overtime, and time spent at the workplace waiting, standing by, or taking short rest periods. Hours paid for but not worked, such as paid annual leave, paid holidays, and paid sick leave, are excluded.
SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, September 1995.

since 1960 (particularly over the past two decades), while it has continued in most other industrialized countries. Figure 1 presents annual data for 1960 through 1995 from the Organisation for Economic Co-operation and Development (OECD). Note that the average annual hours of U.S. workers leveled off in the 1970s and have increased somewhat since the early 1980s.[5] Table 2 shows the decline in hours between 1960 and 1994 in several countries for which the OECD has data. While hours declined only 2.9 percent in the United States over this period, they dropped by about 15 percent in several European countries and Japan, and by almost 27 percent in Germany.

In addition to comparing trends in working hours across countries, many casual observers of these data also compare the level of working hours, despite a warning from the OECD that such comparisons are not meaningful because of differences in data collection methods. Comparing levels, one finds that by 1994, U.S. working hours were the longest of any country listed in table 2.[6] Excluding Japan, annual U.S. working hours are reported to be roughly 200 to 400 hours longer than the rest, or about four to eight hours more per week.[7]

A similar pattern exists across countries for workers in the manufacturing sector. Table 3 presents Bureau of Labor Statistics' data on the change in average annual hours worked in manufacturing from 1960 to 1994. It shows that the hours of manufacturing workers in the United States actually increased over this 34-year period, while declining significantly in every other country studied except Canada. In 1994, annual hours of U.S. workers exceeded those of workers in other countries, except Japan and Canada, by roughly 200 to 400 hours.

Data on weekly U.S. averages, another source of information about secular trends in working hours, shed light on how hours trends have differed across industries. Figure 2 shows post–World War II data on the average weekly hours of all workers and all nonagricultural wage and salary earners. Again, we see that average hours of all workers trended downward through the early 1970s and have leveled off and increased slightly since.[8]

5 I thank Marianna Pascal of the OECD for providing these data.

6 The OECD has more recent data for several additional countries, including Australia, Mexico, New Zealand, Norway, Portugal, Spain, and Switzerland. Of these, only Portugal had a higher reported level of annual working hours than the United States in 1994.

7 Data from Maddison (1991) show a decline in the annual hours of U.S. workers from 1960 through 1987, along with an even larger decline for workers in other industrialized countries. Maddison's U.S. data are based on establishment figures for paid weekly hours per job. Data on average weekly hours at work, collected from the Current Population Survey and shown in figure 2, indicate a much smaller decline in average weekly hours than do the establishment data. Part of this difference is due to an increase in moonlighting over this period, which causes the establishment data to overstate the decline in hours per worker.

8 The series for average weekly hours and average annual hours could exhibit different trends due to changes in vacations, holidays, sick leave, and other factors that affect the number of weeks worked per year.

TABLE 4

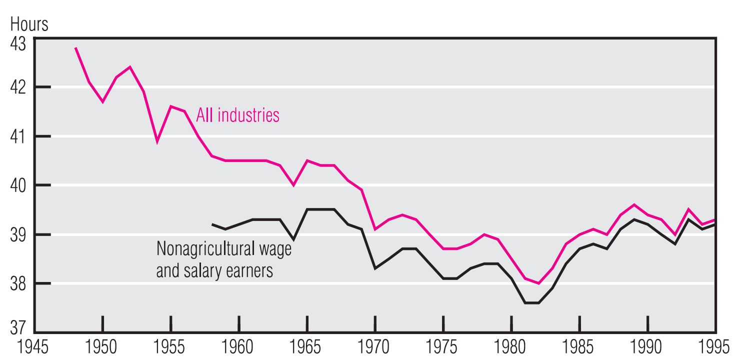
Average Weekly Hours of Production or Nonsupervisory Workers on Private, Nonagricultural Payrolls

	Total	Mining	Construction	Manufacturing	TPU[a]	Wholesale Trade	Retail Trade	FIRE[b]	Services
1947	—	40.8	38.2	40.4	—	41.1	—	—	—
1954	—	38.6	37.1	39.6	—	40.5	—	—	—
1959	—	40.5	37.0	40.3	—	40.6	—	—	—
1964	38.7	41.9	37.1	40.7	41.1	40.7	37.0	37.3	36.1
1969	37.7	43.0	37.8	40.6	40.7	40.2	34.2	37.1	34.7
1974	36.5	41.9	36.6	40.0	40.3	38.8	32.7	36.5	33.7
1979	35.7	43.0	37.0	40.2	39.9	38.8	30.7	36.2	32.7
1984	35.2	43.3	37.7	40.7	39.4	38.5	29.8	36.5	32.6
1989	34.6	43.0	37.9	40.9	38.9	38.0	28.9	35.8	32.6
1993	34.5	44.3	38.4	41.4	39.6	38.2	28.8	35.8	32.5
1996	34.4	45.3	38.9	41.5	39.7	38.3	28.8	35.8	32.4

a. Transportation and public utilities.
b. Finance, insurance, and real estate.
SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

FIGURE 2

Average Weekly Hours at Work



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics.

Interestingly, figure 2 shows relatively little decline before the 1970s in the average weekly hours of nonagricultural wage and salary workers. The differences between the trends in these two series are largely due to a shift in the composition of employment. Since the 1940s, the fraction of workers who are self-employed or in agricultural industries has declined substantially. These are also groups that have traditionally worked relatively long hours, so that as their share of employment fell, so did the average weekly hours of all workers.[9]

In several industries, the average weekly hours of wage and salary workers declined little over the past few decades, a fact that has received a great deal of attention. Table 4 shows the weekly hours of U.S. production and nonsupervisory workers on nonagricultural payrolls for several industries. Notice that the hours of workers in goods-producing industries—mining, construction, and manufacturing—have not only failed to decrease over the past 50 years, but have actually increased. By contrast, average weekly hours in manufacturing before 1950 fell markedly, from 54.3 hours in 1901 to 38.8 hours in 1948.[10] The largest declines in weekly hours since 1964 occurred in retail trade and the service industries. (See footnote 7 for a brief discussion of why weekly hours are shown declining steadily in table 4 but not in figure 2.)

To summarize, there is evidence that the steady decline in annual working hours that occurred before the 1960s has slowed or stopped in the United States over the last few decades, while continuing in virtually all other industrialized countries. Furthermore, the average weekly hours of workers in several U.S.

9 For example, in 1958, average weekly hours at work was 47.7 for self-employed workers in nonagricultural industries, compared to 39.2 for all wage and salary workers in the same industries. In 1948, the self-employed and workers in agricultural industries accounted for about 24 percent of total employment. By 1970, that figure had fallen to roughly 11 percent.

10 These numbers are taken from Ehrenberg and Smith (1994).

industries have shown no decline over the past 50 years.[11]

This evidence has led many U.S. policymakers, union leaders, economists, and social commentators to advocate policies that would reduce working hours. One common proposal is to lower the number of hours people work each week.[12] In the remainder of this article, I examine the potential effects of reducing weekly hours per worker so that the annual hours of full-time, full-year workers in the United States are more in line with those for other industrialized countries, as reported in tables 2 and 3. More specifically, I consider a five-hour reduction in the workweek, implying a reduction in annual hours of roughly 200 to 250, depending on the number of weeks actually worked (excluding holidays, vacations, sick leave, and so forth).

II. A Model of the Firm

In order to evaluate the implications of reducing weekly hours, we need a model of how weekly hours and employment are determined. In this section, I lay out a simple model in which the firm chooses both the weekly hours of its workers and the number of workers it employs.[13] I then examine the effects of reducing weekly hours from 40 to 35 within this framework.

The Production Technology

Output in the model is produced by competitive firms that combine capital and the labor services of workers. Labor services are assumed to be a function of the number of workers, n, and the hours per worker, h. In general, labor services, L, may be written as

$$(1) \qquad L = F(h, n),$$

with labor services typically assumed to be an increasing function of both arguments. Following Hart (1987), I assume that the labor service function may be written as

$$(2) \qquad L = g(h)n^{\theta},$$

where $g(\cdot)$ is assumed to be positive and strictly increasing, with $g(0)$ equal to 0.

Output during a week is produced by combining an exogenously given and fixed amount of capital, k, with the labor services of n employees working h hours each, and is assumed to be

$$(3) \qquad y = f(k)g(h)n^{\theta},$$

where $0 < \theta < 1$. Since capital is assumed to be fixed and exogenous, the exact form of the function f is unimportant. For a given amount of capital and number of workers, $g(h)$ determines total output, and $g(h)$ divided by h determines average output per hour, or productivity.

I assume that the weekly working hours of capital at the firm are exogenously given.[14] For simplicity, I assume that the firm is operated continuously during the week—that is, for 168 hours—and that its workers are distributed evenly across these hours. The firm's manager must decide how many people to employ and the number of hours per worker.

For example, suppose the manager is told to hire 16,800 hours of labor, so that 100 people are working at the firm during each hour. Among its many options, the firm could employ 210 workers for 80 hours each, 420 workers for 40 hours each, or 840 workers for 20 hours each. These choices are likely to be associated with different levels of output. The model is weekly, and makes no distinction between five eight-hour days and four 10-hour days.

It is difficult to determine a reasonable specification for the function $g(\cdot)$ from the data. Typically, this function is assumed to be convex at low values of h, reflecting fixed warm-up or set-up costs, and concave at high values of h, reflecting worker fatigue and boredom after long hours, as well as the decreasing returns associated with having more people at the firm each hour. (Recall that people are evenly distributed across the working hours of the firm, so that an increase in hours per worker implies

11 An important issue, not examined here, is the underlying cause of cross-country differences in both trends and levels of working hours. More specifically, one would like to know whether the leveling off of working hours in the United States was associated with efficient production, distortionary labor market policies and regulations, or some other factor.

12 There have been several proposals to modify the hours and overtime pay provisions of the Fair Labor Standards Act. These proposals seek to reduce the "standard" workweek below 40 hours and/or to increase the overtime premium that firms must pay to employees working more than the "standard" workweek.

13 This model is similar to the framework used by Hart (1987), who builds on the work of Ehrenberg (1971), Lewis (1969), and Rosen (1968), among others.

14 How reduced working hours might affect capital utilization is an interesting question, but one that this article does not explore.

more people at the firm each hour.) The assumption of decreasing returns to workers also explains why the exponent on the number of workers is restricted to be less than one.

Fortunately, for the purposes of this paper there is no need to specify the entire g function. I will elaborate on this point shortly. What will be critical is the ratio of $g(35)$ to $g(40)$, where 40 hours is the equilibrium workweek before the hours restriction, and 35 is the restricted number of hours per worker.

The Firm's Decision Problem

A basic assumption throughout this paper is that firms choose hours per worker and the number of workers so as to maximize profits. In making these choices, a firm takes as given an increasing weekly wage schedule that depends on the number of hours a person works. This schedule is written as

$$(4) \qquad w(h) \equiv \omega h^{\psi},$$

where $\psi \geq 0$ and $\omega > 0$. The wage schedule is constant when ψ equals 0, meaning that the weekly wage is independent of hours, is linear when ψ equals 1 (implying a constant wage per hour), and is convex when ψ is greater than 1 (reflecting an increase in the implied hourly wage as the number of hours increases). This wage schedule may also include other labor costs that vary with hours per worker, and thus may be thought of more generally as describing a firm's variable labor costs, that is, costs which vary directly with hours per worker.

In addition to variable labor costs, the firm also faces per worker costs that, roughly speaking, do not vary with changes in hours per worker. These costs include the time and effort associated with hiring, training, and firing people, and may include payroll taxes and other costs that depend on the number of people employed.[15] To capture these per worker costs, I assume that the total cost associated with employing each worker for h hours is given by $w(h)$ plus ϕ, where the parameter ϕ represents per worker costs.

The profit maximization problem faced by a firm is

$$(5) \qquad \max_{h,n} f(k)g(h)n^{\theta} - [w(h) + \phi]n \quad \text{such that } 0 \leq h \leq 168,\ n \geq 0.$$

Profits to the firm can be interpreted as the return to capital.

Necessary conditions for an interior solution to this problem for h and n are

$$(6) \qquad f(k)g'(h)n^{\theta} = w'(h)n$$

$$(7) \qquad \theta f(k)g(h)n^{\theta-1} = w(h) + \phi.$$

Equation (6) states that the marginal benefit of having all employees work another minute must equal the marginal cost of having them do so. Equation (7) says that the marginal product of hiring an additional worker must be equal to the marginal cost. Combining (6) and (7), I get

$$(8) \qquad \frac{\theta g(h)}{g'(h)} = \frac{w(h) + \phi}{w'(h)}.$$

Notice that the solution for hours per worker is independent of employment and is determined by the shapes of the wage schedules and the $g(\cdot)$ function. That is, the number of hours per worker does not depend on the size of the firm as given by the number of workers. Once h has been determined, equation (7) can be used to solve for the number of workers, n.

As mentioned in the preceding subsection, determining the exact shape of the function $g(\cdot)$ from the data is difficult and, fortunately, unnecessary. In the next section, I consider the implications of restricting hours per worker to 35. I take it as given that the g function is such that 40 hours per worker is profit maximizing, and normalize $g(40)$ to 1. I also select a value for $g(35)$, denoted by γ. For a fixed number of workers and capital, γ determines how much lower the output will be at 35 hours per worker than at 40.

To verify that such a g function exists, given the model functions and parameter values, I define the profit function, $\pi(h)$, as follows:

$$(9) \qquad \pi(h) \equiv \max_{n} f(k)g(h)n^{\theta} - [w(h) + \phi]n \quad \text{such that } n \geq 0.$$

If 40 hours per worker is profit maximizing, then

$$(10) \qquad \pi(40) \geq \pi(h) \quad \text{for all } 0 \leq h \leq 168.$$

15 A full discussion of employment-related costs to the firm can be found in Hart (1984).

This profit-maximization condition constrains the shape of the g function. For example, $\pi(40)$ must be greater than or equal to $\pi(35)$. In effect, this condition restricts how large γ can be. For example, suppose γ were greater than 1. Then, as long as weekly wages are lower at 35 hours than at 40, it would not be profitable for a firm to hire workers for 40 hours, since it could get more output at a lower cost by hiring the same workers for 35 hours. It follows that, for reasonable specifications of the wage function, γ can be no larger than 1 and will generally need to be somewhat smaller for (10) to hold.

If $\pi(40)$ is greater than $\pi(35)$ for a given value of γ, then there are many candidate g functions that satisfy (10) and pass through these two values.[16] The exact form of this function is not important for the purposes of this paper.

A Simple Example

To gain insight into the potential effects of reducing hours, consider an example. Here, it is informative to specify a functional form for the g function. In the case where $g(\cdot)$ is h^{θ}, ψ is set to 1, and ϕ is set to 0, the firm's decision problem is written

$$\max_{h,n} f(k)g(hn)^{\theta} - \omega hn$$
$$\text{such that } 0 \leq h \leq 168,\ n \geq 0.$$

Notice that h and n appear only as h multiplied by n. This implies that for any total number of hours worked (call it H), any combination of h and n for which $hn = H$ produces the same profit and the same output.

This example illustrates the intuition that seems to underlie the arguments of some advocates of work-sharing policies. In this example, the decomposition of total hours into hours per worker and the number of workers is irrelevant for a firm's productivity or output. Some work-sharing advocates implicitly argue that this is a fairly close approximation of reality. Thus, the fixed amount of total hours worked can be reorganized so that more people are working fewer hours, without having much impact on output. We will see that this result depends crucially on the assumptions made regarding the shape of $g(\cdot)$, the wage schedule, and the size of fixed costs per worker.

III. The Effects of Reducing Hours

In this section, I examine the effects of reducing weekly hours per worker by five. The framework has been set up using 40 hours per week as the solution to the firm's decision problem for hours. I consider the effects of restricting weekly hours per worker to no more than 35. This restriction translates into an annual decline of roughly 250 hours for a full-time, full-year worker, which is in line with the differences between the United States and many European countries shown in tables 2 and 3. The experiment amounts to adding the constraint $h \leq 35$ to the firm's decision problem and comparing the result to the solution of the problem without this hours constraint.[17]

After presenting the results for a benchmark set of parameter values, I explore the sensitivity of these results to changes in parameter values. The purpose of these experiments is to give a sense of the qualitative predictions of a standard labor-demand model and to identify which parameter values are crucial in determining the quantitative impact of the policy.

Benchmark Parameter Values

The following parameter values are used as a benchmark. First, $f(k)$ and $g(40)$ are both normalized to 1. I set the productivity parameter γ, the value of $g(35)$, equal to 0.875, so that the 12.5 percent reduction in hours per worker from 40 to 35 leads to a 12.5 percent decline in $g(\cdot)$. This implies that for a fixed number of workers and capital, output per hour is unchanged, so that a 12.5 percent decline in hours

■ **16** One rather stark candidate g function is a step function, where $g(h) = 0$ for $0 < h < 35$, $g(h) = \gamma$ for $35 \leq h < 40$, and $g(h) = 1$ for $h \geq 40$.

■ **17** In this article, I focus on the effects of actually reducing weekly hours, rather than examining the effects of a specific policy, such as amending the provisions of the Fair Labor Standards Act, which may or may not result in a shorter workweek. Much work has been done to examine the effects of changing the Act's provisions (see, for example, Ehrenberg and Schumann [1982]). Other studies have analyzed more generally the effects of policies that attempt to reduce working hours by increasing overtime premiums and/or reducing "standard" weekly work hours (see, for example, Hart [1987] and Owen [1989]).

TABLE 5

Effects of a 35-Hour Workweek (Percent change)

Variable	Benchmark Model
Hours per worker	–12.5
Employment	–1.9
Total hours worked	–14.2
Output per hour	0.7
Total output	–13.6
Weekly wages	–12.5
Profit	–13.6

SOURCE: Author's calculations.

per worker is accompanied by a 12.5 percent decline in output.[18]

Next, the value of θ is set to 0.65, which implies that wage payments plus worker fixed costs equal 65 percent of the value of output. This is roughly consistent with aggregate U.S. data on labor's share of total income, though the specific percentage varies across industries. I set ϕ to 0.05, so that fixed costs per worker equal 5 percent of the wages paid to a 40-hour worker and roughly 3 percent of total output. Again, this number varies across industries and depends greatly on what one includes as fixed costs.[19]

Finally, we must assign values for the parameters of the wage schedule. The value of ω is chosen so that $w(40)$ equals 1, which is simply a normalization. The decline in weekly wages is determined by the value of ψ. For the baseline experiment, I set ψ to 1.0, which implies that the hourly wage is constant, so that the weekly wage falls by 12.5 percent with the hours restriction.

Hours Restriction Experiments

Obviously, there is a large degree of uncertainty in assigning values to some of these parameters, and their values may differ across industries. Therefore, it is important to examine how changes in parameter values affect the results of the experiment. After presenting the results of the hours restriction for the benchmark parameters, I examine how they are affected by changes in some of these parameter values.

Benchmark Results

Table 5 shows the effects of restricting hours per worker to 35 per week, using the benchmark parameter values. Rather than increasing employment, as work-sharing advocates would hope, the restriction causes an employment decline of 1.9 percent.

The qualitative effect of the hours restriction on employment can be understood by looking at the firm's employment condition as given by equation (7), which must hold both prior to the hours restriction (at $h = 40$) and after the hours restriction (at $h = 35$). Holding the value of n fixed, the benchmark value of γ, that is, $g(35)$, implies that the marginal product of the last worker—the left-hand side of (7)—falls by 12.5 percent, matching the decline in h. Although weekly wages, $w(h)$, also fall by 12.5 percent, the marginal cost of the last worker (the right-hand side) declines by less than 12.5 percent, since fixed costs per worker, ϕ, are unchanged. Given that the marginal cost per worker does not vary with employment, equality in (7) can be restored only by decreasing employment so as to increase the marginal product.

The 1.9 percent employment decline does result in a 0.7 percent productivity increase, but this is not nearly enough to offset the 14.2 percent decline in total hours worked. Output falls by 13.6 percent, as do firm profits.

Sensitivity Analysis

Given the uncertainty in choosing benchmark parameter values, it is natural to ask how the results of the experiment change as we vary the assumptions on 1) the decline in the productivity parameter, γ; 2) the size of per worker costs, given by ϕ; and 3) the decline in workers' weekly wages, determined by ψ. Tables 6 through 8 illustrate how the results vary with changes in the values of these parameters. To

18 While there are estimates of output elasticity with respect to hours per worker (see Hamermesh [1993] for a summary), it is unclear that these estimates are useful when evaluating a major policy-induced decline in hours per worker. However, the implied value of 1, which is used in the benchmark case, is within the range of estimates.

19 The 5 percent value used here reflects a back-of-the-envelope calculation of the costs associated with maintaining job positions (hiring, training, record keeping, and so forth). This number does not include employee benefits, some of which are fixed per worker costs. I am implicitly treating employee benefits as being incorporated into the wage schedule. To the extent that 5 percent understates fixed costs, I am biasing the experiment so that the hours restriction will have more favorable employment and output effects.

TABLE 6

Effects of Changes in γ

	Value of γ		
Variables	**0.850**	**0.875**	**0.900**
Hours per worker	–12.5	–12.5	–12.5
Employment	–9.7	–1.9	6.3
Total hours worked	–21.0	–14.2	–7.0
Output per hour	0.7	0.7	0.7
Total output	–20.5	–13.6	–6.4
Weekly wages	–12.5	–12.5	–12.5
Profit	–20.5	–13.6	–6.4

TABLE 7

Effects of Changes in ϕ

	Value of ϕ		
Variables	**0.00**	**0.05**	**0.10**
Hours per worker	–12.5	–12.5	–12.5
Employment	0.0	–1.9	–3.6
Total hours worked	–12.5	–14.2	–15.7
Output per hour	0.0	0.7	1.3
Total output	–12.5	–13.6	–14.6
Weekly wages	–12.5	–12.5	–12.5
Profit	–12.5	–13.6	–12.5

TABLE 8

Effects of Changes in ψ

	Value of ψ		
Variables	**0.0**	**1.0**	**1.4**
Hours per worker	–12.5	–12.5	–12.5
Employment	–31.7	–1.9	13.3
Total hours worked	–40.3	–14.2	–0.9
Output per hour	14.3	0.7	–4.3
Total output	–31.7	–13.6	–5.1
Weekly wages	0.0	–12.5	–17.1
Profit	–31.7	–13.6	–5.1

NOTE: All results show percent change.
SOURCE: Author's calculations.

facilitate comparison with the benchmark experiment, I repeat the benchmark results in the middle column of every table. Each table shows how the results are affected by lowering and raising the value of one of these parameters, leaving the remaining parameters at their benchmark values.[20]

Table 6 presents the effects of restricting hours under different assumptions for the productivity parameter γ. This parameter determines the decline in productivity *for a fixed number of workers* associated with the decline in hours per worker. If employment is held constant, the parameter values used imply that output per hour decreases 2.5 percent, is unchanged (the benchmark case), and increases 2.5 percent.

Not surprisingly, the effects of restricting hours are more favorable for higher values of γ. The declines in output and employment are smaller, and, in fact, employment increases for the highest value of γ. Note that the employment increase, which on its own would lead output per worker to fall, offsets the increase in productivity associated with the hours restriction for a fixed number of workers, so that output per hour rises only 0.7 percent.

Table 7 illustrates how the results vary with different assumptions on the size of fixed costs per worker. As expected, higher fixed costs imply larger employment and total output losses.

Finally, table 8 shows the effects of the hours restriction under different assumptions on the decline in weekly wages, which is determined by the parameter ψ. The results suggest a trade-off between the decline in weekly wages and the decline in output and employment. If weekly wages are assumed to remain constant, the drop in employment and output is massive. If weekly wages are assumed to fall more than proportionally with hours, then output declines relatively little and employment increases substantially.[21]

■ 20 The qualitative nature of the results is not affected by changes in the labor share parameter θ over a plausible range.

■ 21 The value of 1.4 for ψ implies that the weekly wage for 48 hours is 30 percent higher than the weekly wage for 40 hours. This is roughly the percentage that results when workers are paid 1.5 times their base pay for the eight hours worked above 40.

IV. Final Remarks

In this paper, I have presented the predictions of a standard labor-demand model for a policy that restricts weekly hours to 35. In all of the experiments, the output of the firm declined, while employment both increased and decreased, depending on the specific parameter values used. The key determinants of the policy's effects were the production trade-offs between hours per worker, employment, and output, as well as the magnitude of the wage decline associated with the policy.

The framework used here abstracts from a number of potentially important considerations in determining the effects of reducing hours per worker. First, wage schedules are given exogenously, rather than being determined competitively through the interaction of firms and workers. Therefore, the experiments have nothing to say about the impact of the policy on wages. Second, the model is static, so it does not address the implications of the policy for investment and capital accumulation. Third, the model ignores potentially important labor supply considerations, such as the effect on labor force participation and moonlighting. Fourth, the model abstracts from substantial differences in the composition of employed and unemployed people—differences that may be important in determining the policy's impact.[22] Finally, I simply assume that a policy exists which effectively reduces hours per worker, ignoring the problems of implementation and enforcement.

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■ 22 See Fitzgerald (1996) for a discussion of this point.