Education and Work

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Abstract

This paper examines the linkage between the incentives to work and to invest in human capital through education. These incentives are shown to be mutually reinforcing in a simple stylized model. This theoretical prediction is investigated empirically using three large micro datasets covering a broad set of countries. As one might expect, education and work are strongly (positively) correlated. This correlation has important implications for models of fiscal policy and economic growth. It also has important implications for the estimation of labor supply and the rate of return to education.

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1 Introduction

This paper examines the linkage between the level of education and subsequent time spent working. As one might expect, a mutually-reinforcing correlation is found both theoretically and empirically. In addition to being interesting in its own right because of its implications for education and employment policies, the finding that education and work decisions are mutually reinforcing has at least three important implications.

First, it casts doubt on the applicability of the "wealth-maximizing" models of human capital accumulation. Economic models which incorporate human capital creation have become increasingly common over the past decade. Most of these models have been simplified by assuming that leisure time is fixed.[1] By ignoring the choice between work and leisure these wealth-maximizing (as opposed to utility-maximizing) models focus exclusively on the choice between work and education. The results in this paper, however, decisively reject the notion that the work/training choice is independent of the work/leisure choice. Moreover, recent research has shown that the interdependency between the work/training and work/leisure choices may be important in some analyses. Trostel (1993) found that the interdependency between human capital investment and subsequent work is crucial in the debate over the extent that taxation affects human capital accumulation. Similarly, Stokey and Rebelo (1995) found that

[1]A partial list of these studies is Lucas (1988, 1993), Lord (1989), Becker et al. (1990), King and Rebelo (1990), Davies and Whalley (1991), Tamura (1991), Ehrlich and Lui (1991), Jones and Manuelli (1992), Glomm and Ravikumar (1992, 1997), Nerlove et al. (1993), Mulligan and Sala-i-Martin (1993), Caballé and Santos (1993), Barro and Sala-i-Martin (1995), De Gregorio (1996), Mino (1996), Dupor et al. (1996), Kaplow (1996), Steurle (1996), Agell and Lommerud (1997), Perroni (1997), Kim (1998), Lin (1998), and Lord and Rangazas (1998).

this interdependency may be crucial in the debate over the extent that taxation affects economic growth.[2] These earlier results coupled with the findings in this paper show that the frequent simplifying assumption of constant leisure can be an important restriction in human capital models.

Second, empirical research on labor supply[3] has ignored the interaction between the work/education and work/leisure choices. The level of education is treated as an exogenous variable in the estimation of labour supply elasticities (either explicitly or implicitly by splitting the sample by education level). In other words, education is implicitly assumed to affect the rate of pay, but not hours of work.[4] In a full life-cycle perspective, however, education is endogenously determined along with hours of work. Therefore, estimates of labour supply elasticities may be biased and/or inefficient.[5] To be specific, it is likely that estimates of the wage elasticity are understated.[6]

Third, empirical research on the rate of return to education[7]

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[2]This is also found in Jones et al. (1993), Mendoza et al. (1997), and Milesi-Ferretti and Roubini (1998).

[3]See Blundell and MaCurdy (forthcoming) for a recent survey of this literature. See also Killingsworth (1983), Killingsworth and Heckman (1986), and Pencavel (1986).

[4]This point applies not just to structural models of labor supply, such as Mroz (1987), but also to difference-in-differences models, such as Blundell et al. (1998).

[5]Shaw (1996) makes an analogous argument concerning the effect of on-the-job training on estimates of labor supply.

[6]Our very preliminary investigation has indeed found that the estimated labor supply elasticity is understated when education is taken as exogenous, although not by a large amount.

[7]See Ashenfelter et al. (2000), Card (1995), and Psacharopoulos (1994) for recent surveys of this literature.

may also be biased and/or inefficient because it fails to account for the endogenous interaction between education and hours worked. In particular, studies which use the wage rate as the dependent variable typically do not account for the endogeniety of participation and may therefore be subject to sample-selection bias.[8] The potential for sample-selection bias is smaller in studies which use annual earnings as the dependent variable, but in this case endogenous variation in conditional hours of work is not accounted for.[9]

This paper uses a simple two-period model to show that education and work choices are mutually reinforcing under likely circumstances. This prediction is then supported empirically using individual-level data from the U.S. Current Population Survey, the British Family Resources Survey, and the International Social Survey Programme. This conclusion is robust to including the wage rate directly into the hours equation.

Specifically, these datasets show that, for working-age men, one additional year of education is associated with roughly an additional 0.9 to 1.3 hours of work per week. Not surprisingly, the correlation is even stronger for women. Working-age women work roughly 2.1 to 2.4 additional hours per week for each additional year

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[8]This sample-selection bias is related to, but distinct from, censoring or "composition" bias, which appears to be very small [see, e.g., Dearden (1999)].

[9]These issues have been addressed to a small extent in the rate-of-return literature. For example, Ashenfelter and Ham (1979) and Nickell (1979) estimate the risk-adjusted rate of return to education by accounting for unemployment. Some studies, e.g., Mincer (1974), have included weeks of work (assumed exogenous) in their earnings equations. But it does not appear that these issues have been fully appreciated. Our very preliminary examination of this issue suggests that it causes a non-trivial downward bias in the estimated of rate of return to education.

of schooling. Most, but not all, of this correlation occurs on the extensive margin, that is, through differences in the probability of working. For men (women), the probability of working increases by roughly 1.6 to 2.6 (3.4 to 3.8) percentage points per year of education. A significant negative correlation between education and unemployment is an important part of the story; but most of the correlation between education and employment comes from the negative correlation between education and labor-force participation. For working-age men (women), an additional year of education is associated with a 0.8 to 1.5 (3.1 to 3.5) percentage point lower probability of being out of the labor force. Moreover, owing to the large sample sizes, these effects are very precisely estimated. And, although there is a fair amount of variation in these correlations across 27 countries in the International Social Survey Programme, the same general pattern is found in practically every country.

Before proceeding to the analysis it should be acknowledged that many of the findings of this study are implicit in many earlier studies. The idea that education and work choices are mutually interdependent ex ante is clearly demonstrated in Blinder and Weiss (1976).[10] The original contribution of the theory presented in the next section is that the interdependence between education and work choices is examined explicitly and in depth. Moreover, the specification of human capital is more general in an important dimension than those used in previous theoretical work. A positive empirical correlation between education and work has also been shown

[10] See also Ghez and Becker (1975), Heckman (1976), Ryder et al. (1976), Weiss and Gronau (1981), Killingsworth (1983), and Killingsworth and Heckman (1986).

previously.[11] The previous empirical work, however, did not explicitly explore the interaction between schooling and labour supply (this interaction was not the primary focus in the earlier work). In other words, although the interaction between years of education and subsequent hours of work has been indicated in previous theoretical and empirical work, this is the first study to explore it, and its implications, in depth.

2 Theory

2.1 The Model

The basic intuition can be shown most easily in a two-period model with no uncertainty. A two-period framework simplifies the analysis considerably, but it is sufficient to model the essence of the decisions to work and to invest in human capital from education.[12] Ignoring uncertainty also simplifies the analysis, particularly because it is not clear how investment in human capital is uncertain.[13] The focus is restricted to human capital from formal

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[11]See, e.g., Mincer (1974), Ghez and Becker (1975), Pencavel (1986), Killingsworth and Heckman (1986), Eckstein and Wolpin (1989), Becker (1993), Ríos-Rull (1993), Card (1994), Phelps and Zoega (1997), and Blau (1998).

[12]The important restriction imposed in a two-period framework is that it does not capture potential intertemporal substitution of leisure within each period. As will become apparent below, except for in a special case, the opportunity cost of leisure changes over time as the human capital stock evolves, which creates an incentive to substitute leisure intertemporally. This possibility reinforces the mutual reinforcement of human capital and work decisions shown below.

[13]It is not even clear that investment in human capital is risky. There is considerable evidence that investment in education reduces income risk by reducing the probability of unemployment. This evidence is surveyed in Trostel, Perroni, and Walker (1998).

education because of the lack of data on on-the-job training. Moreover, education is likely to be the most important type of human capital for most workers.

Individuals are assumed to be endowed with one unit of time per period, t, which is allocated among three alternatives: working, l, schooling, s, and leisure, R. Thus the time constraint is

$$(1) \qquad 1 \ / \ l_t + s_t + R_t, \qquad\qquad t = 1,2.$$

As mentioned earlier, more often than not, models with human capital accumulation have been simplified by assuming R is constant.

Time allocated to schooling in the first period produces human capital, H, which increases earnings from working in the second period.[14] Thus the wage rate, w, in the second period is

$$(2) \qquad w_2 = H(s_1)w_1, \qquad\qquad H(0) \ / \ 1.$$

Human capital production is assumed to be governed by a simple isoelastic function:

$$(3) \qquad H(s) = Ns^F, \qquad\qquad 1 > F > 0,$$

where N reflects learning ability, and F measures the returns to scale in producing human capital. To produce an interior solution (i.e., l_1, $s_1 > 0$), diminishing returns in human capital production is assumed.

It is worth emphasizing that the first period in this model is not just the schooling age, but is the entire first half of economic life. Thus the assumption of an interior solution is not at odds

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[14] Non-time inputs in the production of human capital are not important in this context and for simplicity are ignored.

with the fact that most young people initially specialize completely in producing human capital. Full-time schooling ends long before middle age. Similarly, the second period in this model is not just the working age. The second period also includes retirement age, and variation in the age of retirement is one of the ways that work can vary in the second period.

A frictionless financial market is assumed which allows individuals to save or borrow at rate r in the first period. An initial financial endowment, e, is assumed. Bequests are ignored (or e can be interpreted as the initial endowment less the present value of the future bequest). Thus the budget constraint is

$$(4) \qquad (1+r)e + (1+r)w_1 l_1 + w_2 l_2 = (1+r)c_1 - c_2,$$

where c is consumption per period.

Utility, U, is a function of consumption and leisure in each period. Human capital produced in the first period is assumed to increase the productivity of leisure, v, in the second period. Thus the utility function is

$$(5) \qquad U = U(c_1, c_2, R_1, v(H)R_2)(1+D)^{1-t}, \qquad v(1) \;/\; 1,$$

where D is the rate of pure time preference. v(H) is assumed to be a simple isoelastic function:

$$(6) \qquad v(H) = H^{"}, \qquad 1 \;\$\; " \;\$\; 0.$$

" measures the leisure-productivity returns to human capital.

Most modelling of human capital ignores its potential impact on the productivity of leisure time (i.e., " = 0 and v(H) / 1), but there are a few exceptions. In particular, beginning with Heckman

(1976),[15] human capital has sometimes been assumed to affect the productivity of leisure in the same proportion that it affects the productivity of work (i.e., " = 1 and v(H) / H). This "neutral" specification of human capital, however, may be no less restrictive than the usual specification. In other words, neither of the special cases used in the literature appears particularly likely. It does seem likely that human capital will affect the productivity of leisure time to some extent. Indeed, Michael (1972) provides some empirical evidence that education affects the productivity of leisure. But it seems unlikely that human capital affects the productivity of work and leisure in the same proportion. Because there is much less scope for specialization, limits on leisure productivity seem much more likely than limits on work productivity.[16] Moreover, the extent that human capital affects the productivity of leisure is crucial for the interaction between human capital and hours of work. Thus a general specification is assumed.

2.2 The Equilibrium Relationship between Education and Work

The equilibrium relationship between investment in education and expected future hours of work can be easily deduced from the first-order conditions of the individual's optimization problem (assuming, of course, that the budget constraint is continuous). Specifically, maximizing (5) by the choices of c_1, c_2, s_1, l_1, and l_2 (s_2 is obviously zero and for brevity is ignored) subject to (1) -

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[15]More recently, Killingsworth and Heckman (1986), Rebelo (1991), Stokey and Rebelo (1995), Mendoza et al. (1997), Ortigueira and Santos (1997), and Milesi-Ferretti and Roubini (1998) have used this specification.

[16]Becker (1965) makes a this argument in a similar context.

(4) and (6) yields the following first-order conditions:

(7.1) $MU/Mc_1 - 8(1+r) = 0,$

(7.2) $(1+D)^{-1}MU/Mc_2 - 8 = 0,$

(7.3) $- MU/MR_1 + (1+D)^{-1}\text{"}FN^{\text{"}}s^{\text{"}F-1}R_2MU/MR_2 + 8FNs^{F-1}wl_2 = 0,$

(7.4) $- MU/MR_1 + 8(1+r)w = 0,$

(7.5) $- (1+D)^{-1}vMU/MR_2 + 8wH = 0,$

(7.6) $(1+r)e + (1+r)wl_1 + wHl_2 - (1+r)c_1 - c_2 = 0,$

where 8 is the shadow value of wealth, and the time subscripts have been left off of s and w and are understood to be their first-period values.

Combining first-order conditions (7.3) - (7.5) shows the equilibrium relationship between education and work:

(8) $s = [FN(l_2(1-\text{"})+\text{"})/(1+r)]^{1/(1-F)}.$

This equation reveals that the relationship between education and future work is weakly positive. Unless human capital from education affects the productivity of leisure time and the productivity of work time proportionately (i.e., " = 1), there is a positive relationship between education and work. Moreover, this relationship is independent of preferences about work, consumption, and discounting. Equation (8) shows a no-arbitrage condition rather than a preference relationship.

The intuition for this result is straightforward. First consider the typical specification (" = 0). Combining first-order conditions (7.3) and (7.4) shows that the marginal return on investment in education is equated to the rate of return on financial assets:

$$(9) \qquad FNs^{F-1}l_2 = 1+r.$$

This equation shows that l_2 affects the rate of return on investment in human capital. Expected future hours of work is the utilization rate of human capital. Thus l_2 directly affects the rate of return on investment in human capital and the incentive to invest in education.

When the productivity of leisure is affected by human capital, however, increases in work increase the market utilization of human capital while decreasing its nonmarket utilization. In the neutral specification (" = 1) where human capital is utilized in both sectors proportionately, the overall utilization of human capital is unaffected by future work, thus s and l_2 are independent. This independence property makes the neutral special case much easier to analyze than the general case. Thus it is a somewhat common simple alternative to wealth-maximizing specification.

2.3 The Effect of Education on Subsequent Work

At first glance it might seem that the effect of education on subsequent labor supply is ambiguous. Investment in human capital increases the wage rate, and increases in the wage rate produce opposing income and substitution effects on hours of work. The higher wage rate, however, is only part of the story of how investment in education affects later labor supply.

To illustrate the way that education affects hours of work, s is treated as an exogenous parameter in this section. The analysis in this section is simplified considerably by imposing the simplifying assumptions that human capital does not affect the productivity of leisure (i.e., the typical specification where " = 0), and that utility is separable in its four arguments (i.e., u_{ij} = 0 œ i … j).

The labor supply response to education, dl_2/ds, is derived by totally differentiating the first-order conditions of the individual's optimization problem with s treated as exogenous. Totally differentiating (7.1) - (7.2) and (7.4) - (7.6), applying Cramer's Rule, and simplifying yields

$$(10) \qquad \frac{dl_2}{ds} = \frac{8FNs^{F-1}wU_{cc}[(1+D+(1+r)^2)U_{RR} + (1+r)^2w^2U_{cc}]}{(1+D)*J*} + \frac{Hw^2U_{cc}^2U_{RR}[FNs^{F-1}l_2 - (1+r)]}{(1+D)*J*},$$

where *J* is the determinant of the bordered Hessian matrix associated with the maximization problem. If s is at its optimal value, then the second expression in (10) is zero (see FOC (7.3) and (7.4)). The second-order condition requires that *J* > 0, thus $dl_2/ds > 0$.

The labor-supply responses to the wage rate and income (i.e., dl_2/dw and dl_2/de) can be derived in an analogous manner. Comparing the terms in these equations to the terms in equation (10) reveals that s affects l_2 in four ways. In fact, equation (10) can be rewritten as

$$(11) \qquad \frac{\%dl_2}{\%ds} = 0^*F + \frac{8FHw^3(1+r)^2U_{cc}^2}{(1+D)l_2*J*} + \frac{0^I(FHl_2 - (1+r)s)}{e}$$

where $O^* > 0$ is the compensated static wage elasticity of labor supply, and $O^I < 0$ is the income elasticity of labor supply. The four terms in (11) correspond to the four terms in (10).

Equation (11) reveals that the way education affects labor supply is not simply that it causes opposing income and substitution effects from a higher wage rate. The higher wage rate in the second period does cause the usual static substitution and income effects (these are the first and third terms). Education also causes two additional effects. First, schooling reduces earnings in the first period. Thus there is a negative income effect in the first period (this is the fourth term). When s is optimally chosen the two income effects exactly offset each other (because the marginal return equals the marginal cost). Second, the higher wage in the second period relative to the first period also induces an intertemporal substitution effect toward more work in the second period (this is the second term).[17] Thus, equation (11) shows that when s is at its optimal level, s induces two unambiguous substitution effects on l_2 (assuming, of course, that human capital affects the productivity of leisure less than it affects the productivity of work).

3 Evidence

The previous section demonstrated that education and work decisions are (weakly) mutually reinforcing. It is unclear, however,

[17]This can be shown by comparing dl_2/ds to dl_2/dT^*, where $dT^* / d(w_2/w_1)|_{dU=ds=0}$. In fact, dl_2/ds and dl_2/dT^* are very similar. They both induce static substitution effects, offsetting static income effects, and an intertemporal substitution effect. In other words, the effect of education on work is conceptually similar to an intertemporal substitution of life-cycle labor supply (note that this is intertemporal substitution is over, say, 25 year periods and not annual periods as emphasized in the real business cycle literature).

if this result and its potential implications discussed in the Introduction are economically important. Thus, the economic importance of this theoretical result is investigated below.

3.1 The Data

We use three large micro datasets: the 1991 merged outgoing rotation group file of the U.S. Current Population Survey, CPS (1991 was the last year that education was measured as years of schooling as opposed to a credential-based measure); the pooled 1994-98 British Family Resources Survey, FRS;[18] and the pooled 1989-95 International Social Survey Programme, ISSP. The ISSP is a continuing annual set of cross-national surveys covering various social research topics. It contains comparable data from 33 countries (27 of these have complete labor-market data) over the period 1985 through 1995, although many of the countries participated only in a few of the later years. Data from the years prior to 1989 were not used because they lacked complete information on labor force participation.

All samples are restricted to those aged 25 to 64 inclusive, not in school, not self-employed, with less than 21 years of education, and without missing information on education or labor force status. Table 1 gives the most relevant summary statistics for the three datasets. Tables 2 and 3 give the summary statistics for the individual countries in the ISSP.

To illustrate the basic education-work correlations, the three

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[18]The FRS is a large continuous survey of British households administered by the (U.K.) Department of Social Security and is designed for tax and social security analysis. It contains high-quality data on all sources of income. See Department of Social Security (1997).

datasets are collapsed by the level of education. Figures 1 and 2 show the raw correlation between (unconditional) weekly hours of work and education for men and women. Figures 3 and 4 illustrate the raw relationship between schooling and weekly hours of work conditional on being employed. And Figures 5 and 6 show the raw correlation between working rates and years of schooling for men and women. These figures reveal a positive raw correlation between education and labor supply. That is, the idea that education and work are mutually reinforcing is found in the unconditioned data. This idea is now formally tested on the micro data.

3.2 The Correlation Between Education and Work

Hours of work are truncated at zero, thus OLS residuals are non-normal and the coefficient estimates can be biased and inconsistent. Thus a tobit procedure is used.[19] Tobit estimates of the correlation between education and weekly hours of work are reported at the left of Table 4.[20] The results confirm the theoretical prediction and the impression shown in Figures 1 and 2. They reveal a precisely-estimated positive correlation between education and work. The largest correlations in the three datasets are found in the U.S. CPS. For men (women), each year of education is associated with an additional 1.35 (2.36) hours of work per week. The smallest correlations occur in the G.B. FRS, where each year of

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[19]We would have preferred to use a Heckman two-stage approach, but we have been unable to find exogenous variables in our datasets to separately identify the selection equation.

[20]In all the regressions in Table 4 there are unreported controls for a fourth-order age polynomial and for: race and interview month in the CPS, each of the 51 interview months in the FRS, and each year in each country in the ISSP.

education is associated with an additional 0.87 (2.09) hours of work per week. The correlations in the pooled ISSP are closer to that in Britain. In addition to being highly statistically significant, these correlations are economically huge. These coefficients are between 2.6% to 3.8% of the sample means for men, and between 10% to 11.9% of the sample means for women. That is, one additional year of education is associated with about 3% (11%) more work for men (women).

Tobit estimates of the correlation between education and weekly hours of work for the separate countries in the ISSP are reported in Table 5.[21] Although there is a fair amount of variation in the coefficients across the countries, they show the same general pattern. The estimated coefficient on education is positive and statistically significant at the 99% level in 23 of the 27 countries for men, and in 25 countries for women. Japan is the only country which does not display a statistically-significant positive correlation for either men or women. This table reveals that positive correlation between education and work emerges despite wide variation in the degree of economic development, culture, labor market policies, etc.

It must be emphasized, however, that the estimated coefficient of schooling on work should not be interpreted as a causal effect. The level of education is predetermined when work decisions are observed (except for perhaps an extremely small proportion of observations). But, as stressed earlier, the level of education is not exogenous in a full life-cycle perspective. Observed levels of

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[21]There are unreported controls for a fourth-order age polynomial and for each year.

work are likely to be very closely correlated with anticipated levels of work, and anticipated work should affect the chosen level of education. Thus the coefficient should be interpreted as estimate of the equilibrium relationship, and not the causal effect.[22]

3.3 The Intensive Margin

Table 4 also reports OLS estimates of the correlation between conditional weekly hours of work and education. Not surprisingly, the correlation is much smaller. In other words, as stressed in Heckman's (1993) survey of empirical labor research, most of the action occurs on the extensive rather than the intensive margin. Conditional on being employed, each year of education is associated with an additional 0.32 (0.39) hours of work for men (women) in the CPS. The corresponding numbers in the pooled ISSP are smaller, 0.012 (0.19). Paradoxically, the corresponding numbers in the FRS are both much smaller and much larger. For British men, the relationship is reversed; there is a large and statistically-significant negative correlation between education and conditional hours.[23] But for

[22]We also have run seemingly-unrelated regressions of education and work. These regressions perform well and show a very strong positive correlation between their residuals (indicating that schooling and work affect each other). These results do not add any additional insight, however, and are not reported. To isolate the causal effect of education would require a two-stage instrumental-variable approach, but it is difficult to conceive of valid instruments in this context.

[23]A negative correlation on the conditional-hours margin is not necessarily inconsistent with the theory and the other empirical correlations. It is possible, perhaps even likely, that those which are subject to higher unemployment risk and/or more likely to retire early (i.e., those with less education) will work longer hours when employed. In other words, intertemporal substitution is likely to reduce the correlation on the condition hours margin, possibly enough to make it negative. On intertemporal substitution of work, see, for example, Altonji (1986), Ham (1986), and Card (1994).

British women, there is an even larger positive correlation between education and conditional hours.

OLS estimates of the correlation between education and conditional weekly hours of work for the separate countries in the ISSP are given in Table 6.[24] Again, the results for the individual countries are consistent with those found in the large datasets. The conditional correlations between work hours and schooling are much weaker than the unconditional correlations. In fact, in many cases [11 (7) of the 27 for men (women)] there is a negative correlation in the conditional-hours dimension. There is a positive and statically-significant correlation in only 9 (10) of the 27 countries for men (women). There are also a few statistically-significant negative correlations (4 for men, and 3 for women). Overall, however, there is more evidence for a positive correlation. There are negative correlations for both men and women in only 3 countries (compared to 12 countries that have positive correlations for both men and women). Table 6 also confirms that Britain is indeed unusual in this dimension. Both the largest negative coefficient for men and largest positive coefficient for women occur in Britain.

3.4 The Extensive Margin

Probit estimates of the correlation between employment and education are also presented in Table 4. There is an economically-huge correlation between employment and education. For American men, one additional year of education is associated with a 2.0 percentage point higher probability of being employed. For British men, the

[24]There are unreported controls for a fourth-order age polynomial and for each year.

corresponding number is 2.6 percentage points. And in the pooled ISSP, the figure is 1.6 percentage points. For women, one additional year of education is associated with a higher probability of employment of 3.7 percentage points in the CPS, 3.4 percentage points in the FRS, and 3.8 percentage points in the pooled ISSP.

Probit estimates for the individual countries in the ISSP are reported in Table 7. They reveal a similar picture. For men (women), there is a significant positive correlation between employment and education in 24 (26) of the 27 countries. Moreover, for men (women), an extra year of education is associated with at least a one percentage point higher probability of employment in 20 (26) countries.

The last two columns in Table 4 report the correlations between unemployment and education and between not-in-the-labor-force and education. These cases show that most of the correlation between employment and schooling comes from the correlation between labor-force participation and schooling, especially for women.

As shown in numerous previous studies,[25] there is a statistically-significant negative correlation between unemployment and education. For men, an extra year of education is associated with about a half percentage point reduction in the probability of unemployment in the CPS and pooled ISSP, and a one percentage point reduction in the FRS. For women, each year of education associated with about a quarter percentage point reduction in the probability of unemployment in all three datasets.

[25]See, e.g., Mincer (1974, 1993), Ashenfelter and Ham (1979), Nickell (1979), Becker (1993), Nickell and Bell (1996), and Phelps and Zoega (1997).

There is much more variation in the unemployment-schooling coefficient in the separate ISSP country probits shown in Table 8. But the general pattern is consistent with that found in the large datasets. In particular, the coefficient is negative in 24 of the 27 countries for men (and significant in 19), and in 22 countries for women (and significant in 13 of these). The Philippines is the only country where the correlation is positive for both men and women. Table 8 also confirms that in unemployment dimension, unlike in all the other dimensions, the correlations are generally stronger for men than women. The men have a larger negative correlation in 21 of the 27 countries.

The strongest correlation between education and work occurs in the not-in-the-labor-force dimension, particularly, and not surprisingly, for women. Each year of schooling is associated with a 1.2, 1.5, and 0.8 percentage point reduction in the probability of being out of the labor force in the CPS, FRS, and pooled ISSP, respectively. For women, the negative correlations are between 3.1 and 3.4 percentage points per year of schooling.

Table 9 reports the correlations between not-in-the-labor-force and education for the separate countries in the ISSP. For men, there is a negative correlation in every country (and statistically significant in 18 of the 27 countries). For women, the correlation is negative in 26 of the 27 countries (and significant in 23 of those). The negative correlation is larger for women than men in 25 countries.

3.5 Some Sensitivity Analysis

Some brief sensitivity analysis is presented in Table 10.

Three additional probits are reported to demonstrate that the positive link between education and work also operates on the retirement dimension. The not-in-the-labor-force probits reported previously included those classified as retired. Part of the reason for counting retired as not-in-the-labor-force is dictated by the data. The FRS does not have a separate retired category. The CPS measure of retired is not consistent with the measures that we use for weekly hours and not-in-the-labor-force. There are also some anomalies in the ISSP measure of retired. But more importantly, the classification of retirement is arbitrary.[26] For instance, most older women not in the labor force are not counted as retired obviously because they have not worked recently.

The top row of Table 10 reports the probits of retirement on schooling. The coefficient estimates are negative and significant for men, negative and insignificant for women in the ISSP, but positive and significant for women in the CPS. As mentioned above, however, we do have much faith in the retirement measures, especially for women. Thus, in the second row of Table 10 we report not-in-the-labor-force probits for those aged 50 and above. Presumably this removes the arbitrary retirement distinction. For comparison purposes not-in-the-labor-force probits for those under the age of 50 are presented in the third row. These probits show that the correlation between schooling and labor force participation is higher for men above the age of 50, confirming that the positive link between education and work occurs through early retirement as well as the other dimensions. For women, however, the correlation is

[26]See, e.g., Gustman and Steinmeier (2000).

somewhat weaker for those over 50 in the FRS and pooled ISSP, and essentially the same for those in the CPS. This obviously suggests that women's education has a large effect on labor force participation through child rearing.

Table 10 also presents two different OLS estimates of the correlation between education and conditional weekly hours of work. The fourth row reports the correlation which is corrected for potential censoring at the lower end of the hours distribution. For men, the results are identical to those in Table 4 (where there is no adjustment for possible censoring). For women, the results, although not identical, are essentially unchanged.

The fifth row of Table 10 reports the correlation between education and conditional hours of work when controlling for variation in the (log) hourly wage rate which is not explained by education or age. That is, this regression includes the residuals from a (log) wage equation on schooling and other controls. Although the (unreported) coefficient on unexplained variation in the (log) wage rate is highly significant, including this variable has no appreciable impact on the coefficient on education.

In summary, the correlations reported in Tables 4 - 10 provide overwhelming evidence that is consistent with the theoretical proposition that education and work decisions are strongly mutually reinforcing.

4 Conclusion

The presumption that education and work decisions are independent, ceteris paribus, is important: in the labor supply literature it facilitates an important exclusion restriction that education affects labor supply only via its effect on wages; in the literature on the return to education it allows unbiased estimates to be obtained from selected samples; and it substantially reduces the extent to which income taxation discourages human capital accumulation, and hence the extent to which taxation retards transitional and/or endogenous growth.

This paper used a very simple, but compelling, model (i.e., the conclusion is not due to the simplicity of the model) to demonstrate that education and work decisions are likely to be mutually dependent. That is, optimizing behavior implies that individuals are likely to have positive correlations between investment in human capital and work. Moreover, simple statistical modelling across extensive micro datasets strongly supports the theory, and indicates that it is an empirically important phenomenon. To illustrate the order of magnitude involved, the male correlation in the U.S. suggests that a college degree relative to a high-school diploma has roughly the same correlation with hours of work as being male relative to female.

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Table 1
Descriptive Statistics

	N	s	l|l>0	P[l>0]	U	NILF
			Men			
US CPS	91106	13.12	42.56	0.821	0.057	0.122
GB FRS	46864	11.74	43.18	0.745	0.081	0.173
ISSP	35947	11.74	43.36	0.791	0.065	0.144
			Women			
US CPS	109398	12.95	36.77	0.644	0.038	0.318
GB FRS	58424	11.59	29.75	0.593	0.042	0.365
ISSP	45444	11.44	35.50	0.555	0.043	0.402

N is the number of observations, s is mean years of education, l|l>0 is mean weekly hours of those working, P[l>0] is the proportion working, U is the proportion unemployed, and NILF is the proportion not in the labor force.

Table 2
ISSP Descriptive Statistics - Men

Country	N	s	l|l>0	P[l>0]	U	NILF
Russia	2948	12.66	42.91	0.840	0.034	0.127
Netherlands	2864	12.44	39.44	0.740	0.054	0.206
United States	2770	13.51	45.80	0.860	0.058	0.082
Norway	2905	12.30	41.47	0.880	0.037	0.083
West Germany	2748	10.39	42.03	0.818	0.036	0.146
Great Britain	2241	11.33	44.27	0.791	0.083	0.126
Poland	2120	10.59	45.58	0.634	0.111	0.255
Australia	1916	11.48	42.91	0.903	0.021	0.076
Italy	1521	11.65	39.53	0.811	0.024	0.166
East Germany	1632	10.57	44.07	0.702	0.118	0.180
Austria	1436	10.65	43.15	0.724	0.056	0.220
New Zealand	1162	12.37	44.41	0.836	0.051	0.113
Israel	1018	12.58	47.77	0.854	0.055	0.091
Northern Ireland	914	11.31	42.10	0.694	0.179	0.127
Philippines	865	10.15	48.17	0.756	0.101	0.143
Japan	901	12.82	48.63	0.925	0.018	0.058
Slovenia	868	10.89	43.36	0.711	0.085	0.204
Czech Republic	865	13.03	46.77	0.858	0.020	0.123
Hungary	637	10.76	44.06	0.592	0.122	0.286
Sweden	661	11.64	40.77	0.920	0.038	0.042
Bulgaria	628	10.92	40.83	0.639	0.154	0.207
Spain	531	9.62	39.99	0.644	0.160	0.196
Ireland	461	11.11	42.40	0.705	0.184	0.111
Czechoslovakia	375	12.53	47.82	0.813	0.037	0.149
Slovak Republic	376	12.44	45.58	0.816	0.064	0.120
Canada	330	14.52	41.24	0.767	0.070	0.164
Latvia	254	11.91	42.83	0.594	0.193	0.213

N is the number of observations, s is mean years of education, l|l>0 is mean weekly hours of those working, P[l>0] is the proportion working, U is the proportion unemployed, and NILF is the proportion not in the labor force.

Table 3
ISSP Descriptive Statistics - Women

Country	N	s	l|l>0	P[l>0]	U	NILF
Russia	3974	12.34	39.35	0.683	0.018	0.299
Netherlands	3885	11.64	24.06	0.407	0.024	0.569
United States	3864	13.24	38.80	0.687	0.019	0.294
Norway	3123	11.78	32.02	0.776	0.024	0.200
West Germany	3037	10.09	32.77	0.462	0.028	0.511
Great Britain	3194	11.31	31.83	0.539	0.049	0.411
Poland	2638	10.69	39.94	0.483	0.090	0.427
Australia	1874	11.28	29.93	0.640	0.016	0.344
Italy	1981	10.66	34.07	0.379	0.033	0.588
East Germany	1734	10.20	39.09	0.596	0.162	0.242
Austria	1925	10.16	34.49	0.425	0.028	0.548
New Zealand	1575	12.27	35.44	0.580	0.035	0.385
Israel	1565	12.58	34.40	0.637	0.062	0.301
Northern Ireland	1308	11.32	32.41	0.441	0.057	0.502
Philippines	1233	9.59	42.09	0.225	0.028	0.747
Japan	1177	12.00	38.79	0.515	0.008	0.477
Slovenia	1077	10.32	40.79	0.613	0.062	0.325
Czech Republic	921	12.56	41.98	0.742	0.027	0.231
Hungary	836	10.21	40.19	0.482	0.081	0.437
Sweden	779	11.71	34.67	0.888	0.036	0.076
Bulgaria	760	10.92	40.18	0.525	0.133	0.342
Spain	670	9.17	35.25	0.237	0.052	0.710
Ireland	658	11.44	35.67	0.372	0.023	0.605
Czechoslovakia	410	12.05	43.26	0.685	0.041	0.273
Slovak Republic	391	12.17	42.32	0.706	0.056	0.238
Canada	434	14.74	35.93	0.664	0.030	0.306
Latvia	421	12.26	38.75	0.451	0.114	0.435

N is the number of observations, s is mean years of education, l|l>0 is mean weekly hours of those working, P[l>0] is the proportion working, U is the proportion unemployed, and NILF is the proportion not in the labor force.

Table 4
The Correlation between Weekly
Hours of Work and Education

	Tobit	OLS (l|l>0)	Probit (l>0)	Probit (U)	Probit (NILF)
			Men		
US CPS	1.345 (0.023)	0.323 (0.011)	0.0195 (0.0004)	-0.0054 (0.0002)	-0.0124 (0.0003)
UK FRS	0.866 (0.049)	-0.441 (0.022)	0.0259 (0.0009)	-0.0098 (0.0006)	-0.0149 (0.0007)
ISSP	0.884 (0.038)	0.115 (0.019)	0.0163 (0.0007)	-0.0055 (0.0004)	-0.0078 (0.0005)
			Women		
US CPS	2.359 (0.032)	0.385 (0.011)	0.0371 (0.0006)	-0.0025 (0.0002)	-0.0339 (0.0005)
UK FRS	2.093 (0.051)	0.756 (0.029)	0.0338 (0.0010)	-0.0025 (0.0004)	-0.0314 (0.0010)
ISSP	2.142 (0.052)	0.194 (0.024)	0.0382 (0.0009)	-0.0023 (0.0003)	-0.0351 (0.0009)

Standard errors are in parentheses. All of the above coefficient estimates are significant at the 99% level. The probit results are reported as the change in the probability per year of education.

Table 5
ISSP Country Tobits

Country	Men	Women
Russia	0.550^{**} (0.107)	0.537^{**} (0.122)
Netherlands	0.604^{**} (0.112)	2.362^{**} (0.157)
United States	1.462^{**} (0.135)	2.621^{**} (0.173)
Norway	1.205^{**} (0.109)	2.335^{**} (0.125)
West Germany	0.579^{**} (0.112)	1.105^{**} (0.255)
Great Britain	1.486^{**} (0.339)	3.177^{**} (0.392)
Poland	2.304^{**} (0.264)	3.569^{**} (0.278)
Australia	0.567^{**} (0.130)	1.271^{**} (0.230)
Italy	0.160 (0.114)	2.289^{**} (0.243)
East Germany	1.501^{**} (0.207)	1.562^{**} (0.277)
Austria	0.845^{**} (0.216)	2.595^{**} (0.408)
New Zealand	0.933^{**} (0.194)	1.723^{**} (0.281)
Israel	0.549^{*} (0.227)	2.648^{**} (0.251)
Northern Ireland	4.455^{**} (0.650)	6.531^{**} (0.761)
Philippines	-0.290 (0.288)	6.077^{**} (0.659)
Japan	0.242 (0.198)	-1.489^{*} (0.635)
Slovenia	1.115^{**} (0.263)	1.991^{**} (0.266)
Czech Republic	1.271^{**} (0.220)	1.293^{**} (0.284)
Hungary	2.775^{**} (0.473)	3.530^{**} (0.427)
Sweden	0.536^{**} (0.146)	0.819^{**} (0.167)
Bulgaria	2.161^{**} (0.337)	2.359^{**} (0.367)
Spain	0.800^{**} (0.275)	4.096^{**} (0.613)
Ireland	2.352^{**} (0.457)	5.196^{**} (0.668)
Czechoslovakia	1.578^{**} (0.424)	0.726 (0.459)
Slovak Republic	1.087^{**} (0.414)	1.151^{**} (0.442)
Canada	1.241^{**} (0.358)	2.046^{**} (0.396)
Latvia	2.251^{**} (0.650)	2.282^{**} (0.625)

Standard errors are in parentheses. ** and * denote significance at 99% and 95%.

Table 6
ISSP Country OLS (l|l>0)

Country	Men		Women	
Russia	-0.032	(0.061)	-0.139**	(0.052)
Netherlands	-0.101*	(0.050)	0.758**	(0.090)
United States	0.276**	(0.087)	0.344**	(0.092)
Norway	0.411**	(0.059)	0.921**	(0.077)
West Germany	0.321**	(0.050)	0.119	(0.100)
Great Britain	-0.415**	(0.161)	1.240**	(0.183)
Poland	-0.232*	(0.112)	-0.824**	(0.100)
Australia	0.226*	(0.090)	0.131	(0.144)
Italy	-0.218**	(0.057)	-0.488**	(0.082)
East Germany	0.444**	(0.073)	0.309**	(0.091)
Austria	-0.089	(0.102)	0.413*	(0.165)
New Zealand	0.183	(0.107)	0.615**	(0.144)
Israel	-0.059	(0.130)	-0.187	(0.136)
Northern Ireland	-0.169	(0.241)	1.138**	(0.273)
Philippines	0.050	(0.165)	0.100	(0.238)
Japan	0.075	(0.124)	0.024	(0.248)
Slovenia	0.413**	(0.142)	-0.329**	(0.111)
Czech Republic	0.515**	(0.138)	0.125	(0.147)
Hungary	-0.153	(0.191)	0.023	(0.141)
Sweden	0.372**	(0.069)	0.442**	(0.101)
Bulgaria	0.230	(0.126)	-0.242	(0.130)
Spain	-0.031	(0.091)	0.184	(0.183)
Ireland	-0.025	(0.170)	0.046	(0.231)
Czechoslovakia	0.888**	(0.278)	-0.187	(0.189)
Slovak Republic	0.279	(0.197)	0.146	(0.168)
Canada	0.092	(0.173)	0.154	(0.196)
Latvia	0.432	(0.259)	-0.120	(0.215)

Standard errors are in parentheses. ** and * denote significance at 99% and 95%.

Table 7
ISSP Country Working Probits

Country	Men	Women
Russia	0.0102** (0.0018)	0.0125** (0.0025)
Netherlands	0.0172** (0.0026)	0.0345** (0.0027)
United States	0.0206** (0.0020)	0.0435** (0.0030)
Norway	0.0171** (0.0020)	0.0435** (0.0030)
West Germany	0.0060* (0.0026)	0.0165** (0.0039)
Great Britain	0.0427** (0.0065)	0.0420** (0.0067)
Poland	0.0449** (0.0047)	0.0661** (0.0044)
Australia	0.0057** (0.0017)	0.0257** (0.0044)
Italy	0.0080** (0.0023)	0.0314** (0.0029)
East Germany	0.0256** (0.0044)	0.0288** (0.0060)
Austria	0.0330** (0.0069)	0.0350** (0.0058)
New Zealand	0.0155** (0.0034)	0.0230** (0.0047)
Israel	0.0095** (0.0033)	0.0551** (0.0049)
Northern Ireland	0.0991** (0.0128)	0.0899** (0.0112)
Philippines	-0.0054 (0.0041)	0.0325** (0.0032)
Japan	0.0033 (0.0023)	-0.0194* (0.0081)
Slovenia	0.0169** (0.0057)	0.0597** (0.0072)
Czech Republic	0.0142** (0.0036)	0.0279** (0.0060)
Hungary	0.0517** (0.0086)	0.0632** (0.0078)
Sweden	0.0040 (0.0028)	0.0102** (0.0035)
Bulgaria	0.0387** (0.0066)	0.0474** (0.0071)
Spain	0.0178** (0.0056)	0.0294** (0.0043)
Ireland	0.0426** (0.0079)	0.0596** (0.0076)
Czechoslovakia	0.0190* (0.0077)	0.0194* (0.0090)
Slovak Republic	0.0213* (0.0093)	0.0259* (0.0108)
Canada	0.0224** (0.0065)	0.0363** (0.0071)
Latvia	0.0305** (0.0106)	0.0322** (0.0088)

Standard errors are in parentheses. ** and * denote significance at 99% and 95%. The results are reported as the change in the probability per year of education.

Table 8
ISSP Country Unemployment Probits

Country	Men		Women	
Russia	-0.0024^{**}	(0.0007)	-0.0004	(0.0004)
Netherlands	-0.0029^{*}	(0.0012)	0.0018^{**}	(0.0007)
United States	-0.0101^{**}	(0.0013)	-0.0025^{**}	(0.0007)
Norway	-0.0041^{**}	(0.0012)	-0.0036^{**}	(0.0009)
West Germany	-0.0018	(0.0012)	0.0006	(0.0011)
Great Britain	-0.0228^{**}	(0.0044)	-0.0083^{**}	(0.0027)
Poland	-0.0193^{**}	(0.0026)	-0.0034^{**}	(0.0019)
Australia	-0.0035^{**}	(0.0010)	0.0006	(0.0010)
Italy	-0.0005	(0.0009)	0.0006	(0.0008)
East Germany	-0.0095^{**}	(0.0028)	-0.0172^{**}	(0.0038)
Austria	-0.0060^{*}	(0.0024)	-0.0006	(0.0007)
New Zealand	-0.0071^{**}	(0.0020)	-0.0038^{**}	(0.0012)
Israel	0.0002	(0.0022)	-0.0072^{**}	(0.0018)
Northern Ireland	-0.0798^{**}	(0.0107)	-0.0056	(0.0041)
Philippines	0.0050	(0.0028)	0.0013^{*}	(0.0011)
Japan	-0.0028^{*}	(0.0013)	-0.0019^{*}	(0.0009)
Slovenia	0.0010	(0.0030)	-0.0083^{**}	(0.0024)
Czech Republic	-0.0001	(0.0013)	-0.0025^{**}	(0.0028)
Hungary	-0.0101^{**}	(0.0038)	-0.0004^{**}	(0.0010)
Sweden	-0.0022	(0.0020)	-0.0022	(0.0021)
Bulgaria	-0.0191^{**}	(0.0043)	-0.0158^{**}	(0.0034)
Spain	-0.0084^{*}	(0.0038)	-0.0008	(0.0018)
Ireland	-0.0316^{**}	(0.0065)	-0.0029	(0.0016)
Czechoslovakia	-0.0063^{**}	(0.0046)	-0.0000^{*}	(0.0000)
Slovak Republic	-0.0136^{*}	(0.0052)	-0.0006	(0.0020)
Canada	-0.0047	(0.0033)	-0.0002	(0.0005)
Latvia	-0.0212^{**}	(0.0075)	-0.0009	(0.0015)

Standard errors are in parentheses. ** and * denote significance at 99% and 95%. The results are reported as the change in the probability per year of education.

Table 9
ISSP Country Not-in-the-Labor-Force Probits

Country	Men	Women
Russia	-0.0061^{**} (0.0014)	-0.0114^{**} (0.0024)
Netherlands	-0.0126^{**} (0.0022)	-0.0377^{**} (0.0027)
United States	-0.0079^{**} (0.0013)	-0.0396^{**} (0.0029)
Norway	-0.0115^{**} (0.0015)	-0.0388^{**} (0.0028)
West Germany	-0.0033 (0.0020)	-0.0174^{**} (0.0040)
Great Britain	-0.0151^{**} (0.0044)	-0.0339^{**} (0.0067)
Poland	-0.0220^{**} (0.0037)	-0.0593^{**} (0.0046)
Australia	-0.0011 (0.0009)	-0.0265^{**} (0.0043)
Italy	-0.0065^{**} (0.0019)	-0.0337^{**} (0.0030)
East Germany	-0.0090^{**} (0.0025)	-0.0054 (0.0052)
Austria	-0.0212^{**} (0.0057)	-0.0338^{**} (0.0060)
New Zealand	-0.0061^{*} (0.0024)	-0.0176^{**} (0.0046)
Israel	-0.0074^{**} (0.0023)	-0.0434^{**} (0.0044)
Northern Ireland	-0.0181^{*} (0.0075)	-0.0865^{**} (0.0115)
Philippines	-0.0002 (0.0031)	-0.0358^{**} (0.0034)
Japan	-0.0005 (0.0012)	0.0229^{**} (0.0081)
Slovenia	-0.0161^{**} (0.0039)	-0.0452^{**} (0.0064)
Czech Republic	-0.0003^{**} (0.0014)	-0.0198^{**} (0.0055)
Hungary	-0.0383^{**} (0.0077)	-0.0575^{**} (0.0084)
Sweden	-0.0009 (0.0011)	-0.0068^{**} (0.0025)
Bulgaria	-0.0112^{**} (0.0040)	-0.0240^{**} (0.0068)
Spain	-0.0062 (0.0038)	-0.0317^{**} (0.0048)
Ireland	-0.0070^{*} (0.0036)	-0.0556^{**} (0.0077)
Czechoslovakia	-0.0044 (0.0053)	-0.0103 (0.0084)
Slovak Republic	-0.0040 (0.0058)	-0.0119 (0.0078)
Canada	-0.0152^{**} (0.0047)	-0.0337^{**} (0.0069)
Latvia	-0.0026 (0.0063)	-0.0265^{**} (0.0097)

Standard errors are in parentheses. ** and * denote significance at 99% and 95%. The results are reported as the change in the probability per year of education.

Table 10
Sensitivity Analysis

	Men			Women		
	CPS	FRS	ISSP	CPS	FRS	ISSP
Probit (retired)[†] age ≥ 50	-0.0013* (0.0007)		-0.0104** (0.0014)	0.0027** (0.0004)		-0.0015 (0.0014)
Probit (NILF) age ≥ 50	-0.0228** (0.0009)	-0.0172** (0.0018)	-0.0204** (0.0016)	-0.0342** (0.0011)	-0.0211** (0.0020)	-0.0284** (0.0015)
Probit (NILF) age < 50	-0.0095** (0.0003)	-0.0122** (0.0007)	-0.0039** (0.0004)	-0.0323** (0.0006)	-0.0323** (0.0011)	-0.0323** (0.0010)
Censored OLS	0.323** (0.011)	-0.441** (0.022)	0.115** (0.019)	0.384** (0.015)	0.705** (0.028)	0.184** (0.024)
OLS (l|l>0) (with $\hat{e}$)[††]	0.322** (0.012)	-0.443** (0.021)	0.117** (0.019)	0.398** (0.016)	0.757** (0.029)	0.207** (0.024)

Standard errors are in parentheses. ** denotes significance at the 99% level. The probit results are reported as the change in the probability per year of education. [†]The CPS measure of retired is not consistent with its measures of l and NILF, thus the these should be interpreted cautiously. [††]The OLS regression with $\hat{e}$ includes the residual from a first-stage regression of ln(hourly wage rate) on education, age polynomial, etc.