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EDUCATION, HUMAN CAPITAL, AND GROWTH: A PERSONAL PERSPECTIVE

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ABSTRACT

This paper reviews the literature on the relationship of economic growth to the education levels of the labor force. The emphasis is on Ben-Porath's contribution to some of the issues in this field: the endogeneity of schooling, the role of the public sector as an "absorber" of educated labor, and the importance of personal human capital created by investments in reputation and personal relationships, the F-connection.

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Yoram made a major contribution to the theory of human capital: he formalized the investment-in-education process and described its main determinants (Ben-Porath 1967). In his model an individual produces additions to his own human capital by combining his pre-existing human capital with his own time and other market resources. This process is subject to diminishing returns because cost rise as one attempts to speed up the production process and also, because returns decline eventually as the result of the finiteness of life. If the initial human capital is low, the maximizing individual will specialize first in the production of human capital, i.e., full time schooling. Subsequent to the completion of the full-time, formal schooling phase, part-time investment may continue in the form of on-the-job training. The resulting model of optimal distribution of human capital investments over the life cycle yields the strong implication of logarithmic concavity for age-earnings profiles. This was a seminal contribution, which had important implications for subsequent empirical work.[1]

I will discuss this contribution, however, only from a narrow and rather personal perspective: How it entered into the discussion about the relative importance of education as a source of economic growth, especially as it related to my own work on this subject. He also made a less well appreciated but equally important contribution to the theory of economic and social organization in his work on the F-connection (Ben-Porath 1980). I will speculate briefly, at the end of this paper, on why this contribution has not had as much impact as the first, especially on the empirics of the subject.

I

When the "growth accountants" such as Fabricant, Abramovitz, Kendrick, and Solow found that most of the observed economic growth was not explained by conventional labor and capital measures, they pointed directly at the possibility that the changing quality of the labor force may be an important component of the explanation for the appearance of this "residual".[2] The notion of investment in human capital as a major factor behind wage and income differences has a long history, going back to Adam Smith and before, and will not be reviewed here. The conceptual basis for much of the modern empirical work was laid down in Friedman and Kuznets (1945). The availability of detailed earnings-by-schooling data from the 1940 and 1950 Censuses made possible Mincer's (1958) pathbreaking contribution and related work by Houthakker (1959) and Miller (1960). The emphasis of most of this work, and the later but most influential work by Becker (1962), was primarily on the role of education in explaining aspects of the personal income distribution. It was Schultz (1960) who, I think, first connected this work with the puzzle of the "residual." He made an estimate of the growth in total human capital in the U.S. created by the educational system and considered how much of the growth in output it could account for (about one fifth was his estimate).

A more direct way of adjusting the labor input for quality change due to the changing educational attainment of the labor force is to create a "weighted" measure of labor input, weighting different types (levels of schooling) of labor by their relative wages in the marketplace. This approach fits well with the overall national accounting scheme where different outputs and different investments are weighted in proportion to their prices. The idea is quite obvious. Its first implementation was actually in the context of industry wage differentials by Kendrick (1956),

implying a disequilibrium in the use of labor across industries and a gain in productivity from shifts in employment from low wage to higher wage industries. But this type of adjustment is more relevant for characteristics of individuals rather than the characteristics of their jobs. Working independently, both I (Griliches 1960) and Denison (1962) produced estimates of quality change in labor input, using data on the changing distribution of the workforce by educational attainment and mean income by education as weights. My work on such labor quality indexes was extended to manufacturing in Griliches (1963) and to the economy as a whole in Jorgenson and Griliches (1967). It was continued subsequently by Jorgenson and his associates (see especially Chinloy (1980) and Jorgenson and Pachon (1983)). More recent estimates can be found in (BLS 1993) and (Jorgenson, Ho, and Fraumeni 1994). The basic finding, both in Denison and Jorgenson-Griliches was that such educational improvements in the U.S. labor force accounted, at that time, for about one-third of the calculated residual TFP, or about a .5 percent per year contribution to the growth rate of aggregate output. This contribution declined to about .2-.3 percent per year in the more recent decades but so did also measured TFP growth, leaving the fraction accounted for by educational improvements in the labor force at about the same level as before.

A most interesting recent development has been the series of new estimates of human capital produced by Jorgenson and Fraumeni (1992a,b). As distinct from Schultz's original computations, their estimates are based on the present value of the increments in the future income flows produced by the educational system, rather than on its costs. This provides a relevant output measure for the educational sector and opens up the possibility for computing its changing productivity over time. But it also points out the fact, that once incorporated into a wider definition of GDP, one which includes also the investment in human capital, "education" and the improvements in the quality of the labor force will become "inside" inputs and one will not be able to use them in accounting for the

growth in overall factor productivity, except to the extent that the social returns to such investments may exceed the private ones, both because of the possibility of capital rationing constraints, and the indirect externalities produced by education and the associated scientific enterprises.

Two major assumptions underlie such computations: 1. Differences in earnings correspond to differences in contribution (marginal products) to national and sectoral outputs. 2. These differences are in fact due to schooling and not to other factors such as native ability or family background which happen to be correlated with schooling. These assumptions are obviously controversial and were challenged from many directions. Feeling uneasy with "adjustments" for which there was no direct econometric evidence led me to pursue a number of studies whose main purpose was to investigate the validity of such labor quality adjustments.

The main, and possibly, only, approach to testing the productivity of schooling directly is to include it as a separate variable in an estimated production function. If one defines a weighted schooling-based labor quality index and includes it multiplicatively in a Cobb-Douglas production function framework, one has the additional implication that the coefficient of such an index should equal, approximately, the coefficient of labor quantity. This was the rationale behind a series of such studies which I pursued, both in agriculture and manufacturing. The results of these studies, summarized in Griliches (1970), Table 4, supported the productivity interpretation: the schooling index coefficients were both statistically "significant" and of the right order of magnitude. Much of the subsequent work that was done along these lines was done on agricultural data from various developing countries with largely similar results (see Jamison and Lau (1982) for à survey). An example of such work using Israeli data is presented in Table 1, where the inclusion of a quality of labor index, based on the occupational distribution of a firm's labor force, contributes significantly to an explanation of inter-firm differences in productivity (Griliches and Regev, 1995).[3]

This work actually anticipated and responded to a strand of criticism which was to arise later on under the label of "signaling" (Spence, 1974). It provided direct and, to my mind, the best evidence on the productivity of education without using the **a priori** assertion that wage differences are proportional to marginal products. There is also quite a bit of indirect evidence against the empirical importance of "screening" or "signaling" as major determinants of the returns to schooling. If the returns to schooling were largely due to the informational content of the certificate and not to the process of schooling itself, one would expect that (1) cheaper ways of testing would be developed by employers and employees; (2) returns to schooling would be lower or non-existent among farmers and other self-employed, since they cannot collect on a false signal (Wolpin, 1977); and (3), the returns to schooling should decline with age as more experience is accumulated by employers about the true worth of their employees and the initial signal provided by schooling fades away into insignificance. But little of that is observed in the data. (For a more recent analysis of these issues see Kroch and Sjoblom (1994).)

II

The most direct challenge to the original estimates of the contribution of schooling to economic growth was the issue of "ability bias." To what extent did observed income differentials exaggerate the contribution of schooling because of a positive correlation between native ability and the levels of schooling attained by different groups in the population? There were conflicting views on this at that time (early to mid-1960's) and it is still an issue which has not been fully settled. Denison (1964) claimed, on the basis of very little data, that as much as 40 percent of the observed income differentials could be due this "bias." This seemed rather high and I embarked on a search

for data that would throw some light on this topic. Starting with Griliches (1970) and Griliches and Mason (1972), a number of papers tried to estimate the magnitude of this bias using large data sets with army test scores (AFQT), IQ type test scores collected from high schools, and data on siblings. The main results of this work are summarized in Griliches (1977) and Griliches (1979). They show that if "ability" is measured (albeit imperfectly) by test scores, the bias from this source is small, on the order of .01 on a .06 or so coefficient, and that it possibly goes in the **opposite** direction! If one treats ability as an unobservable that is related to such test scores and on which family members are positively correlated, then the unobservable that fits these requirements works primarily via schooling and has little or no direct effect on earnings while the unobservable that is connected to the family component of earnings appears to have little to do with test scores. In either case, the original estimates of the contribution of schooling were largely upheld. If anything, recent work has raised rather than lowered these estimates.[4]

It is here that I connected first directly with Yoram's contribution (Ben-Porath, 1967). One can think of the whole "ability bias" problem as just another example of the "simultaneity problem" in economics: Schooling is not strictly exogenous. It may be related to the same unmeasured components of human capital that also enter into the disturbance in the individual's earnings equation, either because these components are rewarded in the market directly, above and beyond their effect on schooling attainment, or because they represent unmeasured variables in the future earnings equation forecasted by the individual but unobserved by the econometrician. To analyze this effectively one needs not only decent estimates of the earning equation but also a relevant model of the schooling decision itself which would provide the "other" equation for this system, and indicate how other determinants of schooling might be used as instrumental variables to get a consistent estimate of its coefficient. By setting up the investment-in-schooling problem for the

individual in a rigorous fashion, Yoram provided a framework for discussing this problem and deriving its implications. It did not have, however, a closed form solution. Using Sherwin Rosen's (Rosen, 1973) extension of the Ben-Porath model, I showed (Griliches, 1977) that if one accepts Yoram's assumption of "neutrality," that human capital is equally productive in learning and in the market, this implies that the ability bias is negative! Given that human capital accumulation is costly, those who start out with a larger initial pre-school endowment of it, which is one simple definition of "ability," will actually invest less than those with a smaller initial endowment. To get a positive bias one has to abandon the neutrality assumption and allow for the possibility that this type of initial human capital is more productive if invested in learning than if it is taken directly to the market. That would produce a positive correlation between ability and schooling, but leave little room for a bias in the earnings equation because of the low direct value of such capital in the market.

Recent work on this topic, using better twin samples (Ashenfelter and Krueger, 1992) and better instrumental variables for schooling (Angrist and Krueger 1991 and Card 1995), has reached similar conclusions. If anything, the schooling coefficient is underestimated within the standard OLS earnings equation framework. The current attempt by Herrnstein and Murray (1994) to resurrect the importance of "ability" (IQ) in *The Bell Curve* is largely besides the point, since it never considers the role of education explicitly, especially the component of education that is not correlated with the available test scores.[5] There is some evidence that the role of measured IQ may have increased somewhat in recent samples, but that may be largely a reflection of the same forces that have raised the returns to higher schooling in general, which is my next topic.

III

The surprise of recent years has been the widening of educational wage differentials (see Murphy and Welch (1992) and many others). The increasing number of educated workers in the labor force should have driven down these differentials as the earlier discussion of the "overeducated American" might have predicted (Freeman, 1976). But it did not, despite continued worries about the declining quality of American labor. A number of only partially convincing explanations have been offered for this increase in the educational premium. The ones I want to mention are "capital-skill complementarity" (Griliches, 1969 and 1970), for which the evidence is rather weak (Berman, Bound, and Griliches, 1994), and the technology-skill interaction. The latter hypothesis, enunciated first by Nelson (1964), Nelson and Phelps (1966), and Welch (1970) asserts that education becomes more valuable in periods of rapid technological change; that it takes more education to cope with the ensuing upheavals and to figure out what is the right thing to do. The actual empirical work on this topic is not all that convincing, primarily because it is so difficult to get an independent and relevant measure of technological change (see, e.g., Huffman (1974), Mincer (1993), Bartel and Lichtenberg (1987), Berman, Bound, and Griliches (1994), and Allen (1994)). Nevertheless, for lack of a more decisive explanation, the recent literature has attributed this phenomenon to the rising price of "skill" as the result of a technology induced rising demand for it (see, e.g., Katz and Murphy (1992), Juhn, Murphy, and Pierce (1993), and Card and Lemieux (1995)).[6]

Whether the weights used in the construction of the labor quality index are just right or a little too high or a little too low does not make much difference, however, in assessing the direct contribution of schooling to growth. Changing the weight structure a little has usually only second order effects in index number construction. The major facts are relatively clear, at least in the U.S.

The changing education of the labor force during the last fifty years has accounted for a significant proportion of overall productivity growth, perhaps as much as a third of it. But it has not accounted for most of it, nor can it explain why productivity growth declined in the last two decades. The rate of improvement in the average schooling of the labor force did not slow down significantly in the U.S. in recent decades, or in most of the other countries. Nor is it likely that the quality of schooling declined sharply enough, due to increased TV watching, declining homework, and the decline in average ability due to the expansion of schooling in the last two decades, to account for the rather sharp productivity declines that happened in the 1970's and 1980's in the U.S., Israel, and most everyplace else. Moreover, as noted above, the private returns to schooling increased during this period!

It is also the case that, as conventionally measured, the growth in average education per worker is bounded, both mechanically, by the finiteness of our measures of schooling, and more substantively, by the finiteness of human life.[7] Thus, investment in education cannot be a source of indefinite growth in real income per capita unless one considers also the externalities produced by it, in direct knowledge accumulation via investments in science and R&D and indirect effects via learning by doing and other knowledge spillovers. That is were the "new growth theories" come in.[8]

IV

Recently a new style of econometric research has become popular with the public release of the Summers and Heston (1991) data on the growth experience of many countries. A robust finding of that literature is the positive contribution to growth of the initial average level of schooling, measured by literacy rates or primary and secondary school enrollment rates (Barro (1991), Barro

and Lee (1994), and Mankiw, Romer, and Weil (1992)). But what was rather jarring is the repeated finding, in these international data, that changes in the estimated levels of schooling or human capital do not contribute positively to growth, at least as measured over the 1965-1985 period (see Benhabib and Spiegel (1991), Jovanovic, Lach, and Lavy (1993), and Kyriacou (1991)). The explanations for this in the literature, besides pointing to poor quality of the data, are not very convincing. They tend to focus on the embodiment of human capital externalities in new physical capital or in subsequent advances in knowledge and organization (Lucas, 1993). But the estimated role of physical capital is not that large in these studies either. I would like to suggest another possible answer to this puzzle, which is already implied in some of the earlier work by Yoram and Ruth Klinov (Ben-Porath, 1986; Klinov, 1986): Much, if not most of the growth in human capital was absorbed in the public sectors of many of these economies. This is definitely true of Israel, where more than 80 percent of highly educated labor is employed in the public sector, in services, and in other "unmeasurable" (as far as output is concerned) sectors such as construction (see Table 2). The story in the U.S. is similar though the magnitudes are smaller (see Murphy and Welch (1993), Table 3.5): 65 percent of the 17 percent increase in the employment of workers with college education were absorbed in such "unmeasurable" sectors. The role of the public sector was, however, much smaller in the U.S.; it took only 13 percent of this increase. But in many of the LDC's, which make up the majority of the Summers and Heston data, the role of the public sector in absorbing highly educated workers is likely to be more similar to what it was in Israel, if not more so. This does not necessarily mean that such workers are unproductive in these sectors, they may indeed contribute a lot to the efficient functioning of the economy. But their contribution to productivity, to growth in per capita real output is not reflected in such data, because we have no good measures of real output in these sectors in the national income and product accounts of the various countries. At

best, only their externalities could show up in the data, and that is unlikely, given that the estimated first order effect of the size of the government sector on per capita income growth is negative! One does not have to be a Marxist to worry whether in emphasizing the importance of education for economic growth we may be somewhat self-serving, especially if we do not worry about the fact that much of the highly educated labor winds up working for governments or various international agencies and its subsequent contribution to economic growth may be problematic, at best. Thus, it is not surprising that human capital change variables do not show up strongly in cross country productivity growth regressions.

V

In the F-connection paper (Ben-Porath 1980), Yoram emphasized the importance of another kind of human capital, the specific human capital invested in institutions such as families, friends, and firms, and in the creation of our own identities and reputations. The building blocks of his model were the importance of transaction costs in an uncertain world, the non-anonymity of most of the transactions in the market and outside of it, especially within families and firms, and hence also the opportunity provided by such settings to invest in reputation and identity building as one possible way of reducing such costs. Since "reputation" becomes a quasi-public-good capital, subject to increasing returns, it fosters the creation of various identified groups, such as families, tribes, and firms, which internalize, *in part*, the cost of creating such capital and provide the larger economic framework for its utilization. Yoram emphasized the pervasiveness of such capital and its importance to the functioning of the economy and society. He was excited by the vistas his work opened up and was rather hurt by the profession's eventual cool reception of it. In spite of a

favorable referee report, Stigler turned it down for the *Journal of Political Economy* (it was not "sharp" enough for his taste), and it was published obscurely in a new and not widely read demography journal. It is not cited in Parson's survey chapter on labor contracts in the *Handbook of Labor Economics* or in the more recent literature on "social capital" (see Coleman 1990 and Putnam 1993). I think this happened because the paper had only "insights" but no clear or sharp model which could be used directly in subsequent work. But the topic raised by Yoram, what makes for such relationships and how they endure or collapse, is of great importance in our lives and has many interesting economic implications. How do economics departments function in a non-profit environment with no direct relationship between performance, either inside or outside, and remuneration? Why is there esprit de corps in some departments for some of the time? What creates it and how does it collapse, as it often does? What will be the consequence for labor relations, for productivity, of the collapse of such standard setting firms as IBM, Digital, or Eastman Kodak, where workers were socialized into the idea that they are part of the firm and that the firm will take care of them, if they do their bit?

Other aspects of our lives can also be looked through this lens. Urbanization leads to a loss of identity and reduces the private costs of criminal activity. The communication revolution expands the reach of relationships but also dilutes them, both by overload and distance. On the other hand, it also increases the returns from a successful investment in reputation. For younger economists entering the field today, both the costs and returns of reputation building are higher. For society as a whole, such increasing emphasis on visible and less personal signals may actually involve a significant diversion of resources into socially unproductive activities. In the meantime, many of the institutions that Yoram talked about, such as families and firms, are fraying and it is hard to discern what will take their place. Let us hope that the third category, the one that brought us together here,

the individual relationships grouped under the label "friends," will hold up better under the centrifugal forces that keep engulfing us.

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Notes

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1. Tighter mathematical formulations followed quickly, see Oniki (1968) and Sheshinski (1968) and Blinder and Weiss (1976) and the surveys by Willis (1986) and Weiss (1986). Subsequent important empirical work such as Heckman (1976), Heckman and MaCurdy (1980), Mincer (1974) and Rosen (1973) can also be viewed as building on and extending his framework further.

2. See, for example, footnote 6 in Solow (1957).

3. See also Hellerstein and Neumark (1995) for a related use of these same data.

4. See Willis (1986), Bishop (1992), and Card (1995) for later surveys and for some additional evidence on this topic.

5. See Golberger and Manski (1995) for a review.

6. Another explanation is that the quality of the lower educated has declined relatively because of the increasing number of high school completers. But the shift in the relative numbers is too small and the timing is wrong to explain much of this differential. Also, about two thirds of the widening of the differential has come from a rise in the real wage of the college educated, and only a third from the decline in the real wage of the less educated.

7. Even if one extends the concept of "education" to the more inclusive "human capital" and includes on the job training and learning by doing in it, still the rising opportunity cost of time and the fall in remaining time over which such investments have to be amortized would result in the cessation of investment at some point. That was one of Yoram's original insights.

8. See Jovanovic (1995) for a survey of the role of human capital accumulation in the various versions of "new growth theories."

Table 1

Production Function Estimates for Israeli Industrial Firms
1979, 1982, 1985, and 1988

Dependent Variable: Production (Gross) per Person/Year. Coefficients (t-ratios).

	Levels: pooled, full sample (NT = 7742)			Growth Rates: pooled (NT - 5018)	
	Unweighted	Weighted		Unweighted	Weighted
Intermediate inputs	.69	.68		.66	.74
	(157)	(148)		(83)	(95)
Capital services	.06	.06		.05	.02
	(11)	(12)		(4)	(1)
Labor quality	.41	.74		.14	.66
	(7)	(14)		(1)	(6)
R&D services	.03	.04		.04	.03
	(5)	(10)		(2)	(3)
Year 1982	-.02	.01	1979-82	.015	.031
	(-2)	(.1)		(2)	(6)
Year 1985	-.07	-.02	1982-85	.015	.011
	(-7)	(-2)			
Year 1988	-.05	.06	1985-88	.023	.049
	(-5)	(6)			

The regressions contain also, in addition to the intercept, dummy variables for scale, sector, branch, life cycle status, mobility, and R&D status. Adapted from Griliches-Regev (1995), Tables 5 and 7.

Table 2a

The Employment of Scientists, Professionals and Technicians by Sector in Israel, 1970-1990

	(Thousands)			(Percent of total growth)	
	1970	1980	1990	1970-80	1980-90
1. "Measurable" sectors	14.6	37.5	56.7	18	21
2. Public services	109.3	191.1	240.8	63	53
3. Other "unmeasurable" sectors	23.9	49.4	73.8	19	26

Table 2b

The Employment of Highly Educated Workers (with 16+ years of schooling) by Sector in Israel, 1980-1990

1. "Measureable" sectors	29.0	45.5	17
2. Public Services	86.1	131.5	48
3. Other "unmeasurable" sectors	37.1	70.3	35

Source: CBS Labor Force Surveys (1970, 1980, and 1990), Special Series Nos. 376, 690, and 912.

1. "Measurable": Agriculture, Industry, Public Utilities, Transportation, and Communications
2. "Unmeasurable": Construction, Trade, Financial, Business, Personal, and other services