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**Growth With Equity Through
Investment in Human Capital**

Robert M. Solow

The George Seltzer Distinguished Lecture
Industrial Relations Center
University of Minnesota
1992

ROBERT M. SOLOW

Robert M. Solow is Institute Professor at the Massachusetts Institute of Technology, where he has been a professor of economics since 1949. He teaches macroeconomics and other subjects to undergraduate and graduate students. Professor Solow studied at Harvard and received the Nobel Prize in Economics in 1987 for his theory of growth. For a number of years he served as a member of the Board of Directors of the Federal Reserve Bank of Boston and was Chairman of that Board for three years.

Some of the books for which he is most noted include *Capital Theory and the Rate of Return* (1963); *Growth Theory: an Exposition* (1970); *Made in America: Regaining the Productive Edge* (1989, with M. Dertouzos, R. Lester and the MIT Commission on Industrial Productivity); and *The Labor Market as a Social Institution* (1990).

GEORGE SELTZER

George Seltzer earned his B.A. and Ph.D. degrees in economics from the University of Chicago. Prior to his academic career, Professor Seltzer served in the federal government in a variety of posts including: Special Assistant, Office of Defense Mobilization, Executive Office of the President; Executive Director, Economic Stabilization Agency, Special Assistant to the Secretary, Department of Commerce; Economist, Antitrust Division, Department of Justice; and Labor Advisor to the War Production Board.

Professor Seltzer began his service to the University of Minnesota in 1954. In addition to his research and teaching responsibilities with the Industrial Relations Center, he served as the Center's Acting Director and also held posts as Director of the Bureau of Business and Economic Research and Associate Dean for Academic Affairs of the Carlson School of Management.

Professor Seltzer's expertise has been actively sought in the development and implementation of public policy. He was chairman of the Minnesota Public Employment Relations Board for three terms and was its sole public member between 1972-79. He was also Chairman of the Advisory Council to the Minnesota Department of Employment Services for 20 years.

At the end of the 1987-88 academic year, Professor Seltzer became Professor Emeritus of Industrial Relations. He continues his active involvement in the research and teaching program of the Industrial Relations Center consistent with his other broad interests.

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examines public policy incentives for investment in physical and human capital and suggests mechanisms for spurring productivity growth through human capital investment.

Professor Solow's lecture guides us through contemporary thinking on the results of investing in capital and focuses our attention particularly on the consequences of investment in human capital. The lecture adds a macroeconomic dimension to the picture this series has been developing.

Professor Solow's visit involved not only this lecture, but also included meetings and discussions with faculty members and doctoral students. His generosity in visiting with us provided an additional level of enrichment consistent with the goals of the Seltzer lectureship.

The organization and coordination of this lecture continues to be performed by Professors John Fossum and Mahmood Zaidi (chairs); Donna D'Andrea, the Administrative Director of the Industrial Relations Center; and Jonathan Seltzer.

The Annual George Seltzer Distinguished Lecture is made possible by various private contributions and University matching funds on the occasion of the retirement of George Seltzer from the University of Minnesota in 1988 and in support of the continuing enrichment of the curriculum and research of the Industrial Relations Graduate Program with which Dr. Seltzer has been affiliated for some 35 years.

Growth With Equity Through Investment in Human Capital¹

Robert M. Solow²

The George Seltzer Distinguished Lecture
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It is an honor for me to have been invited to give the fifth lecture in this series and thus to follow in the footsteps of such eminent students of labor economics and industrial relations as Orley Ashenfelter, Janet Norwood, Clark Kerr, and the late Albert Rees. I am not a labor economist, let alone an eminent one. The most I can say, in a familiar phrase, is that some of my best friends are labor economists. Probably the main reason I find myself in this role is that I have for a long time opposed the hankering of economic theory after institution-free generalizations, propositions that will be true in every economy worth talking about. It seems to me that this tendency is most dangerous in labor economics, but my doubts cover a wider territory. The consequence of ignoring social institutions in economic theory is not failure but narrow and insignificant success.

The first four lectures in this series kept to a single general theme: "The American Dream: Education and Work." I can not quite make it five in a row, not if the theme is interpreted narrowly. But I have tried to choose a subject that has several points of contact with that broad topic, including those prefatory words about "the American dream." My goal is to

connect up economic growth, which is where my work lies, with the theme of education and work.

We have just been through a presidential election in which the condition of the U.S. economy was a central, continuing issue. Without taking sides, one can safely say that the political debate took that form -- and the election had the result that it did -- because there was and is a widespread and nagging sense of discomfort about the performance of the American economy, a feeling that things are not going well and will not soon get better. That is not uncommon in recessions. The difference this time is a suspicion that the problems are not temporary and superficial, but more deeply embedded than that, especially as regards employment, and therefore more of a challenge to the traditional optimism embodied in that phrase about "the American dream."

There are two distinguishable aspects of this longer-run "malaise" -- to use a word that got President Carter in trouble when he used it in a speech but has since become domesticated through familiarity. The first aspect is what we economists are used to calling, familiarly, the productivity slowdown. For two decades now, real output per hour worked in the U.S. has risen very slowly, at a trend rate that may be less than one percent a year. This is often compared with our experience during the 1950s and 1960s, when hourly labor productivity rose at something like three percent a year in round numbers. A reasonable case can be made that the decades immediately after the War and the Depression were necessarily atypical and unrepeatable, so that the comparison is misleading and unfair. That may well be true. Even after making allowance for the special advantages of the postwar period, one would have to say that the longer-run growth of productivity had been something like two percent a

year for many decades and fell to less than half of that in the 1970s and 1980s. Since the growth of productivity is the only permanent source of a rising standard of living on the national scale, the productivity slowdown implies a standard-of-living slowdown, and that does not fit well with the American self-image. Worries about environmental decay and resource exhaustion, justified or not, add to the prevailing pessimism.

The second source of doubt and discouragement about our economy is the widening inequality in the distribution of income. There has been a good deal of predictably ideological argument about the extent of this tendency. I do not need to review the details because my argument does not depend on them. I do not think it can be doubted that the distribution of annual incomes has become more unequal since the mid-1970s. The lower tail has been getting worse off and the upper tail has been getting better off. That would be compatible with unchanging or even narrowing inequality in the distribution of lifetime incomes -- which is what we really care about -- if the amount of year-to-year mobility between income classes were increasing sufficiently. If we each spent half our lives being poor and half our lives being rich, equality would be maintained even if low incomes got lower and high incomes got higher. But there is no evidence that social mobility has increased in this sense, and it may even have diminished. The sense that income inequality is widening is surely accurate. That finding eats away at a central part of the American ideology that was evident and striking to travelers like Tocqueville and Bryce a century or two ago, and colors a lot of our attitudes today.

I have been speaking in American terms because this is Minnesota and that is my brief. During the election campaign it was pointed out for the

defense that these two tendencies are common to advanced industrial countries and are not specifically American. That is certainly true of the productivity slowdown. It is less easy to know about inequality because comparable data are scarce. My guess is that there is more variety among national economies on this score than on the other. In any case, I am not conducting a post mortem on the election. If inequality is widening elsewhere in the industrial world, that only makes the whole question more interesting.

Within economics, the study of the evolution of productivity, its sources and its speed, is the province of the theory of economic growth and its empirical counterpart. During the past half-dozen years this branch of economic analysis has come back into fashion with a bang. The combination of new ideas, new data and new problems is a sure recipe for intellectual ferment. I have been describing the new problems. For the next part of my argument I turn briefly to the new ideas and the data.

The "old" growth theory -- the growth theory of the 1950s and 1960s, of which I am a surviving witness -- focussed on technological change as the source of permanent growth. It is sometimes said that the old growth theory regarded technological progress as an exogenous force and thus left economic growth, the long-term increase in output per person, unexplained. That account is a little naive. Old growth theorists were quite aware that there was a significant endogenous element in technological progress. It is hardly a difficult thought, after all. Technical innovations come from research and much research is undertaken and its results applied in the hope of profit. This is certainly economic behavior and open to economic analysis.

Quite analogously, old growth theory took the rate of population and labor-force growth to be exogenous, although even I, unlettered as I was, had heard of T.R. Malthus. The explanation was the same in the two cases. We had nothing new or interesting to say about the growth of population or the growth of knowledge. That being so, it seemed reasonable to treat both as exogenous and study economic growth conditional on the path of population and technological knowledge. The end result was the same: it is true to say that the old growth theory left the rate of productivity increase fundamentally unexplained, although there were occasional forays on both the technology and population fronts.

I should also point out, in preparation for what is to come, that the old growth theory used the phrase "technical change" quite consciously as a catch-all for anything that shifted the production function, including improvements in the skills and talents of workers. I mentioned this in passing as early as 1957 and Edward Denison -- who died less than a month ago, alas -- was quite explicit in including these factors in his detailed explorations of the sources of productivity growth.

The "new growth theory" of the past half-dozen years has taken up where the old growth theory left off. The goal was to say more about the ultimate determinants of the economy-wide growth rate. There turned out to be two ways of getting there. The simpler path involves a single very strong assumption: that there are constant returns to capital alone. "Capital" can be interpreted narrowly to include only productive equipment, or broadly to include human capital or even the stock of productive knowledge, or it can account for each of them separately. The indispensable requirement is that there should be constant returns to the bundle of factors of production

that can be accumulated. This has to do with increasing returns to scale only in an indirect and inessential way.

I described this basic assumption as strong, and it is so in several ways. For one thing, it is utterly non-robust. The least touch of diminishing returns to capital will blow the theory away, and the least bit of increasing returns to capital will blow it away in a difference direction. There is no leeway. The second respect in which it is a strong assumption is in its consequences. Old folks in the audience may have realized that this amounts to a reversion to the Domar model of growth, with bells and whistles added. The characteristic result of the Domar model survives: a change in the fraction of output saved and invested changes the permanent rate of growth of aggregate output. Thus any policy move -- any tax or subsidy or regulatory inefficiency -- that can increase or decrease the propensity to invest can increase or decrease the rate of growth and thus affect the fate of the economy in a very big way.

There is a second path toward an endogenous rate of growth. It is more complicated because it involves committing oneself to a theory about the way in which new productive knowledge is generated. Nor will just any old theory do. What is needed is something very ambitious: a theory that determines the rate of technological progress. One way or another the new growth theory has to convince itself that the rate of growth of productive knowledge is roughly proportional to the amount of time or effort devoted to the accumulation of knowledge. This rather resembles the first path I mentioned, and it produces the same powerful result. It does not seem hard to find policies that affect the level of research performed or the amount of time spent in education. If doing so will

move the permanent rate of growth, then the theory truly has a tiger by the tail. Theoretical ingenuity in this field has created a great variety of cats, but they are all a lot like tigers.

Should a reasonable skeptical person believe any of these stories? You can try to persuade yourself in the following way. There are large and lasting differences in the growth rates of national economies. Something must be responsible for those differences. Maybe they can be associated with the sorts of characteristics or policies that the theory suggests as likely determinants of growth rates. Cross-country regressions might thus produce persuasive evidence for one or another version of the theory. Lots of such regressions have been run. I think it has to be said that on the whole they have not been very convincing. Of course significant regression coefficients turn up here and there. They always do, at least one in twenty, usually. Generally, however, they turn out to have little staying power; minor changes in the nature of the sample, the functional form, the collection of right-hand-side variables can change the results significantly. This sort of expedition is not exhausted. There remain a few promising leads to follow. But on the whole you should not be holding your breath. These international comparisons are full of holes; the number of alternative hypotheses capable of accounting for the gross facts must be huge. Time series analyses within a single national economy do not seem to show the sensitivity of growth rates to investment propensities that the theory requires. If we really had a tiger by the tail, we would surely have seen the fur fly more spectacularly than seems to have been the case. Skepticism is in order.

The book has surely not been closed on these theoretical and empirical experiments but it can not be

to be measured. Ideally I suppose one would like to measure the stock by cumulating investments in constant dollars. But we are a long way from having data in that form (and there would be a puzzle about the treatment of depreciation, as I can attest from personal experience). So nothing that I deduce from this model should be taken seriously in a quantitative way; I hope to make a qualitative point, and that is enough. Nevertheless it is convenient to make the point through an arithmetical example.

Suppose we could bring about a ten percent increase in the current stock of human capital, leaving the other inputs, physical capital and raw labor, unchanged. Then the rough model says that the national income should rise by about three percent. Now the distributive-shares interpretation of Cobb-Douglas elasticities tells us that thirty percent of the incremental income would go to the owners of physical capital and the remaining seventy percent of wages and salaries. It is true that thirty percent of that seventy percent is compensation for human capital and forty percent is the wages of raw labor; but both of those inputs are combined in human participants in production. So the outcome of the experiment is that national income rises by three percent and human earnings go up by about 2.1 percent of the starting national income. Since the number of people involved has not changed, we can say that earnings per person have risen by a little over two percent compared with initial output per person. (Of course earnings have gone up by 3 percent of themselves.)

Exactly the same thing would happen if the volume of physical capital were somehow increased by ten percent. That symmetry reflects the fact, if fact it is, that the Cobb-Douglas elasticities for human and physical capital are about equal. Nevertheless there is

a difference between growth induced by investment in human capital and investment induced by growth in physical capital. It comes about because of the different ways in which we typically try to induce higher investment in physical and human capital, and because of the facts of the distribution of income by size. Neither of those play any role in this simple model of production. I will come to them pretty soon as the argument develops.

First I want to pass from this rather abstract way of looking at investment in human capital to something more concrete. In doing so I have the pleasant opportunity to remind you of last year's George Seltzer Lecture by Orley Ashenfelter. It was called "How Convincing is the Evidence Linking Education and Income?" The answer was: pretty convincing. But it is the magnitude of the link that concerns me here. Ashenfelter describes and discusses the generic problem that vexes simple attempts to measure the relation between education and earnings. The puzzle is self-selection. It is easy to verify that there is a positive correlation between education and earnings in the population at large. It is hard indeed to make sure that the correlation does not arise because talented people earn more and acquire more education. Ashenfelter quotes a couple of studies that make clever use of natural experiments to isolate -- pretty convincingly -- the causal effect of additional years of education on additional dollars of annual earnings.

He concludes that the evidence is consistent with the statement that "(T)he implied return to schooling is about 10% per additional year of education attained. He also cites some work of his own (with Alan Krueger) on twins and suggests that 10 percent may be an underestimate. An additional year of education may add as much as 14 percent to the

income of a twin, compared to the twin with less education.

Since then, Ashenfelter and Krueger have collected more data on twins and analyzed them further. Their current best estimate is that the average effect of an additional year's schooling is to increase wage rates by about 16 percent. This is larger than other research has turned up and there is some chance that it is a statistical artifact. But they report that no matter how they treat the data the twin-based estimates of the return to schooling are never less than 9 percent per year completed. We can take 10 percent as fairly solid minimum number, keeping in mind that the true return to schooling may be considerably higher than that.

These results confirm the typical conclusions from more abstract and indirect evaluations of the productivity of human capital. Education pays; and this is without giving any credit for the direct personal value of liberal education. The effects may be uncertain, but they are not trivial.

Now I return to the main thread of my argument. The old growth theory and the new growth theory agree that the only route to accelerated economic growth is through increased investment in the broadest sense, defined to include not only the ordinary paraphernalia of plant and equipment but equally investment in education, in training, and in the creation of new technology. The old and new growth theory may disagree as to whether a maintained increase in the propensity to invest will support a permanent increase in the growth of aggregate output or, less optimistically, a temporary acceleration of growth followed by the permanent achievement of a higher plateau. But they agree on the means.

If attention is confined to investment in the traditional sense, primarily industrial plant and equipment, then there is an equally traditional set of policy tools that become the focus of discussion. They include investment tax credits, and even, as you may occasionally have heard, accelerated depreciation schedules for tax purposes, the favored tax treatment of capital gains. The point is after all straightforward: in a system in which investment is done for profit, the way to get more investment is to make it more profitable. So systematic investment incentives are designed to increase the after-tax return on investment. Debate is about the merits of this proposal or that, not about the principle.

Of course the whole population benefits from increased investment and faster growth. Suppliers of labor benefit because a more capital-intensive and therefore more productive economy will deliver higher wages and salaries. That was the point of my earlier demonstration that raw labor and human capital gain in much the same way from an increase in the stock of capital, whether physical or human capital. But the conventional investment incentives provide a little something extra for precisely those participants whose incomes come in the form of profits. They get the tax reductions or subsidies, in whatever form they are delivered. In other words, the standard investment-increasing policies have distributional effects as well as aggregative effects. They favor those classes in the population whose incomes come from the ownership of capital. On the whole, therefore, they are regressive. They provide extra benefits for the relatively rich, because the profit component is higher for high incomes than for low incomes. The degree of regressivity will vary from one device to another, but some regressivity is probably unavoidable.

This is exactly what has lately come to be called, almost ad nauseam, "trickle-down economics." There is some justice to that label, as I have pointed out. Remember that trickle-down economics really works, in just the way described earlier. It has acquired a bad name for a number of reasons. It has been vastly oversold by its advocates, who predict wonders that are beyond belief. It has been inefficiently applied, but the choice of relatively weak instruments, further blunted by contradictory policies. The emphasis has been on eliciting saving, which is at best a very indirect way of increasing investment, as well as an invitation to free-riding. And finally, its proponents have been too greedy, apparently much more interested in regressive redistribution than in stimulating economic growth. But even apart from those failures, there is a deeper reason for wanting to look beyond the conventional incentives for physical investment. In a period when income inequality has been worsening anyway -- this is the second long-run economic problem I mentioned at the very beginning -- a conscientious person would look for growth-promoting policies that will not make inequality worse. On the contrary, a reasonable person will look for policy directions that promote productivity growth and improve distributional equity at the same time.

It seems to me that putting the emphasis on investment in human capital offers exactly that opportunity. My detour through the econometrics of economic growth served the purpose of emphasizing the symmetry of human and mechanical capital, extending even to the size of their Cobb-Douglas elasticities in the aggregate production function. No one can know if that result will hold up under further research. It is actually not very important; the principle would be the same even if the elasticities were different. It is only important that human capital be a significant factor of

production, and the evidence for that is ample and diverse, extending from the Ashenfelter-Krueger results on twins to qualitative comparisons of industry in Europe, North America and Japan. The symmetry is just an expository bonus and I make use of it in that spirit.

A ten or twenty percent increase in the stock of human capital would have approximately the same aggregative effects as a ten or twenty percent increase in the stock of plant and equipment. (Not in every respect, of course: whichever one rises will experience a fall in its marginal return, while the marginal return to other factors of production increases. The aggregate return to human capital rises anyway, because the stock increases by more than the marginal return falls; other factors get their share only through the rise in marginal product.) The difference between a policy emphasizing mechanical capital and one emphasizing human capital lies elsewhere, in their distributional implications.

A policy aimed at increasing investment in mechanical capital does so by using tax dollars to subsidize investment directly and higher incomes indirectly. A policy aimed at increasing investment in human capital does so by using tax dollars to subsidize education and training directly and lower and middle incomes indirectly. Profits and high incomes will benefit even more indirectly. The presumed symmetry between physical and human capital implies a symmetry between "trickle-down" and "percolate up" (if I have the lingo right). At a time when market forces are widening income inequality anyway, it is difficult to resist the conclusion that there is a very strong case for seeking equity through working the human-capital side of the street, and working it hard. The case is strengthened, though perhaps not in everyone's

opinion, by anecdotal evidence that attributes some of the rapid conquest of high-technology industry by Europe and Japan to a more comprehensive approach to vocational education and subsequent training and retraining. But I am depending more on the argument from symmetry. I should add that human capital is unequally distributed in the population. A policy of investment in human capital could choose to aim at bringing up the lower tail of that distribution. This would certainly reduce inequality and there is also a possibility that it might favor growth. I was interested to learn this morning that a Ph.D. thesis here at Minnesota, by Debasis Bandyopadhyay seems to provide some theoretical basis for that suspicion.

Having said that, I want to qualify my argument in two ways. First of all, it is not clear that we know how to bring about a substantial increase in the effective stock of human capital. There are enough horror stories about semi-literate high-school graduates and Mickey-Mouse training programs to make anyone hesitate before betting on the marginal product of this or that dollar spent with the aim of investing in human capital. On the optimistic side I can cite the fact that the Ashenfelter-Krueger results ran simply in terms of years of schooling. Since the comparisons are within pairs of twins, the observed earnings-differences are presumably related to years of equivalent schooling. That seems easier to deal with. This is not a topic on which I am qualified to speak, but I would be naive not to mention it.

The second qualification is that I would not want to be understood to be suggesting that policy can afford to ignore conventional investment in productive equipment. In the normal way, a bigger and better stock of human capital could be expected to raise the return on physical capital, and thus generate some

extra investment automatically. (Here the symmetry is likely to break down. It might not work the other way, partly because some human-capital investment normally falls to the public sector, and partly because the capital market can not be expected to work very well in the financing of human capital.) I see no reason to stop there. Public policy might conclude that a much broader pro-investment policy is desirable for fairly standard reasons. I would agree. My concern is only to emphasize that a second interest is served on the human-capital side.

The last point I want to make is quite different although it bears directly on the issue of a diversified pro-investment policy. The problem that besets any attempt to stimulate investment is diminishing return. (Even the new growth theory sometimes allows diminishing returns to any one form of investment.) Every increase in the stock of capital makes the next increment less profitable. A society that can spread its investment over both human and physical capital will find that the return on investment attenuates more slowly. Here I am even less confident about the results that flow from the mechanical application of Cobb-Douglas parameters. For what they are worth, they say that a 20-percent increase in the stock of physical capital will push the rate of return down by about 13 percent. By symmetry, the same applies to human capital. But the same amount of investment spread over both forms of capital will reduce the combined return at only about half the pace, by 7 percent. It will be an easier act to follow, in the sense that five years later the economy will feel less saturated with capital, and the profitability of still further investment will be higher.

To summarize, I come back to the theme of the first four lectures in this series: "The American Dream: Education and Work." My goal was to call attention to another role for education in the broad picture. Precisely because of the role for education and training in increasing the productivity of work, investment in education and training provides a way to combine two important social goals: growth and equity. It also provides employment for enormous numbers of economists. I hope Professor Seltzer would approve of that too.

Footnotes

1. Prepared for delivery as the George Seltzer Distinguished Lecture, Industrial Relations Center, University of Minnesota, 1992.
2. Robert M. Solow is Institute Professor at the Massachusetts Institute of Technology, where he has been a professor of economics since 1949.