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Returns to Higher Education

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RETURNS TO HIGHER EDUCATION

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Abstract

This study gives an account of theory, models and measurements of returns to higher education, seen as the results of economically rational investment decisions. The focus is on returns in the form of increased wages and salaries.

These returns vary considerably between different countries and tend to be considerably larger in the USA than in western Europe. One of the reasons for these differences in returns may be the differences in systems of funding of higher education. It is claimed that practically all studies of returns to investments in higher education disregard the benefits from reductions in consumer transaction costs and the role played by education as an important input in household production functions. Econometric studies, reported in the paper, accordingly indicate that the level of education has a considerable impact on the structure of household consumption expenditures.

The Development of Education Investments

At the beginning of the 20th century most contemporary economically developed countries were only moderately industrialized. The general level of education was quite limited as can be illustrated by the following quote:

> ”In 1976 the average stock of formal education per person in these [industrialized] countries was 9.7 years, in 1950 it was 8.2 years. The evidence for a few countries suggests that in 1870 the average stock of education per person in these countries was about three to four years, with substantial sections of the population illiterate and with very little higher ecuation at all”. Maddison, 1988, p.111..

In 1976 the variance in formal education of the labor force was quite large, with USA having the highest average level of education of 11.6 years and Italy as low as 6.9 years of formal education. In 1992 the average level of education of the OECD countries had reached 11.3 years and the level of education of the US adult population was then 12.6 years. By 2005 the US level of education of the population between 25 and 64 years of age has passed 14 years.

Financing of extended education has consequently become a major issue facing most households. However, in many developed economies some or even most of the financial stress for the households has thus been relieved by the supply of tax-funded higher education.

The distribution of number of years of education in 1870 was skewed – a small segment of the population had up to 18 years of schooling. The limited educational capacity was reserved for the prospective leaders of industry and bureaucracy. Financing of their extended schooling was also seen as a limited problem. Costs of education was normally paid directly out of pockets of their well-to-do parents.

All of the industrialized countries have since then undergone a dramatic increase of the number of school years of their labor forces. Meanwhile the variance has been radically decreased in absolute and relative terms. The required number of formal school years for leaders of government and industry is still in the first decade of the 21st century around 18 years, while the average number of school years has risen to 12 – 14 years in the OECD countries.

Investing in Education.

The importance of knowledge as an input in the economy was discussed already by Adam Smith in his *Wealth of Nations* (1776). The acquisition of knowledge by education was by Smith assumed to be regulated by the same mechanisms as the accumulation of material capital:

Fourthly, of the acquired and useful abilities of all the inhabitants or members of society. The acquisition of such talents, by the acquirer during his education, study, or apprenticeship, always costs a real expence, which is a capital fixed and realized, as it were, in his person. Those talents, as they make a part of his fortune, so do they likewise of that of the society to which he belongs. The improved dexterity of a workmanmay be considered in the same light as a machine or instrument of trade which facilitates and abridges labour, an which, though it costs a certain expense, repays the expense with a profit.

Smith, Adam, An Inquiry into the Nature and Causes of The Wealth of Nations. Everyman´s Library,1910, 1991.

Disregarding the direct utility increasing effect of higher education, the size of the voluntary educational effort is regulated by an ordinary household investment calculation in which the sum of discounted real income effects of the investment into a higher education are weighted against the (immediate) cost of the education. Each potential choice of education would imply a different net present value and the informed consumer would choose the education giving the highest expected net present value.

The following simple deterministic model can be used to illustrate the importance income and consumption (or direct utility increasing) effect of education.

In this model we assume that the utility of an individual is not only influenced by the prospective level of consumption standard but also of the level of education, within the aspired occupational career. We furthermore assume that the level of education is costly, but that it also would increase the lifetime level of income. We also disregard the problem of discounting of future incomes as well as the uncertainty associated with the future. In the model the utility function is assumed to be concave and differentiable (at least twice). It is further assumed that income as a function of schooling exhibits diminishing returns. The problem is thus the following:

Maximize $u = u(c,s)$ (1)

subject to: $c + p_S \cdot s = y(s)$

where u = utility
c = consumption
s = schooling time
y = life long income

The price of the consumption basket is for convenience assumed to be equal to 1, i.e. a *numeraire*. Consumption is thus measured in the same dimension as income. The necessary conditions for an optimal choice of consumption, income and schooling is given by the following Lagrange function to be maximized.

$$\max_{\{c,s,\lambda\}} L = u(c,s) - \lambda\left[c + p_S \cdot s - y(s)\right] \tag{2}$$

The necessary conditions of a maximum, which under the assumptions made are also sufficient are the following:

$$\frac{\delta L}{\delta c} = \frac{\delta u}{\delta c} - \lambda = 0 \tag{3}$$

$$\frac{\delta L}{\delta s} = \frac{\delta u}{\delta s} - \lambda\left[p_S - \frac{\delta y}{\delta s}\right] = 0 \tag{4}$$

$$\frac{\delta L}{\delta \lambda} = c + p_S \cdot s - y(s) = 0 \tag{5}$$

i.e. $$\frac{\delta u}{\delta s} \Big/ \frac{\delta u}{\delta c} + \frac{\delta y}{\delta s} = p_S ; \frac{\delta u}{\delta s} \Big/ \frac{\delta u}{\delta c} = -\frac{dc}{\phi c} \equiv W_S$$

$$W_S + \frac{\delta y}{\delta s} = p_S$$

These optimality conditions have the following interpretation:

1. The marginal utility of consumption must equal the shadow price of consumption, equal to the shadow price of income.
2. Substituting the $\delta u / \delta c$ for λ in (4) gives the second condition, implying that the marginal rate of substitution between income and years of schooling should equal the price of schooling minus the marginal income return to schooling.

If utility is only dependant on lifetime consumption the optimality conditions reduce to

$$\frac{\delta u}{\delta c} = \lambda \; ; \; \frac{\delta y}{\delta s} = p_s \; ; \text{ and } \; c + p_s = y(s)$$

If the only object of schooling is to achieve a maximized life income, then the optimality requirement would be to choose a number of periods (say months) of schooling at which the price of schooling corresponds to the marginal lifetime income return. Otherwise the marginal return to schooling plus the marginal willingness to pay for schooling (the marginal rate of substitution of schooling for income or consumption) would be equalized to the price of schooling. With the assumptions made this implies that schooling influencing utility directly and in a positive way increases the duration of schooling.

Dynamics of Returns to Education Investments

As remarked above investments in higher education can be looked upon as any other investment decision problem. The simplification of the former model is obvious. The individual is there assumed to have a lifelong plan, involving consumption and schooling. In reality the decision to invest in education is taken each year after the completion of high-school. The decision to spend the next year at some college or university involves a cost, C(0). A cost normally includes tuition, fees and the loss of income during the coming periods of schooling. The revenue from a year of schooling is a real wage income accruing during future years and must be large enough to compensate for the cost incurred during the school year. The net present value of investing in an additional school year can correspondingly be formulated as

$$N(0) = C(0) + \int_{1}^{T} \Delta W(t) e^{-rt} dt \qquad (6)$$

where

N(0) = net present value of education investment at time

$\Delta W(t)$ = yearly real wage income advantage of education (at cost C)

r = discount rate (= real opportunity rate of return)

g = expected rate of growth of yearly real wage advantage

C(0) = cost of education investment at time 0

There is ample evidence that the yearly real income advantage of education will be increasing over time.

Assume that $\Delta W(t) = \Delta W(1) e^{gt}$; and r>g; (7)

The integral of equation (1) has a value as shown in equation (8).

$$N(0) = -C(0) + \Delta W(1)\frac{1}{r-g}\left(1-e^{rT}\right); \tag{8}$$

Most investment decisions are taken during the years between 17 and 25. This implies that the number of years of work will be no less than 40. With a reasonably high discount rate the exponential term of equation (8) will be close to zero.

Then

$$N(0) \cong -C(0) + \frac{\Delta W(1)}{r-g} \tag{9}$$

The internal (marginal) percentage return to education investment with cost C(0) is defined as

$$r = \frac{\Delta W(1)}{C(0)} + g \tag{10}$$

If, for example, the yearly real wage income advantage of education of one year amounts to $10.000 and the cost of education is $100.000 and the rate of growth of the yearly wage advantage is expected to be 2 per cent, then the percentage return to one extra year of education investment is 12 per cent.

Let us now assume that the net present value of the first year of education after high school is positive. After the first year of “higher” education the student can redo the net present value calculation and this can be done year by year as shown in equations (7) to (10). Every year a decision can be taken to proceed with education as long as the net present value of a further year of education is positive. The investment process will go on until the net present value of a further year of education equals zero. Proceeding with an education beyond the point of zero net present value indicates a pure consumption value from an extension of years of study. The decision problem can be illustrated as in the following diagram.

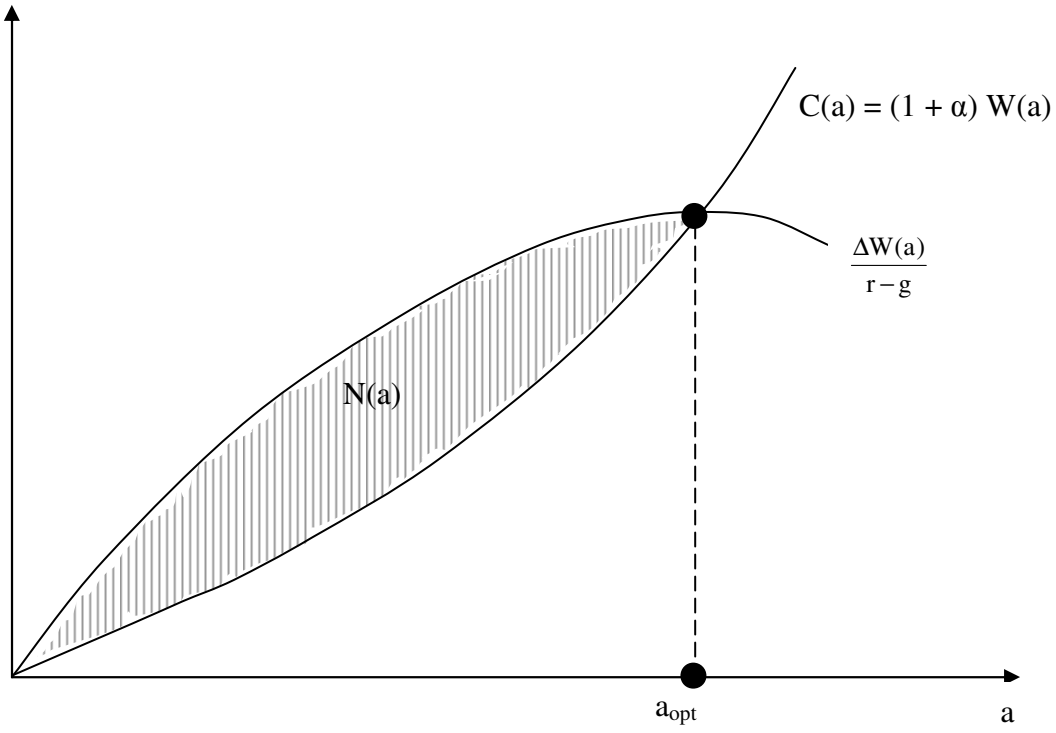


Figure 1 Development over time of net present value of additional education

a = years of education

N(a) = net present value of a years of education

ΔW(a) = yearly additional wage with a years of education

(1+α)W(a) = cost of education at a years of education

r = discount rate

g_a = expected real rate of growth of wage rate with a years of education

Education and Income – Comparative Empirical Results

A large number of studies of the empirical relation between education and income have been performed, all supporting a strong positive relation between personal income and the level of education (ceteris paribus). Relating the gender, age and years of education with income gives the following estimate for Sweden, 1990. The estimation is based on census data after grouping. The result of the regression is given by the following table.

Table 1 The econometric relation between personal income, age, gender and years of education in Sweden 1990

Variable	Coefficient	Standard error of estimate	t-value
Intercept	2.307		
Gender	-0.248	.026	9.615
(female = 1, male = 0)			
ln of age (experience)	.32	.05	6.425
ln of years of education	.727	.05	14.689

Source: Swedish Central Bureau of Statistics, census 1990.

There is no self-evident way of deciding on a best functional form and therefore a number of different forms were tested, including the linear form proposed by Becker and Mincer. The advantage of the equation estimated as in table 5.1 is the non-linearity of returns to years of education. The rate of return declines from around 10 per cent at the level of junior high school towards approximately per cent returns on post graduate university education. The result is robust and in all cases it turns out that the years of education has a much larger influence on the level of income than the age of the individual (looked upon as an approximate measure of work experience). Likewise, the influence of gender is stable under variations of the functional form. This rather large effect of the gender can either be explained as a consequence of discrimination or by a possible preference for more interesting but less profitable work among women. Other empirical material from Sweden would suggest that both factors are at work in determining lower returns to education for women as compared to men. A similar estimation based on household budget survey data for 1969 results in an elasticity of education of 0.7 with a t-value of 4.4.

These econometric results indicate *decreasing returns to education*. They also indicate a substantially larger impact of education in comparison with the returns from experience (or learning by doing).

In some of the studies based on micro-data it has been possible to separate private from public returns. In most of these studies the return to education is calculated as the net return on investment under standardized assumptions on the investment cost of education and the discounted flow of net income (after deduction of taxes). Some studies also include the investment cost carried by governments and base the income calculation on gross income (including taxes). In many of the estimations an econometric procedure proposed by Jacob Mincer (1974) has been used. In that proposed econometric equation the logarithm of income was assumed to be linearly dependent on the number of years of schooling.

The following table provides a summary of estimated returns to education investments in different countries, as presented by OECD.

Table 2 Returns to higher education (extensive university education) in 1989 or 1992 by country and gender

	Male	Female
France	16	12
Finland	15	14
Germany	14	9
USA	13	12
Sweden	12	10
Denmark	11	8
Netherlands (1989)	10	8
Switzerland	8	5
Belgium (1989)	8	13
Average	12	10

Source: OECD, 1995, Education and Employment, Paris

As has been argued above there are strong analytical reasons for expecting the returns to investments in education to be varying between occupations as consequence of differences in volatility of salaries and other risks associated with the choice of an education and occupation and differences in the consumption value of different educations and occupations.

The following table gives some indication of occupational differences in returns to investments.

Table 3 Returns to investment (%) in education by country and industry or occupation

Country	Industry/occupation				
	Private employment	Public employment	Commerce or law	Engineering	Medicine
Canada (1985)			13	14	22
France (1971, 1975)	12	8	14	..	13
UK (1971, 1975)	9	6			
Japan (1970)	19	7	..	..	..
USA (1978)	9	9			

Source: Psacharopoulos, G. (1993), Returns to Investment in Education. A Global Update. The World Bank, WPS 1067, Washington, DC.

The estimates of table indicate considerable differences in the returns to education between different occupations. Public employment tends to give smaller returns than private employment, probably as a consequence of the higher risk of unemployment in the private sector.

Marginal returns to education tend to be falling both with the level of education of the individual and with the level of economic development of society. The development level effect is illustrated by the following table.

Table 4. Returns to investment in education of countries at different levels of economic development.
Average percentage returns by per capita income group of countries

	Level of schools	
Per capita income group of countries	Secondary	Higher
Low income (≤USD 755)	15.7	11.2
Middle income (USD 756 to 9265)	12.9	11.3
High income (≥USD 9266)	10.3	9.5

Source: Psacharopoulos and in Policy Research Working Paper 2881, The World Bank, September, 2002

The following table, complied from Psacharopoulos and Patrinos (2002), provides an overview of estimated returns to education in different developed economies. The table shows that an unweighted average return is 8.3 per cent with substantially higher returns in the UK and USA. The returns to higher education investments is consistently estimated by a number of economists to be around 10 per cent in the USA.

Table 5.5 Returns to investment in education, estimated for different years in economically developed countries

Rate of return Country	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Aver-age
Australia		7.9	8.4				10.9		5.4		8.0							8.1
Austria			11.6		7.9		7.6		7.4		7.6		7.4		7.2			8.1
Canada			8.5					8.8			8.9							8.7
Denmark		*2.6										4.5						3.6
Finland		9.1							7.0		8.2		8.8		8.2			8.3
Germany								5.5		7.7								6.6
Italy					5.5		4.5	4.6	2.7									4.3
Japan										13.2								13.2
Netherlands		10.9		7.0			7.2	5.2		5.7	7.3					6.4		7.1
Norway		5.5			6.1				5.4		4.9		5.4				5.5	5.5
Spain							7.7					9.0	7.1					7.9
Sweden			3.5			3.9						4.5	3.5					3.9
Switzerland									7.9			7.5						7.7
UK				15.3		13.3			6.8									11.8
USA									9.8				10.0	10.0	10.0	10.0	10.0	10.0
Average																		8.3

Sources: The World Bank WPS 2881, Psacharopoulos, G., Patrinos, H.A.
Australia: Miller, Mulvey and Martin, Patrinos, Cohn and Addison; Austria: Psacharopoulos (1994), Ferster and Winter-Ebner; Canada:Patrinos (1995); Denmark: Christensen and Westergard-Nielsen; Finland: Asplund (1999); Germany: Ichino and Winter-Ebner, Cohn and Addison (1998); Italy: Brunello, Comi and Lucifora (1999); Japan: Cohn and Addison (1998); Norway: Barth and Roed (1999); Spain: Cohn and Addison (1998), Alba-Ramirez and Segundo (1995); Sweden: Arai and Kjellström (1999), Isacsson (1999), Palme and Wright (1992); Switzerland: Psacharopoulos (1994), Weber and Wolter (1999); UK: Patrinos (1995), Harmon and Walker (1995, 1999); USA: Psacharopoulos (1995, 1999).

According to table 5 returns to investments in education are higher in the USA, Australia, Canada and Japan than in most parts of Europe.

The following table 6 shows the returns to education as reported for men and women in studies from the 1980s and 1990s. Nine out of the twelve studies indicate somewhat higher returns to education for women with clear exceptions in Denmark and Sweden.

Table 6 Returns estimated by gender (1980s and 1990s)

All levels of education	Men	Women
Austria (1981)	10.3	13.5
Denmark (1990)	5.1	3.4
Finland (1993)	7.8	8.3
Italy (1985)	3.5	3.9
Norway (1991)	4.2	5.3
Sweden (1991)	5.0	4.0
Switzerland (1995)	9.1	9.0
University level		
Canada (1985)	8.3	18.8
Denmark (1990)	3.5	5.2
Finland (1987)	6.6	7.7
Norway (1991)	4.0	4.2
Sweden (1991)	4.4	4.0

Source: The World Bank, WPS 2881, 2002

Comparative Analysis of Private Returns to Education in Europe

The meta-analysis, reported above provides a rough overview of estimates of returns to educational investment in different parts of the world based on different approaches to the estimation problem. A weakness of this analysis is of the heterogeneity of methods employed, data bases and time periods.

This heterogeneity has to a large extent been avoided in a large study by Asplund and associates (2002). In this study (PURE) returns to higher education have been estimated for the fifteen European Union member countries based on data for the mid 1990s. The private

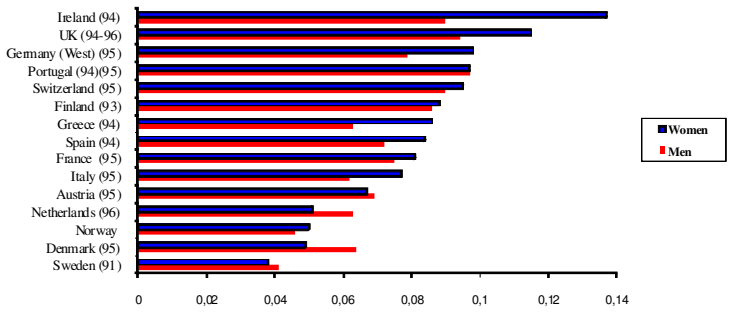


Figure 2 Returns to education investments in European countries based on Mincer´s estimation procedure.

Year of observations given in the figure.

Source: PURE, Asplund and associates.

Figure 5.1 shows that the real rate of return is on the average for EU countries approximately 7 per cent. However, the variance between countries is large. Portugal, Spain, UK and Ireland have returns substantially higher than Denmark, Sweden, Norway and the Netherlands. These differences in returns points to the effect of the differences in public funding of higher education. The Scandinavian welfare states employ extensive subsidies not only of tuition and fees but also of living costs of students. This has tended to give rise to more years of higher education, sometimes oriented to occupations with bleak opportunities of gainful employment, reducing the average real wage advantage of higher education and the average private rate of return.

The empirical studies also show sometimes substantial gender differences in the returns to higher education as shown in figure 5.1. Women have had much higher returns to education in Ireland, UK, Germany and Greece. The opposite is the case in Netherlands, Sweden and Denmark.

The PURE study group has also shown that there has been a substantial decline in the real returns to education in the EU countries between the 1960s and the 1970s and a stabilisation around 6.5 per cent thereafter.

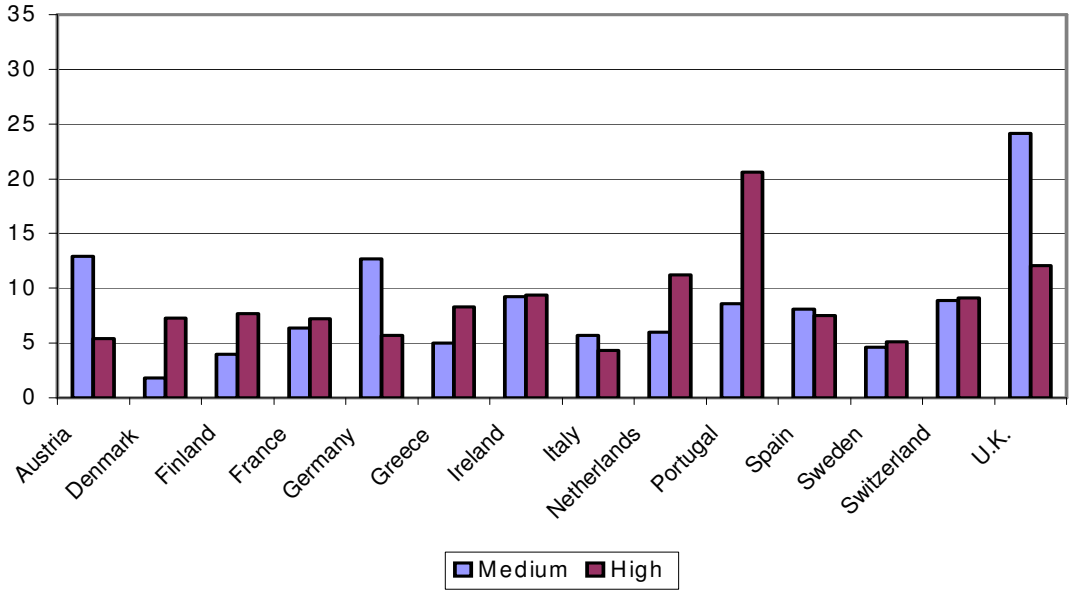
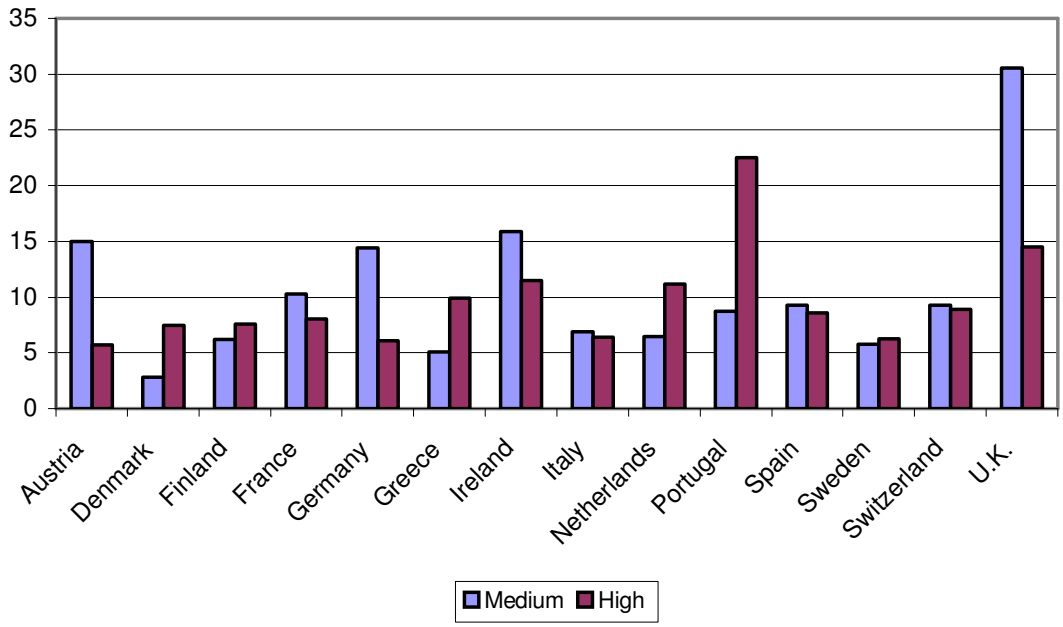


Figure 3 Rates of returns to investments in medium and high levels of education, unadjusted for differences in unemployment, men

In most studies rates of return on education investments are estimated under the assumption that the probability of unemployment is independent of the level of education. Especially in Europe this is an erroneous assumption in most countries. The application of equality based negotiation strategies in the labor market implies that the insiders in low education jobs will have wage rates well above equilibrium levels. As a consequence unemployment rates will be decreasing with increasing levels of education.

According to Nickell (1979) rates of return should be thus *adjusted* for expected unemployment. This implies that we should expect returns to education to be substantially increased in most European countries when unemployment differentials are taken into account. The following figures give the unemployment *unadjusted* and *adjusted* internal rates of return to education at medium and high education levels in different European countries.



Source: Unemployment and returns to education in Europe by Fernando Garceinas-Taretes et.al. in Public Funding and Private Returns to Education, Final Report, January 2001, SOE2-CT98-2044.

Figure 4 Adjusted internal rates of return for European countries, Men

As can be seen from the diagram the adjustment is substantial, especially at the level of medium education. The adjustment is especially pronounced in the United Kingdom, Ireland, Germany and Portugal. In the UK the returns to medium level education is, after adjustment, approximately 30 per cent and a further education onto the highest level gives an adjusted real rate of return of almost 15 per cent. It is obvious that the expectations of higher level of employment plays a very important role in the step from compulsory to non-compulsory education as compared with the returns to investment in a step from medium to high level of education. The effect of improved employment possibly exists but is quite small in Sweden and Finland (and even negative in Denmark), a reflection of the generous unemployment benefits of these countries.

Financing Higher Education

The differences between countries in public financing of higher education (university and similar institutions) are considerable. The following table provides some examples of differences in public funding of higher education.

Table 7 Percentage shares of public funding of expenditure of higher education institutions in some OECD countries, 1992

Country	Expenditure per student (US$)	Public share of expenditure
Japan	7140	40
USA	13890	50
Denmark	6710	62
Sweden	7120	63
Ireland	7270	67
Netherlands	8720	71
UK	10370	78
France	5760	84
Canada	12350	85

Source: OECD Education at a Glance

Public expenditure per student in the USA was (and still is) higher in absolute terms than in most developed countries during the 1990s, although the public share of expenditures was only 50 per cent of total expenditure per student. The major cost of consumption and many years of foregone income remains a considerable financial problem, mostly to be solved by loans to students or subsidies from their parents.

At the levels of PhD education most countries have developed some combination of scholarship and part-time employment of the students, which is not the case for the bulk of college and university students. For the early years of higher education there is in most cases a need for financing from loanable funds at some rate of interest. For the analysis of the optimality problem it is convenient to formulate optimization models that can highlight some of the important factors involved in the choice of an optimal educational strategy for the household

In the United States a large part of the cost of higher education is carried by the student and his family. Tuition, fees and cost of literature can amount to a very substantial part of the cost of higher education. This cost regularly amounts to US$30.000 or more per year in the United States. This cost should be added to the cost of living.

In Europe the situation is quite different. In many countries, e.g. Germany, the Netherlands and the Scandinavian countries, higher education is free of charge for tuition and fees. Other living expenses are covered by state subsidies, grants or loans. As an example Denmark and the Netherlands cover such living cost as grants, amounting to two thirds of the cost, and the remaining costs are covered by student loans. Many countries in Europe have been changing their system from grants to loans. Norway, Sweden and the UK are examples of such a change of the financing system into primarily loan financing of higher education costs (beside tuition and fees). In the UK the system was changed in the year 1999 into a fully loan-based education financing system. In Norway and Sweden the share of loans is increasing towards 80 per cent of the cost of living. In most countries interest rates on student loans are charged with some of the risk-taking carried by the state. In the cases of Sweden and the UK the risks of education loans are reduced for the student by income contingency rules.

Government strategies in terms of subsidies to cover education investment costs and future taxation of income accruing from education obviously influence the returns to education investments.

The returns on education investment to the individual are thus in most countries influenced by the marginal taxation of income as well as by subsidies during time of schooling in the following way.

The internal rate of return calculated at zero net present value, r_0, is

$$r_0 = \frac{\Delta W}{C} \cdot \frac{1-\tau}{1-\sigma} + g; \qquad (11)$$

where τ = marginal rate of taxation of income increases

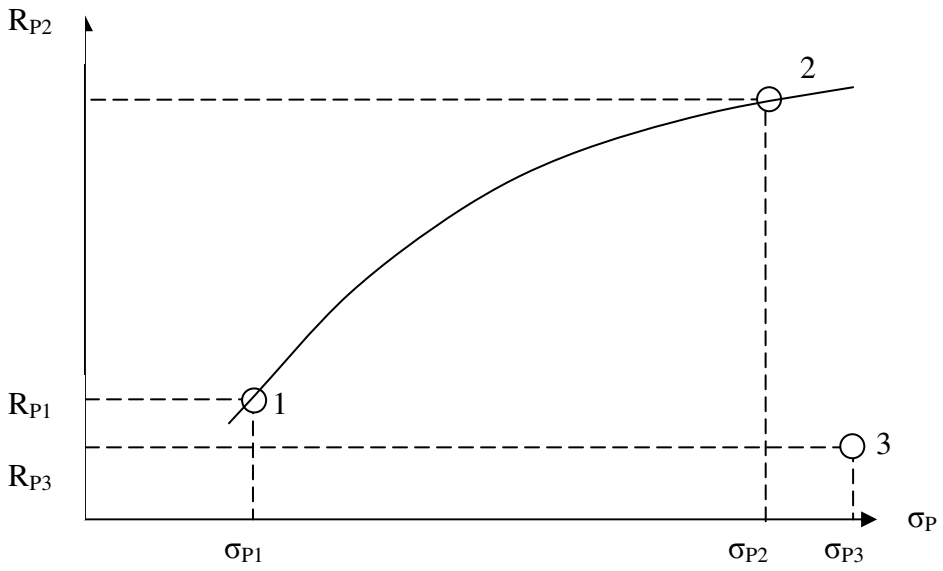
and σ = share of schooling cost, covered by government subsidies.

This internal rate of return is calculated under the assumption that from the total cost a fixed percentage share is deducted and from the increase of wages a fixed percentage share is taxed away. It is furthermore assumed that the income increase will be ruling for sufficiently many years to allow the approximation of equation

In some developing countries income tax rates are low, while costs of education are covered by government funds to a significant extent. One typical example is Hong Kong, where the internal rate of return to education, unadjusted for subsidies and taxes, was 12.4 per cent as compared to the tax and subsidy adjusted private return, which wasd calculated to be 25.2 per cent (Psacharopoulos, 1994). Opposite cases were Belgium, Denmark, Norway, Netherlands and Sweden, where the tax and subsidy adjusted internal rates of returns were on the average 2 per cent lower than the unadjusted rate.

Uncertainty of returns

As in any other type of investment planning returns are not certain. Some jobs are associated with industries that have a larger tendency to business cycle and other fluctuations than other industries. Examples of such a tendency to larger fluctuations than the average are stock brokerage, construction engineering and architecture and trade in information and communication equipment. In the same way as securities exhibit different combinations of expected return and risk the young consumers (or their parents) are faced with choice between different combinations of risk and uncertainty as illustrated in the following diagram.



Figur 5 Expected returns (R) and risks (σ) of investment portfolios.
The curve from point 1 to point 2 indicates the maximum combinations of opportunities of different investment portfolios. All point below the opportunity curve are feasible but inefficient portfolios

Point 1 in figure 5 indicates the choice of an investment portfolio including an education leading to low returns combined with a minimum risk. This might be the choice of an education leading to some public sector occupation. The choice of education (and occupation) is seen as one investment within the household investment portfolio. The portfolio of investment assets might further include a house in a safe area, and a set of government bonds rather than securities. Point 2 indicates a possible choice of a portfolio composed of an education leading to an occupation as a financial broker, a condominium on Manhattan and a set of high-tech securities. A high rate of expected return would then be combined with quite a large risk of no return at all or even bankruptcy. Point 3 in the diagram indicates an *inefficient* point in the sense that a low rate of return is combined with a high risk. Such choices do occur quite frequently but need not be an indication of irrationality or lack of information about the returns and risks. It could be a choice of a career exhibiting an inefficient combination of expected returns (but not expected utility) and risks as found in the arts, humanities and professional sports. In these cases empirical evidence strongly suggest that the choice of such creative occupations is guided not only by financial returns but equally much or even more by consumer preferences for the occupational activity itself. To the

pecuniary returns one must therefore add the willingness to pay for the possibility of getting an education leading to an occupation full of working pleasures. The willingness to pay for the consumption advantage from the working pleasures of such an education could be measured as the vertical distance from point 3 of the figure to the income opportunity frontier curve

A psychological study by Gudmund Smith and his associates (1984) has shown that creative individuals working in the arts and science are only weakly motivated by standard economic incentives. Recent statistics from Sweden also show that e.g. consulting architects have much lower returns to their education than e.g. management and law consultants with similar levels of schooling. One explanation could then be that a law or business education is for most students considered boring in comparison with the expected working situation of an architect.

Increasing Wage Gaps between Levels of Education in the USA and Europe

The development in the USA over the three decades after 1973 indicates a substantial change in the returns to education. In 1975 the real wage rate difference between a university degree and school leave before high school was 116 per cent corresponding to an expected average gross return per school year of less than 9 per cent. In the year 2003 the real wage rate difference had increased to 192 per cent, corresponding to an expected average (gross) return per school year of close to 12 per cent. The widening real income gap between different education levels is further illustrated by the following table.

Table 8 Development of hourly wages in the USA, 1975 – 2003, (2003 dollars) (index: Less than high school 1975: 100)

Year	Less than high school	High school	Some college	College	Higher degrees
1975	100	116.5	125.6	168.7	215.8
1980	104.2	116.6	126.3	166.4	202.3
1985	96.4	114.3	126.5	175.5	220.3
1990	90.5	111.0	126.8	179.0	229.7
1995	83.5	110.5	123.6	183.4	241.9
2000	86.8	116.8	132.8	204.0	258.0
2003	90.0	120.7	135.5	208.5	263.2
Wage increase by	+34%	+12.2%	+53.9%	+26.2%	

level of education 2003 One additional year of education of gross returns	+11%	+12%	+27%	+9%

Table 9 Average annual change of real wage rate (%)

	Less than high school	High school	College	Higher degrees
1975 – 1985	-0.37	-0.19	+0.40	+0.21
1985 – 1995	-1.4	-0.34	+0.44	+0.94
1995 – 2003	+0.9	+1.1	+1.6	+1.1

In Europe the development of wage inequality by levels of education has been somewhat different as shown in the following figure.

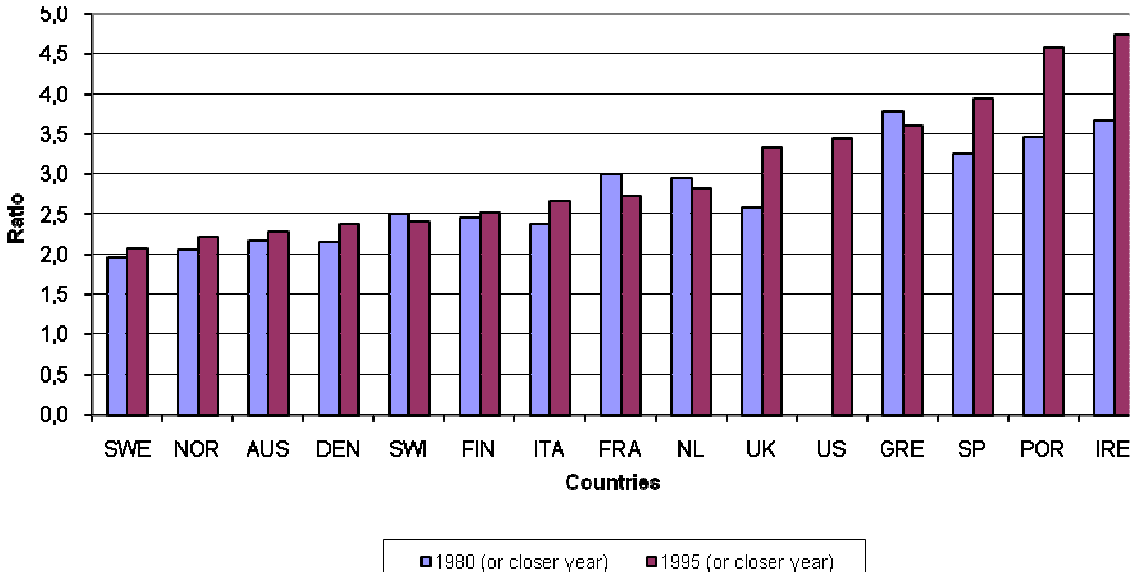


Figure 6 Wage inequality in EU-countries and the US, 1980 and 1995, measured as the ratio between the 9th and the 1st decile (gross hourly wages)

The main cause of an increasing real wage gap by level of education can be explained by:

1. Increasing global division of labor with outsourcing of low education jobs to newly industrialized countries and

2. Increasing focus on knowledge based goods and services in the USA (and other advanced economies)

Systematic Underestimation of Returns to Investments in Education

Education and

Reduced Transaction Costs

The conventional estimates of the economic returns are based on simplified assumptions. Although references are regularly made on the non-labor-market such benefits are rarely estimated or even indicated by empirical data.

One such obvious consequence of most kinds of higher education is a reduction of transaction costs following upon education in e.g. mathematics, languages, information and communication technology.

The impact upon benefits to education investments can be illustrated with a model of consumer decisions, if the level of education has an impact on prices of consumer goods including transaction costs.

Thus $p_i = p_i(E)$ where

p_i = price of consumer good i

$p_i = p_i(E)$ are monotonously non-increasing differentiable functions with respect to increasing level of education. Thus: $\frac{\partial p_i}{\partial E} \leq 0$.

For simplicity E is assumed to be measured in years of schooling. The following analysis can easily be extended to the case of a vector representation of different kinds of education.

The consumer is assumed to maximize the (remaining lifetime) utility U=U(x,F), where x is a vector of consumer goods (i = 1, ..., n) and F equals the leisure time, subject to the following constraint

$$\left[p(E)\right]^T x + C(E) = w(E)(T - F) \qquad (12)$$

where $p(E) = \{p_1(E), \ldots, p_i(E), \ldots, p_n(E)\}$

C(E) = cost of education as a function of the level (or duration) of education (E)

Assumption: $\frac{\partial C}{\partial E} > 0$; (A1)

w(E) = labor income per unit of time as a function of the level of education

Assumption: $\frac{\partial w}{\partial E} > 0$; (A2)

The Lagrange function to be maximized is

$$H = U(x, F) - \lambda\left(\left[p(E)\right]^T x + C(E) - w(E)(T - F)\right)$$

The necessary conditions of a maximum are

$$\frac{\partial H}{\partial x_i} = \frac{\partial u}{\partial x_i} - \lambda p_i(E) = 0; \quad (i = 1, \ldots, n); \tag{13}$$

$$\frac{\partial H}{\partial F} = \frac{\partial u}{\partial F} - \lambda w(E) = 0; \tag{14}$$

$$\frac{\partial H}{\partial E} = \lambda\left(\sum_{i=1}^{n} \frac{\partial p_i}{\partial E} \cdot x_i + \frac{\partial C}{\partial E}(T - F)\right) = 0; \tag{15}$$

$$\frac{\partial H}{\partial \lambda} = \left[p(E)\right]^T x + C(E) - w(E)(T - F) = 0 \tag{16}$$

$$\frac{\partial H}{\partial E} = 0 \Rightarrow \lambda \neq 0$$

Thus $\frac{\partial w}{\partial E}(T - F) - \sum_{i=1}^{n} \frac{\partial p_i}{\partial E} \cdot x_i = \frac{\partial C}{\partial E}$

The term $\frac{\partial w}{\partial E}(T - F)$ corresponds to the conventionally measured financial returns to investment in education. $x_i > 0$ and $\frac{\partial p_i}{\partial E} \leq 0$, thus the term $\sum_{i=1}^{n} \frac{\partial p_i}{\partial E} x_i < 0.$

Conventionally measured returns to investment in education thus underestimate the true returns, *which should include the reduction in consumer transaction costs.*

Education and Efficiency of Consumption

Hicks ( ), Morishima ( ) and Lancaster ( ) have proposed a production function approach to consumer analysis. The main argument is that consumer goods are used as inputs by the household in order to generate outputs of utility enhancing characteristics of fundamental services to the household members.

Thus the household decision problem is subdivided into an objective production decision part on how to efficiently purchase and use goods and a subjective part on how to trade off different fundamental services against each other in order to maximize utility of the household.

The production functions can be formulated as

$$Z_j = Z_j\left(x_{ij},\ldots,x_{ij},\ldots,x_{nj},E\right); \qquad (17)$$

where Z_j = the output of fundamental services j

x_{ij} = the input of good i into the production of service j

E = level of education.

Assumption: The marginal productivities are positive and diminishing.

For simplicity we assume the utility function to be additive

$$u = \sum_{j=1}^{m} w_j z_j\left(x_{1j},\ldots,x_{ij},\ldots x_{nj};E\right); \qquad (18)$$

The utility is to be maximized, subject to the following budget constraint.

$$\sum_{i=1}^{n} p_i(E)\,x_{ij} + C(E) - w(E)\left(\bar{T}-\bar{F}\right)$$

Labor time $=\left(\bar{T}-\bar{F}=\bar{L}\right)$ is assumed to be given. The corresponding Lagrange-function to be maximized is:

$$H = \sum_{j=1}^{m} w_j \cdot z_j\left(x_{ij},\ldots,x_{ij},\ldots,x_{nj};E\right)$$

$$-\lambda\left(\sum_{j=1}^{m}\sum_{i=1}^{n} p_i(E)\,x_{ij} + C(E) - w(E)\cdot\bar{L}\right)$$

The necessary conditions of an equilibrium are

$$\frac{\partial H}{\partial x_{ij}} = w_j\frac{\partial Z_j(E)}{\partial x_{ij}} - \lambda p_i(E) = 0; \qquad (19)$$

$$\frac{\partial H}{\partial E} = \sum_{j=1}^{m} w_j\frac{\partial Z_j}{\partial E} - \lambda\left(\sum_{j=1}^{m}\sum_{i=1}^{n}\frac{\partial p_i}{\partial E}x_{ij} + \frac{\partial C}{\partial E} - \frac{\partial w}{\partial E}\bar{L}\right) = 0$$

$$\frac{\partial H}{\partial \lambda} = \sum_{j=1}^{m}\sum_{i=1}^{n} p_i(E)\,x_{ij} + C(E) - w(E)\bar{L} = 0$$

This implies:

$$\sum_{j=1}^{m}\left(\frac{w_j}{\lambda}\right)\frac{\partial Z_j}{\partial E} - \sum_{j=1}^{m}\sum_{i=1}^{n}\frac{\partial p_i}{\partial E}\cdot x_{ij} + \frac{\partial w}{\partial E}\cdot\bar{L} = \frac{\partial C}{\partial E}$$

The level of education should thus be adjusted until the marginal cost corresponds to the sum of weighted marginal household productivities of education plus the marginal income returns to education.

Empirically we should expect consumer demand for different goods to be dependent on education, *ceteris paribus*. This is also the case as shown by the following tables.

Table 7 Consumption Elasticities of Education (measured in years) estimated on household budget survey data for Sweden 1969 (ceteris paribus with respect to income, age, household size and location). (All estimates are significant on the 1 per cent level and there is no substantial multicollinearity recorded.)

Consumption good	Educational elasticity
Social contact expenditures	+2.1
Education	+1.7
International travel	+1.4
Restaurant and hotel services	+1.2
Child care	+1.1
Telecom services	+1.0
Housing	+0.5
Books and magazines	+0.4
Toys	+0.3
Interior decoration goods	+0.3
Domestic travel	-0.3
Clothing	-0.4
Wine and liquor	-0.4
TV and radio	-0.8
Cigarettes and tobacco	-2.0
Entertainment	-2.7

The negative education elasticity of cigarettes and tobacco as well as alcohol is probably indicating a perceived health effect in the Swedish population already in the 1960s.

A separation of transaction cost effect from a household productivity effect is of course impossible in the consumption good demand with positive education elasticities.

However, it seems reasonable to assume that the household productivity of education, books and magazines and international travel is positively influenced by education.

Conclusions

This paper is oriented to the analysis of private knowledge acquisition by education. It is shown that the choice of education is similar to other investment choices, facing the household. In the case of a household regarding knowledge acquisition by education as purely a means to improve the consumption standard the basic optimality condition boils down to a requirement that the marginal lifetime income (properly discounted) should be equal to the marginal cost in terms of direct costs of schooling and loss of income.

However, the very large differences in net returns to years of schooling between different occupations indicate that there are also other factors than the future real incomes influencing educational choices. One obvious example is the choice of some artistic education, where financial returns are notoriously small. This is compatible with rational decision making under the proviso that the educational capital itself enters the household utility function. With this assumption the marginal rate of substitution between knowledge and consumer income is added to the real income effect, explaining the large demand for education in occupations with minimal expected financial returns.

Although much of the analysis of household choices of education can be done within a deterministic framework, there are considerations of risk and uncertainty of importance to some of the long-term choices facing the household. Similarly to other long-term financial decisions returns have to be traded off against risk. A typical example is the differences in returns and risk between public and private occupations in most countries. Many private occupations give much higher expected returns to education than corresponding public occupations, e.g. as illustrated by the differences in returns between a defense attorney and a public prosecutor or a judge. Similarly an economic consultant normally earns much more than a tenured professor with similar or higher level of knowledge and skills. But the exposure to income volatility and other financial risks are in this case much larger for the business or law consultant, making the choice an issue of differences in risk aversion. Many longer educations do not provide any choices between different occupations in terms of combinations of risk and returns after completion of the education. The trade-off between risk and returns has then to be made already in the choice of education.

Financial problems are central to contemporary choice of education. The number of years of schooling implies increasing cost of education and foregone income opportunities. Higher education is for most students a problem of financing by loans at some positive real rate of

interest to be covered by future incomes. Proper household planning of higher education consequently requires a lifecycle prospective.

Most of the empirical studies of returns to education substantiate that households base their decision making on rational calculation of long-term consequences of their choices in terms of financial returns. Substantial deviations from the rationality postulate can mostly be seen in the educational preparation for careers that are looked upon as inherently joyful or subjected to extremely skewed returns as in the case of occupation in performing arts or professional sports. The meta-analysis of returns to education investments indicate substantial differences in returns between countries. The “welfare countries” of Scandinavia with their substantial subsidies to students show systematically lower returns to investments in higher education than the countries, where most of the costs have to be covered the students (or their families).

A probable interpretation there is a systematic loss of incentives to choose educations with high expected future returns if current costs are covered by government subsidies.

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