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Swedish input and output of the education sector

Draft paper for the Workshop "Quantifying knowledge: human capital measurement, ca. 1700-2010", Utrecht, 9-10 December, 2011

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I. Introduction

The impact of education provides puzzles for both economic theory and economic history. With the theory of human capital education became perceived as an investment, yet, in national accounts it is produced as services and end up in consumption. This is still also the role of education in economic policy, even if not in political rhetoric, and it is treated as a wearing sector which faces diminishing resources in times of economic recession. Maybe part of the explanation is that the contribution of education to economic growth is not visible in national accounts but is hidden in spill-over effects and increasing productivity of other sectors.

Also physical investments may contribute more to GDP than what a simple account indicates. However, in this case it is recognised that the capital equipment is undervalued and as a rule that is due to ignorance of quality change when the current values of investments are converted to constant values or volumes. For example, improved energy efficiency in machinery has greatly contributed to net output growth in manufacturing. Properly measured, this equals a relative decrease in machinery prices which, in turn, would imply a magnification of the machinery capital stock (Gordon 1990). In decomposition of economic growth into the contribution of increase in inputs of the factors of production, labour and capital, the incomplete measurement of such quality changes instead show up in the residual or total factor productivity (TFP). It is also labelled as disembodied technical change since it is an improvement of capital which has not been included in its valuation. Therefore efforts are laid down so that quality change, of machinery etc., to an increasing degree is taken account of in the construction of price indexes and thus mark up the estimates of the capital stock. Could all quality changes, both in capital and labour, fully be taken account of would TFP be reduced to naught. Already in the 1960s, Jorgenson and Griliches (1967) pursued that track of analysis and managed to reduce TFP to a mere three per cent of the growth. However, several heroic assumptions were needed and for growth analysts the examination of TFP is a major aim. Technical improvement or quality change of physical capital remain important to take account of, whether perceived as embodied or disembodied. Moreover, when it comes to the intangible investments in human capital provided by education, efforts to measure the economic contribution to GDP are weak. Thus, a substantial part of technological developments as well as improvements of human capital are indicated by the rather anonymous TFP.

Indeed, it is difficult to measure the economic output of education, at least when education is offered as a non-marketed public service with no price tag and no well defined economic quantity. Hence in national accounts education is measured by its input and as a convention only labour, and not capital, produces the value added that contributes to GDP. In analyses of economic growth GDP must be converted to constant prices, and constant prices of education in national accounts mean constant prices of labour cost. That is, an index of salaries in education is used for the conversion of education into constant prices and consequently the output of education will only change proportionally with the labour input. In other words, no productivity change will by definition occur in education or in other non-marketed services. A teacher, a nurse, or a doctor of medicine is consequently, according to national accounting, producing no more economic value today than, say, in 1870. Indeed this runs counter to reasonable common sense and it is also difficult to square with theories of economic growth. It is easy to point out a number of scientific achievements that have been incorporated in curricula at all levels of education and also greatly have increased the economic value and hence productivity in education.

In this paper, the theoretical puzzles in measurement of education are discussed within the framework of Swedish economic and educational performance since the late nineteenth century. Section II discusses different ways of estimating education within a national accounts framework. Section III goes beyond this framework and, following Jorgenson and Fraumeni (1992), estimates an alternative output measure of compulsory and vocational education. [In later versions of the paper this will be extended with other levels of educatin].

II. Education in national accounts

Output prices and quantities are, as a rule, a prerequisite when calculating the Gross Domestic Product of a country. By subtraction of intermediary inputs, such as raw materials and semi-finished goods, the value added of production is obtained and the aggregate of value added produced within the country sum up to GDP. However, this rule cannot hold when there are no output prices and quantities as in the case of public education, with no tuition fees or fees that are only supplementary. The value added of the education sector is therefore approximated by its factor cost. In principle not only labour cost but also the depreciation value of capital, such as buildings and equipment, should be added but capital is (so far) not recognised for public services in national accounting. Through these calculations it is possible to estimate the share of education in GDP in each single year, but a fundamental problem arises as soon as the change over time should be considered. Prices and productivity do not change proportionally between factors and sectors and the conversion (deflation) of value added to volume series requires knowledge in detail about the price changes. In the manual of national accounting (SNA93[have still to check SNA2008!]), physical output measures, such as the number of students or treated patients, are recommended as a way to measure the development over time of non-marketed services but have so far not been implemented. The valuation, and thus the level, of its contribution would still be determined of the value of the labour input in the sector in a chosen base year. However, the common practice is instead to deflate labour cost by an index of salaries in the education sector. As already pointed out, the account of productivity change through this procedure becomes naught. The whole contribution of the education sector to GDP, in national accounts, is consequently due to the expansion of employment in education. To the extent that education promotes the growth in productivity of other sectors it will be through spill-over effects which are embedded in the value added of these sectors. For the Swedish economy, it has been estimated that about 35 per cent of the GDP growth since 1870 is due to improved productivity of the factors of production (Schön 2004, p.279). In an effort to decompose the elements of this total factor productivity (TFP) Schön zooms in on the manufacturing sector over the period 1890-2000, when productivity contributed to more than half of the growth. Moreover, two thirds of the productivity change he finds explained by improvements in human capital, as proxied by shifts to more skilled labour (Schön 2004, p. 289). It seems not satisfactory that at the same time no productivity change at all should have taken place in the production of human capital, or for that matter in its reproduction (health care).

Table 1 reports the growth of Swedish GDP since about 1870 through the end of the 20th century, as well as the growth of the sectoral contribution of education to GDP. The turning points in the trend of tertiary education, which are shared by other levels of education although with much less variation in the trend, have determined the division into sub-periods. The long-term development of the education sector matches that of the GDP, however, during all sub-periods except for the Golden Age 1945-1970 the growth of education fell behind that of GDP. In this simple

Table 1. GDP and physical output of the education sector in Sweden, 1867-1994. Annual rate of change in per cent

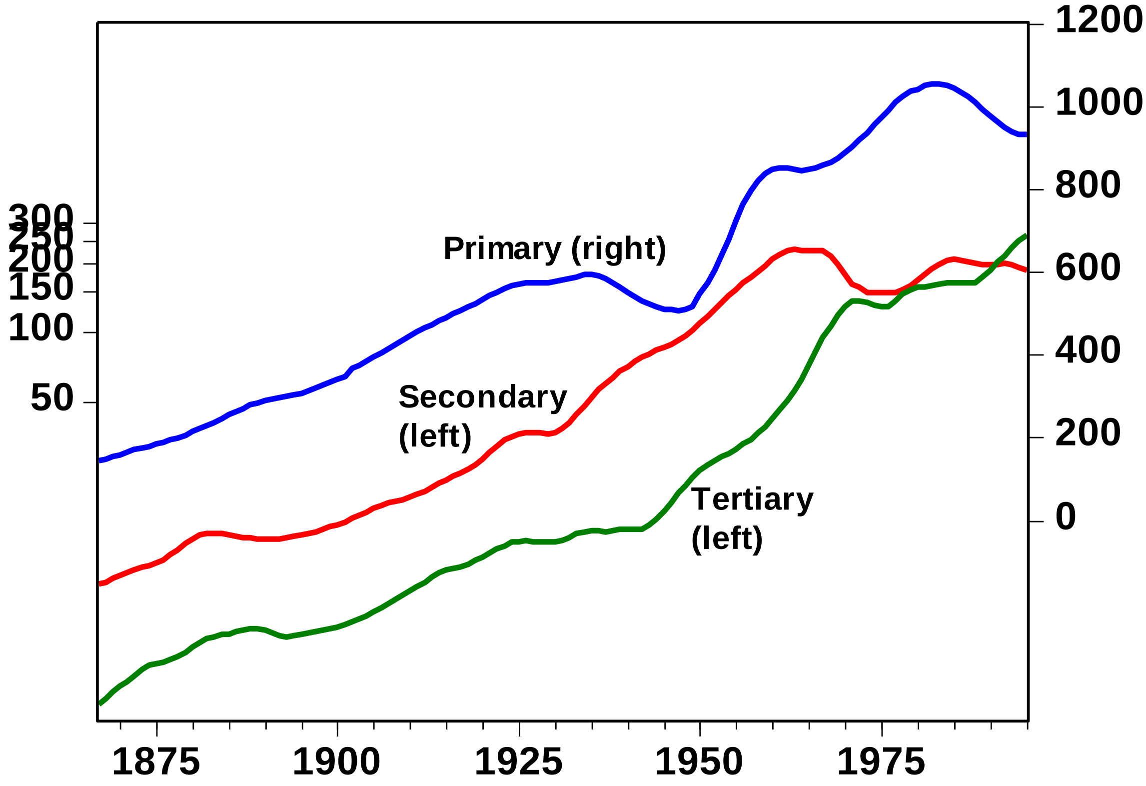
	1867-1994	1867-1920	1920-1945	1945-1970	1970-1994
GDP (at market prices)	3.07	2.59	2.88	4.35	1.85
Education in GDP, conventional approach					
-at factor cost, Primary	3.07	1.52	1.60	4.65	2.52
-"- secondary	3.37	0.83	1.77	7.79	3.62
-"- tertiary	3.80*	1.31	-1.58	10.27	4.65*
-"- total	3.22*	1.34	1.41	5.94	3.63*
Output of standardised school years					
Primary	1.44	2.45	-0.18	2.62	0.16
Secondary	3.02	1.94	4.54	4.08	1.39
Tertiary	3.52*	2.24	1.25	7.62	1.92*
Total	1.71*	2.42	0.25	3.14	0.70*

Note: * end year 1992. GDP from historical database at www.ekh.lu.se. Standardized school years in Ljungberg and Nilsson 2009.

arithmetic education did raise the economic growth only in the Golden Age when the whole education sector grew more than one percentage point faster than GDP.

The lower panel of table 1 meets the demand for physical output estimates of education. It reports the growth rates of the number of completed school years, by adding up the years spent in school by those who finish a certain level of education in each year. Note the term standardised school year which denotes that the length of the school year, part time reading schools, and estimates of the attendance of the children is taken into account. Thus the actual length of the school year in 1868 was only 89 days, increasing to 230 in 1950 and onwards, and it is the latter number of days which equal one standardised school year. Seventy per cent of the expansion of primary education up to 1950 was due to the increase of the actual school year. The figures in table 1 show growth rates and therefore give no information about the magnitudes of the output, and graph 1 provides a picture of that. Of course the output of secondary and tertiary education were originally but a minor share and not until in the 1930s their combined output attained ten per cent of all education, and this figure includes lower secondary education which in the postwar period was transformed and included in compulsory education which here equals "primary education".

Graph 1. Output in thousands of standardised school years of education in Sweden, 1867-1995



Nonetheless, in the 1990s (upper) secondary and tertiary education made out close to a third of all education, measured in output of school years.

While the lengthening of the actual school year explains much of the expansion of primary education well into the twentieth century, the decades around the mid century display a striking variation. Low fertility in the interwar years explain the downturn in the 1930s, and the steep rise in output from the late 1940s is due both to the baby boom and an increase of compulsory education from six to nine years. After 1960 the wave-like output of primary education, around a stationary level, is explained by variations in fertility. Considering secondary education it is notable that expansion of output started already before 1930 and continued in spite of the demographic factor, and its growth rate over the period 1920-1945 was more than double that of the period 1867-1920. Output of tertiary education, on the other hand, slowed-down to a growth rate not much more than half that of the preceding period.

Now it can be asked whether the figures in table 1 can tell anything about productivity in education. There are the rates of change in physical output as well as the labour input volumes, and the difference between the two should show rates of the growth in labour productivity within education. Table 2 reports these figures and for comparison also labour productivity of the aggregate economy. Only during the period 1867-1920 shows the sector as a whole a positive change in productivity. Looking at the different levels of education, the secondary level improves and has a positive productivity change up to 1970, displaying a negative change only for the last period. Tertiary education displays a negative productivity change, according to this measure, for both periods after 1945. In the postwar period up to 1970 labour input in tertiary education increased by 10 per cent annually, though seemingly suffering from diminishing returns. For primary education this seems to have been the case all since 1920. Obviously the physical output measures, if taken to reflect the development of education, would not have added to the aggregate economic growth. The contribution of education remains disembodied in the national accounts even when improved with these physical output indicators.

Thus, even when improved with the recommendations of SNA93, national accounting provides a dismal picture of education's contribution to economic growth. However, so far the problem of quality change has been left out of the picture. Only the number of students and time spent at school have been taken account of in the construction of the output estimates. Probably no one should consider to estimate development of the production, for example, of cars just from the number of vehicles. Quality change must be taken account of in price indexes that are used for the deflation of commodity production. That has a direct bearing on the present case of productivity in education where labour is used for the accounting. In commodity production the remuneration of labour can actually be used for an estimation of productivity, at least under competitive conditions when the marginal product of labour equals the average product of labour. The former is the wage or salary which thus equals productivity. When making an account over time on these parameters deflation becomes a necessary step. However, it is important not to confuse the marginal product of labour with real wages as usually calculated by help of a consumer price index. Real wages so calculated indicate the purchasing power of the

Table 2. Labour productivity in the aggregate economy and the education sector in Sweden, 1867-1994. Annual rate of change in per cent

	1867-1994	1867-1920	1920-1945	1945-1970	1970-1994
GDP per capita of the population in ages 15-65	2.36	1.92	1.95	3.72	1.61
			Physical output/ labour input		
Primary	-1.63	0.93	-1.78	-2.03	-2.36
Secondary	-0.35	1.01	2.77	-3.71	-2.23
Tertiary	-0.28*	0.93	2.83	-2.65	-2.73*
Total	-1.51*	1.08	-1.16	-2.80	-2.93*

Note: * end year 1992. GDP from historical database at www.ekh.lu.se. and age specific population calculated from Wilmoth (2001)

wage earner but it has little to say about the marginal product. Instead the marginal product must be calculated as the nominal wage or salary deflated by the output prices of the actual production. Thus the marginal product of, for example, a shoe worker is the amount of shoes that he or she can buy, had the whole wage been spent on shoes. If productivity in shoe making is increasing faster than in other production, due to the competition in the labour market the shoe worker will not be able to increase the consumption of the usual goods but prices of shoes will go down and the shoe worker will be able to buy more shoes. Thus the real wage, as usually measured, will not reflect the productivity of the shoe worker but the real product wage, or the wage expressed in constant output prices, will do that (for a further discussion and application on sectors of Swedish manufacturing 1913-1980, see Ljungberg 2004).

Can this be of help for the economic estimation of education? Aren't we back on square one since output prices are, yet, missing. However: "To the economist the cost of any item is equal to the value of the opportunities foregone by the purchaser – the alternative use of his funds or his time." (Engerman 1971, p. 243) Education is "bought" by the tax payer, and the opportunity cost of taxes is foregone consumption. By paying taxes citizens confirm the price of education (and other public services) in a similar way as market transactions confirm prices of goods and services. In principle, therefore, the consumer price index (CPI), or the GDP deflator of consumption, could be seen as an output price index of education. In table 3 the labour cost of education has been deflated by CPI, and the result is an alternative estimate of the growth of output of the education sector. Since the input is valued at its opportunity cost it could be said to be the output of education "at market price." Actually this is an economic valuation of the growth of output in education and by deduction of the growth in labour input as shown in table 1, a new measure of productivity change is obtained. Actually it is the same as if the salaries in education were deflated by CPI, or the real salaries. However, the theoretical basis for this estimate of the output of education is more solid than the conventional or the

Table 3. Alternative output and productivity estimates of the education sector in Sweden, 1867-1994. Annual rate of change in per cent

	1867-1994	1867-1920	1920-1945	1945-1970	1970-1994
Education in GDP, alternative approach (CPI deflated)					
-at 'market price', Primary	4.60	4.16	2.20	6.87	1.31
-"- secondary	4.49	2.26	3.17	10.00	2.40
-"- tertiary	4.94*	2.74	-0.18	12.49	3.24*
-"- total	4.64*	3.56	2.18	8.10	2.19*
Less labour input = productivity change					
Primary	1.53	2.64	0.60	2.22	-1.21
Secondary	1.12	1.43	1.40	2.21	-1.22
Tertiary	1.14*	1.43	1.40	2.22	-1.41*
Total	1.42*	2.22	0.77	2.16	-1.44
Difference:Total alternative measure and physical measure	2.82*	0.58	2.05	4.53	-0.29
Difference: Education and GDP per capita of the pop. 15-65	-0.95*	0.30	-1.18	-1.56	-3.05

Note: * end year 1992. CPI from www.scb.se.

improved (SNA93) estimates. Whereas the two latter for simplicity assumes that output equals input and that no quality change takes place, is the suggested use of CPI as the deflator based on the assumption that opportunity cost could be used for the valuation of education.

As can be seen, the picture of productivity change is quite different from the one provided by the physical output estimates. Only for the period 1970-1994 is a negative productivity change displayed, and that pertains to all levels of education. The second line from the bottom shows the difference between the "market price" and physical productivity estimates for the education sector. The difference is substantial, in particular during the Golden Age. However, even if the opportunity cost approach brings us closer a "true" picture of the contribution of education to GDP, still there may remain a "disembodied" element in the output of education. The size of the disembodied element depends on the extent to which quality change in education is considered by the opportunity cost deflator, CPI. If we assume that quality of education has matched quality change in consumption goods then there is no disembodiment. Probably this is an underestimation as quality change in producer durables, such as machinery, has been faster than in consumption goods. Basically such technical change is a result of the growth of knowledge in which education has a part. The bottom line in table 3, showing that even with the alternative approach productivity in education is significantly lower than in the aggregate economy, may give a hint of the magnitude of the disembodiment.

Table 4. Human capital stocks in Sweden, due to different levels of education, 1870-1994. Annual rate of change in per cent

	1870-1994	1870-1920	1920-1945	1945-1970	1970-1994
- primary and lower secondary	2.25	3.27	2.14	1.82	1.13
- upper secondary	4.12	2.97	3.34	6.52	4.93
-"- tertiary	3.42	2.42	2.67	4.76	4.92
-"- total	2.40	3.25	2.20	2.15	1.71

III. Estimating the spill-over of education

Spill-over effects are difficult to measure and in want of unambigous evidence they are underpinned by theoretical arguments. However, Jorgenson and Fraumeni (1992) envisaged a way to estimate the output of the education sector along a human capital approach. Basically, they built on earnings and years of education in American censuses. Premiums on education over the life-time, were discounted to their present values back to the year of graduation, and these premiums were aggregated for the population to an annual series of the total output of education. In national accounts this approach does not fit since it would end up in double-counting, however, arguably it does offer an estimate of the spill-over from education; in other words, an estimate of the part of economic growth that can be attributed to education.

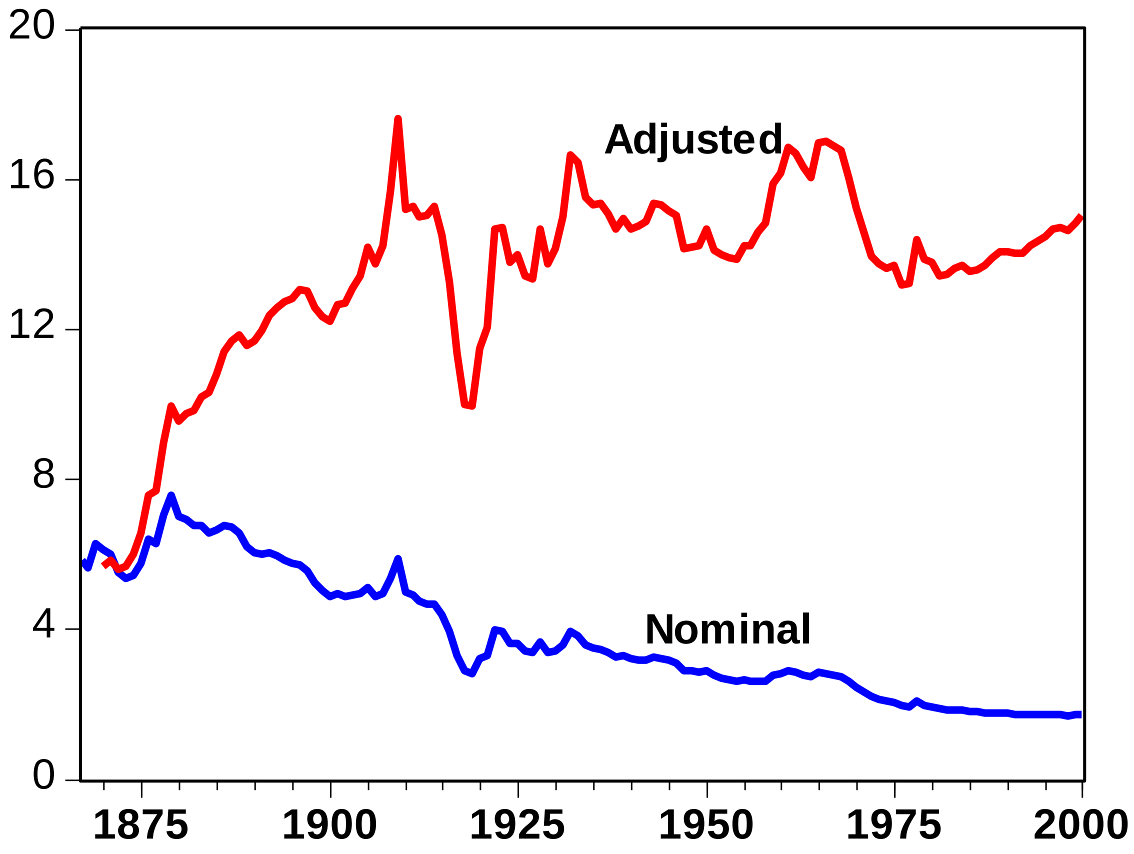
A similar approach is applied here, on the Swedish education sector over the period 1870-2000. However, since population censuses for this period do not provide data on education and earnings, a more macro-oriented approach is sought. A handful of occupations are taken as representative for different levels and tracks of education, and data on wages and salaries are used for the calculation of premiums on education. Age profiles of earnings have been constructed for certain benchmarks, and interpolated between the benchmarks. With annual time series of wages and salaries, earnings differentials have thus been constructed and combined with the age profiles, these have been accumulated up until the age of 65. The premiums on education have then been discounted to their present value in the year of graduation. The number graduating from different levels and tracks of education have then been multiplied with the corresponding present values, and this is taken as a measure of output.

Since this output is already accounted for under other items in the national accounts, and in a growth account will be hidden in the TFP, the volume cannot simply be taken as the contribution to GDP. However, it can be interpreted as the spill-over from education and its rate of change can also be taken as an alternative measure of productivity change in the education sector. By contrast to the physical productivity measure suggested in the preceding section, where the physical output growth less labour input growth would indicate productivity change, this premium on education-based measure actually takes account of quality change in education, i e, the growth of knowledge in science and curricula. Thus, it should be expected to indicate a higher productivity growth than the physical measure, and probably also than the CPI-deflated (opportunity cost measured) productivity estimate.

The calculation of the present value of the life-time premium on education presupposes the conversion of income into constant prices, which is done by the CPI index (reference year 2000). Furthermore, a discount interest rate is needed, and it is set at 2 per cent. Taken over the whole historical period, this is a bit lower than the average for five year government bonds which has been 2.7 per cent. Actually the interest rate has fluctuated a lot but if this were used, the result would be highly dependent on these fluctuations [Check sensitivity with alternative interest rates!]. In that sense the output estimate is a compromise between an *ex ante* estimate, as reflected by the interest rate, and an *ex post* estimate, as reflected by the annual earnings. However, the later we proceed in the period 1870-2000, the more the whole estimate turns *ex ante*. This is due to the simple fact that the life-time earnings of a youngster of sixteen will end first about 2050. Here, age profiles of 2002 has simply been frozen to 2050, and the trend in real earnings 1975-2000 has been extrapolated into the future down to 2050.

The output estimate in the present version of the paper only includes compulsory education and vocational education. As should be clear from the preceding section, compulsory education successively increased from effectively only a few years in 1870 to nine years in 1970. This is taken account of with the measure "standardized school years." For each individual leaving school, the amount of standardized years of schooling has been estimated and this is the physical output which should be valued with the premium on education. However, a fix point is needed, a counterfactual wage of "raw labour" above on which the premium on education can be estimated. This is a particular problem for the estimation of the output of mandatory education. For other levels of education, the premium on education can be based on differentials between earnings of graduates and those who left school at the preceding level. For example, output of higher technical education can be based on the earnings differential between a graduate engineer and a college engineer (Ljungberg 2004). A clue to this problem is provided by the relative earnings of a graduate engineer over a male worker in manufacturing. Figure 1 shows that nominally the relative earnings of the engineer have displayed a secular decline, from about six times the worker's wage, to less than the double. However, if the amount of schooling is taken into account the picture changes. A graduate engineer has over this period had roughly sixteen years of schooling, whereas the worker with only compulsory and compulsory schooling had barely one year in 1870 but eight years in 2000. During the first forty years, up to 1910, the so adjusted relative earnings of the graduate engineer improved a lot, most probably due to insufficient supply of engineers during the "great spurt" of the Second Industrial Revolution in Sweden.

Figure 2. Earnings of a graduate engineer relative to a male worker in manufacturing, 1870-2000. Nominal and adjusted for years of schooling



Assuming a constant elasticity of earnings due to years of schooling, the wage of the worker can be modelled:

LOG(WJRM) = α + β1 LOG(HCW) + β2 log(AINGJ)

where WJRM is the average wage of a male worker in manufacturing, HCW is the average number of standardized years of schooling in the population of age 15-65, and AINGJ is the average earnings of a graduate engineer. The earnings series are Johansen-cointegrated (1%) and the same goes (at 5%) for HCW and WJRM for the period 1910-2000. Thus the model has been run on level data. For this period an OLS regression gives:

Dependent Variable: LOG(WJRM)
Method: Least Squares
Date: 12/08/11 Time: 11:55
Sample: 1910 2000
Included observations: 91

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.955948	0.103600	-28.53243	0.0000
LOG(HCW)	0.437978	0.135362	3.235603	0.0017
LOG(AINGJ)	1.118329	0.029843	37.47360	0.0000

R-squared	0.997286	Mean dependent var	9.437514
Adjusted R-squared	0.997224	S.D. dependent var	1.654451
S.E. of regression	0.087166	Akaike info criterion	-2.009600
Sum squared resid	0.668612	Schwarz criterion	-1.926824
Log likelihood	94.43680	F-statistic	16167.71
Durbin-Watson stat	0.299058	Prob(F-statistic)	0.000000

Here are some worrisome values, the exceedingly high R2 and the low Durbin-Watson, but let's for a moment ignore this with the remark that the variables are independently constructed from different sources. Yet, both independent variables are highly statistically significant and this support that the model can be used for the construction of the counterfactual "raw labour" wage, i e the wage which should correspond to no schooling:

LOG(RAWLABOUR) = -2.956 + 0.438 x 0 + 1.118 x LOG(AINGJ)

The premium on compulsory and vocational education is then calculated on the wage differential between WJRM and RAWLABOUR. Adding the present values for each year with the amount of standardized school years acquired by each individual leaving school gives the value of the output, in the prices of 2000. Table 5 reports the resulting growth rates of the output of compulsory and vocational education on row F. For the whole period the output is not that different from the CPI deflated input measure but there are some differences in the subperiods. In particular the slow-down in the input based measures after 1970 have no correspondence in the earnings-based output. However, the latter is for the end of the 20^{th} century to an increasing extent an *ex ante* measure as the earnings after the early 2000s are extrapolated.

Table 5. Input and output of primary/compulsory education in Sweden, 1870-1994/2000. Annual rate of change in per cent

	1870-1994	1870-1920	1920-1945	1945-1970	1970-1994
A. factor cost input	*3.07	1.52	1.60	4.65	*2.52
B. physical output in standardized school years	1.44	2.45	-0.18	2.62	0.16
C. productivity I (B - A)	*-1.63*	*0.93*	*-1.78*	*-2.03*	*-2.36*
D. CPI deflated input	4.60	4.16	2.20	6.87	1.31
E. productivity II (D – A)	*1.53*	*2.64*	*0.60*	*2.22*	*-1.21*
F. earnings based output	4.26	5.69	2.75	4.83	4.07
G. *productivity III (F – A)*	*1.19*	*4.17*	*1.15*	*0.18*	*1.55*

Note: Items have not been exactly synchronized in this version – row F includes vocational education.

IV. Concluding remarks

The contribution of education to the economy is entrenched in measurement problems. In national accounting the principal problem is that the lack of data on output and prices for non-marketed services, such as education or health care, has given rise to the practice to estimate output from input. As a consequence no productivity change seemingly occurs in these services. Physical output estimates are not a solution unless they take account of quality change. Education as well as health care have developed with the growth of scientific knowledge and therefore quality change has been substantial. Productivity estimates based on physical output series will hence also underestimate growth. I suggested another solution based on the principle of opportunity cost of the taxes that have paid for education. Output is still assumed to equal labour input but its valuation at constant prices should be calculated with the help of CPI and not an index of wages and salaries. Applied on the development of the Swedish economy 1870-1994, the educations sector achieved an annual rate of growth of 1.5 per cent compared with 2.4 per cent for the total economy.

In the accounting exercises of section II, education does not emerge as a driving force in economic growth. If education has played such a role there must be substantial spill-over effects from education that have contributed to a higher productivity growth in other parts of the economy. This is demonstrated in section III which actually indicates large spill-over effects. Should these be taken as measures of productivity change in education, this is far from negligible...

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Table 1. GDP and physical output of the education sector in Sweden, 1867-1994. Annual rate of change in per cent

	1867-1994	1867-1920	1920-1945	1945-1970	1970-1994
GDP (at market prices)	3.07	2.59	2.88	4.35	1.85
Education in GDP, conventional approach					
-at factor cost, primary	3.07	1.52	1.60	4.65	2.52
-"- secondary	3.37	0.83	1.77	7.79	3.62
-"- tertiary	3.80*	1.31	-1.58	10.27	4.65*
-"- total	3.22*	1.34	1.41	5.94	3.63*
Output of standardised school years					
Primary	1.44	2.45	-0.18	2.62	0.16
Secondary	3.02	1.94	4.54	4.08	1.39
Tertiary	3.52*	2.24	1.25	7.62	1.92*
Total	1.71*	2.42	0.25	3.14	0.70*

Note: * end year 1992. GDP from historical database at www.ekh.lu.se. Standardized school years in Ljungberg and Nilsson 2009.

Table 2. Labour productivity in the aggregate economy and the education sector in Sweden, 1867-1994. Annual rate of change in per cent

	1867-1994	1867-1920	1920-1945	1945-1970	1970-1994
GDP per capita of the population in ages 15-65	2.36	1.92	1.95	3.72	1.61
Physical output/ labour input					
Primary	-1.63	0.93	-1.78	-2.03	-2.68
Secondary	-0.35	1.01	2.77	-3.71	-2.23
Tertiary	-0.28*	0.93	2.83	-2.65	-2.73*
Total	-1.51*	1.08	-1.16	-2.80	-2.93*

Note: * end year 1992. GDP from historical database at www.ekh.lu.se. and age specific population calculated from Wilmoth (2001)

Table 3. Alternative output and productivity estimates of the education sector in Sweden, 1867-1994. Annual rate of change in per cent

	1867-1994	1867-1920	1920-1945	1945-1970	1970-1994
Education in GDP, alternative approach (CPI deflated)					
-at 'market price', primary	4.60	4.16	2.20	6.87	1.31
-"- secondary	4.49	2.26	3.17	10.00	2.40
-"- tertiary	4.94*	2.74	-0.18	12.49	3.24*
-"- total	4.64*	3.56	2.18	8.10	2.19*
Less labour input = productivity change					
Primary	1.53	2.64	0.60	2.22	-1.21
Secondary	1.12	1.43	1.40	2.21	-1.22
Tertiary	1.14*	1.43	1.40	2.22	-1.41*
Total	1.42*	2.22	0.77	2.16	-1.44
Difference:Total alternative measure and physical measure	2.82*	0.58	2.05	4.53	-0.29
Difference: Education and GDP per capita of the pop. 15-65	-0.95*	0.30	-1.18	-1.56	-3.05

Note: * end year 1992. CPI from www.scb.se.

Table 4. Human capital stocks in Sweden, due to different levels of education, 1870-1994. Annual rate of change in per cent

	1870-1994	1870-1920	1920-1945	1945-1970	1970-1994
- primary and lower secondary	2.25	3.27	2.14	1.82	1.13
- upper secondary	4.12	2.97	3.34	6.52	4.93
-"- tertiary	3.42	2.42	2.67	4.76	4.92
-"- total	2.40	3.25	2.20	2.15	1.71

Table 5. Deaths during the first year of life per 1,000 born (IMR) and births per 1000 in the population (CFR) in Europe, 1890-1914

Country (in brackets limitation of data)	IMR 1890/94	IMR 1910/14	IMR % change	CFR 1890/94
Austria	248.8	187.8	-24.5	370
Belgium	162.8	136.4	-16.2	293
Bulgaria (1892-1910)	144.3	149.3	3.5	366
Denmark	138	98.2	-28.8	305
Finland	147.8	111.6	-24.5	320
France	169.6	118.8	-30.0	224
Germany	223.6	163.2	-27.0	362
Hungary (1891-1910)	255.3	197.4	-22.7	417
Ireland	99.8	91.8	-8.0	228
Italy	186.6	138.6	-25.7	--
Netherl	166	103.6	-37.6	--
Norway	98.2	66.2	-32.6	301
Romania (1892-94; 1912-14)	221.4	222	0.3	402
Russia (1892-1910)	277.6	254	-8.5	490
Serbia (1890-1910)	169.2	139	-17.8	425
Spain (1884-88; 1910-14)	187.2	151.2	Na	352
Sweden	104.4	72.2	-30.8	276
Switzerl	155	102.2	-34.1	275
Engl & W	148.8	108.6	-27.0	305
Scotland	125.8	109.2	-13.2	306
Unweighted average	171.5	136.1	-20.3	334

Source: Mitchell (2003).

Table 6. OLS regression on infant mortality change among European countries 1890-1910

	(1)	(2)	(3)	(4)
Constant	-0.0041 (0.777)	-0.0057 (0.564)	-0.0014 (0.865)	-0.0054 (0.248)
ENROL1890	-0.0002 (0.105)	-0.0002 (0.065)	-0.0002 (0.039)	-0.0002 (0.019)
GDPC1890	0.0000 (0.281)	0.0000 (0.239)	0.0000 (0.179)	0.0000 (0.179)
GDPCHANGE	-0.3561 (0.457)	-0.3626 (0.411)	-0.2759 (0.569)	
FER1890	0.0000 (0.858)			
FERCHANGE	0.0030 (0.318)	0.0031 (0.275)	0.0051 (0.100)	0.0048 (0.102)
IMR1890	0.0001 (0.800)	0.0000 (0.845)		
Adjusted R2	0.093	0.218	0.307	0.345
F-stat prob.	0.413	0.259	0.089	0.045
Observations	13	13	16	16

Note: Probability in parentheses. Enrolment data from Lindert (2004, p. 91 f) consider number of pupils in primary school per thousand in ages 5-14; enrolment in Ireland calculated from Mitchell (2003); IMR and fertility data from Mitchell (2003); GDP per capita data from Maddison (2008), with series interpolated between benchmarks for a few countries.