Upgrading the Low Skilled:

Is Public Provision of Formal Education a Sensible Policy?

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Abstract

At various political levels, including the OECD and the EU, it is repeatedly emphasized that upgrading the low skilled is an important area for the economic and social development of modern societies. However, employers are typically reluctant to train low skilled, who in their turn are unwilling to participate due to financial constraints or a perception of low quality and/or returns to training. If this is a market imperfection, a possible remedy is suggested by public provision of formal education where enrollees are eligible for financial support. A drawback is that the costs may be large and the economic returns to formal adult education (AE) for low skilled, a crucial measure to assess if expenses should be increased or decreased, is a virtually unexplored issue. This study uses Swedish register data 1990-2004 of low skilled siblings aged 24-43 in 1994 to estimate difference-in-difference-in-differences models which include family fixed effects. The findings indicate a year of AE improves earnings by 4.4 per cent, but calculations indicate that the private returns alone only roughly cover the costs incurred by society. It implies that to justify the expenses, non-trivial social returns to AE are needed.

Keywords: Human capital, adult education, earnings

JEL: H30, H52, I20, J24, O30

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1 Introduction

Adjustments in the demand for skills have been proposed to follow a secular pattern which favors high skilled workers (e.g. Katz and Murphy 1992, Machin and Van Reenen 1998, Acemoglu 2002, Autor *et al*. 2008). In this perspective, upgrading the qualifications of low skilled workers may prompt substantial gains for the individual and for society as it could boost productivity and employability as well as have more far-reaching effects on overall economic growth, democracy and social cohesion (Krueger and Lindahl 2001, Gradstein and Justman 2002, Glaeser *et al*. 2007). Empirical data indicate that while the incidence of training among employed in many countries is between 25 and 50 per cent per year (OECD 2004, 2006), a consistent finding is that it is of short duration and mainly involves the high skilled (e.g. Brunello 2001, Arulampala *et al.* 2004). It partly reflects employer preferences to invest in already productive individuals, but also the unwillingness of low skilled to participate due to financial constraints and/or a perception of low quality and returns to training (Oosterbeek 1998, OECD 2003, 2006). If this represents a market imperfection, a remedy is suggested by public provision of formal education, i.e. schooling integrated into well-known, structured and certified programs, where participants are eligible for financial support. It would alleviate financial constraints, improve the quality of training and (information on) the returns and also circumvent employer reluctance to engage low skilled in training. Although some governments, the Scandinavian ones in particular, do spend large sums on upgrading low skilled, the dominant pattern across countries is that returning to education mainly occurs during the early stages of working life in the form of extended initial education (Müller and Kogan, 2008). The different government strategies may partly stem from that we know surprisingly little about the costs and benefits of policies encouraging adults to return to education. The costs are potentially large, not least in terms of foregone production value, and the literature evaluating labor market programs has provided mixed support for adult schooling as a tool against non-employment traps (Heckman *et al.* 1999, Kluve 2006). However, there is scant research which directly addresses the economic returns to formal education for low skilled, a crucial measure to assess if such expenditures should be increased or decreased. The present study fills some of this gap in the economics literature.

The purpose of this paper is to evaluate the earnings impact of formal education on low skilled, ineligible for tertiary education and aged 24-43 in 1994. The study is based on register data 1990-2004 from Sweden where there has been considerable public supply of adult education (henceforth AE) at compulsory, upper secondary and tertiary levels. The demand for AE is enhanced by the institutional set-up which includes that participants are eligible for financial support, sufficient to cover modest living expenses, and that workers are legally entitled to take (unpaid) study-leave and afterwards be reinstated with the

same terms of employment. According to standard theory, enrolment in education depends on whether the expected present value of the benefits exceeds the costs of enrolment. Skill upgrading is therefore more likely if the expected returns to AE are relatively high and/or the expected opportunity cost is relatively low. In the case of AE, the decision to enroll (or not to enroll) is made repeatedly over time, and the expected benefits and costs may be sensitive to changes in a number of underlying factors such as relative wages, borrowing constraints, preferences, health, the individual's discount rate, new information, business cycle variations and structural changes.[1] Consequently, a decision to not enroll in AE may change the following year since the net value is liable to vary over time as well as between individuals. To take into account any systematic differences between participants and non-participants, the empirical strategy is to estimate difference-in-difference-in-differences (DDD) models. These regressions include controls for completed course credits and pre-treatment earnings trajectories as well as for sick-leave transfers, early retirement pensions and social welfare benefits to reflect health and labor market marginalization. Within this framework, information on siblings is also explored to *i*) generate a control group of siblings which to a greater extent overlap the treated in terms of both unobservable and observable characteristics, and to *ii*) introduce family fixed effects which control for permanent family background characteristics.

This is the first study which comprehensively explores the economic consequences of offering skill upgrading for low skilled via formal education. Of earlier studies, the only peer-reviewed empirical analysis of the earnings effects of AE in Sweden is Stenberg and Westerlund (2008). They found large beneficial effects for a sample of long-term unemployed, on average 14 per cent for males and 23 per cent for females, but with point estimates decreasing for those remaining longest in AE. As will be shown later, the results are highly influenced by the sample of the study. In fact, other evaluations using Swedish data have reported conflicting findings. Albrecht, van den Bergh and Vroman (2004) found, for very small samples, no statistically significant earnings effects while Ekström (2003) reported negative effects for males and insignificant for females.[2] These studies are all based on difference-in-differences (DiD) estimates involving participants aged 25-55, where binary variables indicate AE registration at compulsory and upper secondary level. Information on course credits and further education at tertiary level is disregarded. This is in contrast with the present study and also with earlier US studies which have been based on accomplished course credits at community college, mainly involving education at tertiary level. These provide estimates of the proportional returns to AE, comparable to estimates presented in the returns to schooling literature, but have generally dealt

[1] Altonji (1993), Iwahashi (2004), Killingsworth (1982), Sjögren and Sällström (2004), Wallace and Ihnen (1975), Warner and Pleeter (2001) and Weiss (1971).
[2] A detailed reconciliation of the results is found in Stenberg (2009).

with individuals returning to college after only a couple of years' work experience (Light 1995, Monks 1997, Leigh and Gill 1997). The only peer-reviewed study which regards skill upgrading of adults is Jacobson, LaLonde and Sullivan (2005). They analyzed a sample of laid-off workers aged 20-59 in Washington State, including 16,000 participants in community college, with access to data on quarterly earnings at least three years before and four years after displacement. Individual-specific fixed effects estimates indicated a year of studies was associated with a 9 per cent earnings gain for men and 13 per cent for women, a payoff they found covered the costs incurred by the society. A major difference compared with the present study is that participants had no public financial support. Moreover, 90 per cent of the sample in their study had at least a high school degree and about 50 per cent had completed some college earlier in life. Thus, their results are not necessarily applicable to low skilled or to a situation where study allowances decrease the opportunity cost. One may also expect that the returns to AE are lower in European labor markets which, compared with the US, are characterized by more compressed distributions of wages as well as of skills (e.g. Harjes, 2007, IALS, 2000). [3]

The contribution of this study is to assess a policy which actually has induced low-skilled to upgrade in large numbers. Foremost, it provides a transparent account of its economic consequences and the main finding is that a year of AE on average increases earnings. The most elaborate model specification yields estimates representing 4.4 per cent, proposing that skill upgrading improves employability and/or wages among low skilled. However, calculations indicate substantial costs to society such that the private benefits only roughly cover the total costs. The implication is that, to make a convincing case in favor of an extensive AE policy, the social returns must be of economic importance. The analysis calls for a balanced discussion on AE, as it partly questions the inherent optimism expressed by e.g. the OECD (OECD 2004, 2006) and the European Union's Lisbon strategy for growth and jobs (EU 2007, 2008).

The plan of the paper is the following; the next section briefly outlines the role of AE in Sweden. Section 3 contains a description of the data and Section 4 presents the empirical method and estimates of the earnings return. In Section 5, the estimated benefits are set in relation to approximated costs. Section 6 concludes.

[3] Other Scandinavian countries and Germany have AE-like policies which have not been evaluated. In continental Europe (except Germany), public provision of formal education for adults seems practically non-existent. Studies in the UK have dealt with increases in competence level (NVQ), achieved by attending courses and/or through performing new tasks at the current job. They typically report no increase in earnings (Jenkins 2004, Jenkins *et al*. 2003 and Silles 2007).

2 Formal education for adults in Sweden

All public education in Sweden is free of charge. School is compulsory for children between the age of seven and 15. This is followed by upper secondary school, which until 1996 consisted of some 20 two-year programs, most of which were vocational, as well as five different theoretical three-year programs. To meet the general admission requirements for entering university, three years of upper secondary school is generally needed.[4] The most frequent form of AE takes place at upper secondary level, giving those with short educations the opportunity to improve and/or redirect their educational qualifications and obtain eligibility for studies at tertiary level.[5]

There are several institutional features that encourage enrolment in AE. First, legislation since 1974 entitles employees to take leave to attend any kind of training and to be reinstated with the same working conditions and pay. Second, participants are eligible for study allowances sufficient to cover modest living expenses (approx. €800 per month). Of those registered 1994-1995, six out of ten received some study allowance and the average sum in one year was SEK 31,300 (€ 3,220). One third is a grant and two-thirds is to be repaid under favorable conditions.[6] The deal is that a recipient is obliged to complete at least 75 per cent of the registered courses, or the government will request repayment. The same condition applies if yearly earnings of a full-time student exceed about €10,000, giving a disincentive to work during AE. A third institutional feature is that the supply of AE is vast and free of charge as Swedish municipalities since 1969 are bounded by law to offer adult schooling at compulsory and upper secondary level. The institute responsible is *Komvux* where applicants generally have access to their preferred courses. For those who wish to continue to college, tertiary education is offered in about 30 cities (in a population of 9 million). Apart from traditional theoretical university studies, this also includes vocational programs where one third of the education takes place in a workplace (*Kvalificerad yrkesutbildning*). Thus, tertiary level studies are to some extent designed for specific occupations and professions.

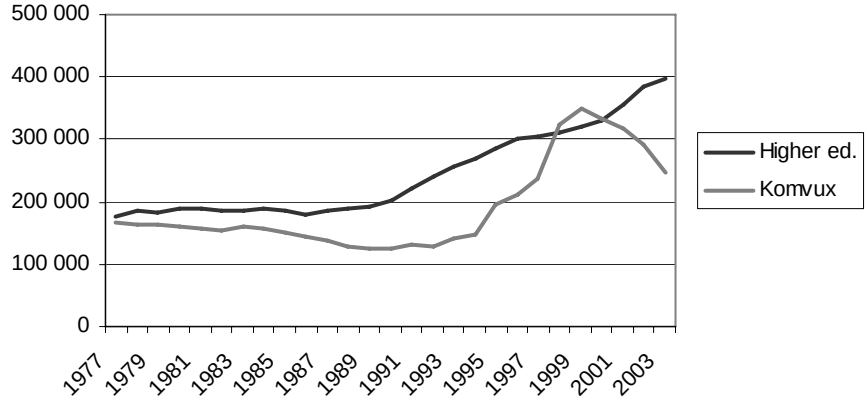
The institutional set-up makes it likely that AE follows from participants' own initiatives, but should the opportunity cost become very low, e.g. due to overall poor employment prospects, participants may merely consume AE or enroll to "escape" a dismal labor mar-

[4] All educational paths share a relatively large element of general (rather than specific) education, plausibly facilitating re-schooling for adults. The design of regular education is of course likely to shape the appropriate supply of AE in a country, but the issue is beyond the scope of this paper.
[5] For individuals at least 25 years old, this could also be achieved through four years of work experience and passing grades in Swedish and English at a three year upper secondary level.
[6] Seftor and Turner (2002) reported that changes in the Pell grant affected adults' probability of college enrolment markedly more than typically college-aged students.

ket situation. Looking at the data, municipalities actually allowed some 5 per cent of the AE participants registered 1994-1995 to draw social welfare benefits; it plausibly concerned individuals who were believed to have slim chances of finding work.

Before turning to the data description, it is useful to consider the AE participation and the labor market situation during the period under study. Figure 1 depicts the numbers registered in Komvux and in higher education since the late 1970s (the population aged 16-64 varied around 5.6 million during the 1990s). A noteworthy point is that, after years of very low unemployment, Sweden underwent a deep recession as unemployment rates soared in 1990-1993 from 1.7 to 8.2 per cent before gradually decreasing to 4 per cent from 2000 onwards. From autumn 1993, the government started to financially assist municipalities in providing seats at Komvux for unemployed individuals. These represented around 20 per cent of the seats in 1994 and 1995. It preceded the introduction of "The Adult Education Initiative" which was in effect from autumn 1997 until 2002, involving a year of full-time studies at Komvux with participants entitled to a Special Grant for Education and Training (UBS) equal to a maintained unemployment insurance benefit. The public expenditures in Komvux then amounted to one-fourth of that for regular upper secondary education, and the numbers enrolled were at one stage comparable to the 300,000 per year in regular upper secondary school for youths. Figure 1 also shows that the supply of college courses steadily increased during this period, facilitating access to most study programs although the financial conditions for studying at this level did not change.

Figure 1. Number of enrollees in higher education and Komvux 1977–2003.



3 Data and descriptive statistics

The longitudinal data of this study originate from several registers administered by Statistics Sweden, covering the whole population residing in Sweden from 1982 onwards. The registers include information on annual earnings, transfer payments, participation in AE, studies in higher education and records of siblings and parents. Course registration in AE is available from 1979, but information on course completion and grades is only reliable from 1994.

The sample is limited to individuals 24-43 years old in 1994 with an educational level conditioned to be two year upper secondary level or shorter, thereby including about 60 per cent of each cohort. The age span allows retrospective information on labor market outcomes of all 20 cohorts and they are also unaffected by retirement decisions up to the year of the final observation in 2004. Foreign born are excluded if they immigrated at age seven or above, and the same applies to individuals registered in AE between 1979 and 1993. This last condition is meant to generate a "clean" sample where both treated and control group individuals have repeatedly taken the same decision to not enroll in AE up to 1993. AE participants who registered for their first semester at some stage 1994-1995 are considered in the treatment group, while the control group is conditioned to not have enrolled in AE before 1996. This constitutes what will be referred to as the "population sample". From the population sample, a subset is extracted consisting of treatment group members who have at least one sister or brother with the same parents within the population sample (i.e. half-siblings are excluded). The treated and non-treated siblings constitute the "sibling sample". Descriptive statistics are shown in Table 1 below.[7]

[7] In the Appendix, Tables A.1 and A.2 present data of males and females (brothers and sisters).

Table 1. Descriptive statistics of treated and control groups of population sample and sibling sample.

	Population sample		**Sibling sample**	
	AE	Controls	AE	Controls
N	29236	781885	13021	19335
Female	.634*	.406	.663*	.406
Age 1994	30.75*	33.17	31.32*	32.43
Family birth order	1.82*	1.93	2.32*	2.40
Years of schooling	10.39*	10.30	10.33*	10.27
− Less than compulsory school (< 9 years)	.009*	.027	.011*	.022
− Compulsory school (9 years)	.245*	.275	.269*	.302
− 1-year upper secondary school (10 years)	.093*	.070	.097*	.064
− 2-year upper secondary school (11 years)	.653*	.629	.622*	.612
Earnings 1992 [a)]	108.9*	137.1	106.4*	129.0
Earnings change from 1990 to 1992 [a)]	- 5.5	- 5.4	- 6.2	- 7.1
Zero annual earnings 1992	.134*	.115	.139	.131
Child(ren) at home 1992	1.27*	1.25	1.41*	1.27
Parental leave transfer 1992 > 0	.250*	.176	.276*	.193
− amount if above zero [a)]	37.0*	30.7	36.3*	31.2
Unemployment insurance benefits 1992 > 0	.222*	.166	.222*	.188
− amount if above zero [a)]	42.5*	48.3	42.5*	49.9
Active labor market prog. benefits 1992 > 0	.155*	.096	.145*	.116
− amount if above zero [a)]	30.1*	32.3	30.1*	32.3
Sick-leave and rehabilitation 1992 > 0	.275*	.204	.283*	.227
− amount if above zero [a)]	20.7	20.3	21.5	20.3
Pension 1992 > 0	.010*	.026	.010*	.024
− amount if above zero [a)]	61.8*	64.9	63.8	64.3
Social welfare 1992 > 0	.145*	.081	.145*	.115
− amount if above zero [a)]	11.9*	11.1	11.5	12.1
Regional employment 1993	.725*	.723	.723*	.722
Stockholm county 1993 [b)]	.180*	.142	.157*	.141
Inland of Norrland 1993 [b)]	.052*	.059	.058	.062
Foreign born	.024*	.019	.027	.028

Notes: * Indicates difference compared with control group is significant at a 5 per cent level.

[a)] SEK 2004 prices in thousands, € 100 is approximately SEK 970.

[b)] Inland of Norrland is a sparsely populated area in the north of Sweden with permanently higher than average unemployment rates. Stockholm County hosts 20 per cent of the population and the overall employment level is higher than in any other region of Sweden.

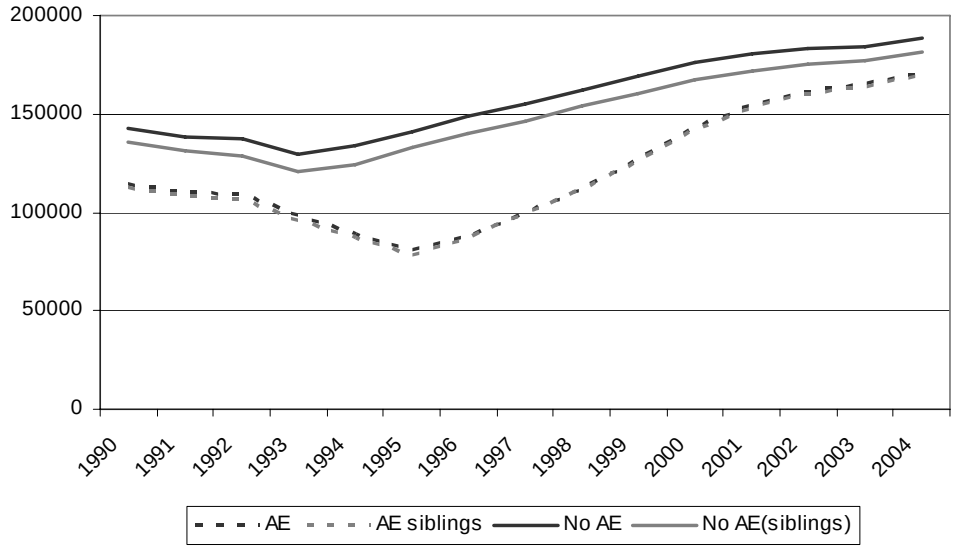
Retaining the population sample makes it possible to check if the sibling sample differs in a manner which drives the results (see Section 4.2). Males are slightly overrepresented among low-skilled in general (.532), and even more so in this sample (.584) since females comprise about two-thirds of the AE enrollees and those in AE prior to 1994 have been excluded. The 29,236 defined as AE enrollees in the population sample represent 1.4 per cent of the total labor force aged 24-43 and 3.6 per cent of the present sample. Participation across age groups within the sample ranges from 1.6 to 7.3 per cent (youngest co-

hort).[8] As expected, the sibling sample generally displays smaller differences in mean values between treated and controls. For instance, the age gap is reduced from 2.42 years to 1.11 years while the difference in years of schooling goes from .09 to .06. The differences typically represent one-tenth or less of the standard deviations, except for the age variable, earnings in 1992, parental leave and unemployment benefits, for which the differences represent about one-fifth of the standard deviations (not displayed). Labor market related outcomes before enrolment, collected from 1992 to elude any Ashenfelter's dip, indicate that public transfers such as unemployment benefits, sick-leave or social welfare are more frequent among AE individuals.[9] For females, parental leave is also more frequent among the treated. Parents are entitled to 13 months of benefits of which most are used before the child is two years old. The overall benefit levels for unemployment, sick-leave and parental leave are relatively generous, varying around 80 per cent of the previous earnings level.

Figure 2 displays the earnings trajectories of the samples (note the recession in the early 1990s). Important differences concern, first, that the average earnings of the treated are below the earnings of the respective control groups and, second, that the sibling sample control group earnings are between 4 and 7 per cent lower than the population sample control group. Both of these patterns indicate that AE individuals partly come from more disadvantaged backgrounds. Earnings of males (brothers) and females (sisters) are shown in Figure A.1 and A.2 in the Appendix. Low earnings reasonably mirrors a lower opportunity cost of enrolment, and possibly also a lower average productivity, which in turn may lead to less on-the-job-training and a higher demand for publicly provided AE. [10] The earnings gap of the treated vis-à-vis the control groups shrinks as compared between the pre-enrolment years 1990-1992 and 2004, but there is a rather long period of low earnings following the first enrolment in 1994.

[8] Comparing the extent of formal AE between countries is difficult as it takes many shapes and financing arrangements vary (Pont, 2004), but it appears safe to say that it is exceptionally large in Sweden.
[9] Using the empirical model specifications presented later in Section 4.1; regressions on the earnings change 1990-1992 overall reject that AE participation is preceded by a fall in earnings.
[10] Lower earnings might also be expected as AE from 1994 partly became an active labor market program, but the gap remains if the samples are restricted to have received no unemployment benefits in 1992.

Figure 2. Annual earnings of the population sample and sibling sample; treated and control groups.



Note: SEK 2004 prices, € 1 is approximately SEK 9.70.

Table 2 presents percentage earnings changes, using the average 1990-1992 as the base. In 1999, five years after the first registration in AE, the increases of the control groups are higher than for the treated groups. Two years later, in 2001, the relation has switched to the advantage of the AE individuals.[11] The long period of low earnings reflects that AE credits were often accomplished slowly across semesters and with considerable traffic in and out of AE. About 45 per cent of the treated were registered in AE after 1998, 22 per cent at some stage after 2001. Individuals do not continuously remain in AE; the fraction registered every year from 2000 was only 2.8 per cent.

Table 2. Annual earnings of treated and control groups.

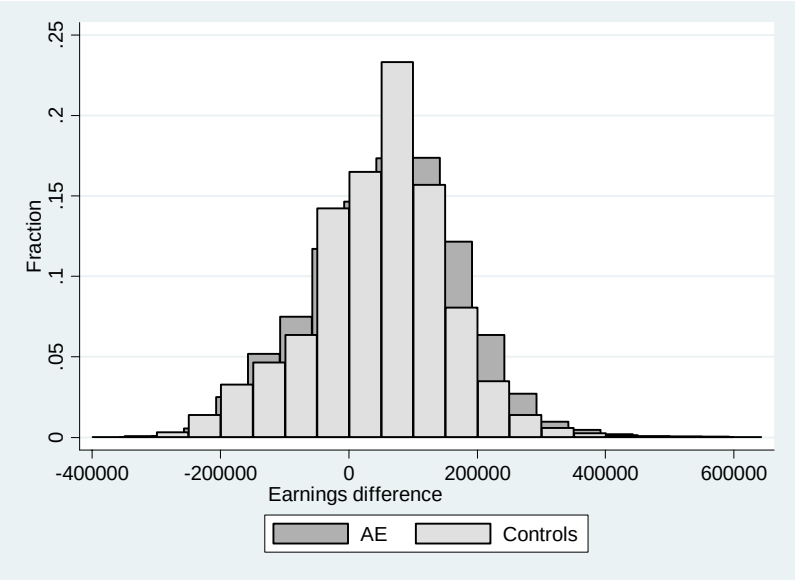
Annual earnings, SEK 2004 prices in thousands.
Percentage earnings change is measured with the average 1990-1992 as the base.

	Average 1990-1992	**1999**		**2001**		**2004**	
Population sample							
AE	111.2	126.6	13.8%	154.9	39.2%	171.2	53.9%
Controls	139.4	168.8	21.1%	180.7	29.6%	188.9	35.5%
Sibling sample							
AE	109.1	126.4	15.9%	153.2	40.5%	170.3	56.2%
Controls	132.3	159.9	20.9%	171.5	29.6%	181.4	37.1%

[11] A higher earnings increase among the treated could reflect their younger age, but comparing the population sample control group with the sibling control group (where the siblings are younger) shows no such pattern.

The behavior could be explained by that the very same variables which influence the decision to enroll in AE, i.e. changes in relative wages, information, employment opportunities, borrowing constraints etc., also work in the opposite direction and make vulnerable the decision to *stay on* in AE. In the empirical analysis, if a participant returns to AE in 2004, and subsequently earns less than in previous years, it is seen as part of the outcome. Figure 3 shows histograms of the difference in earnings between 2004 and the average 1990-1992, for treated and controls. Mean values are SEK 60,000 for treated and SEK 49,400 for the control group (61,300 and 49,100 for the sibling sample).

Figure 3. Distribution of the earnings change 2004 as compared to the average 1990-1992, treated and control group of the population sample.

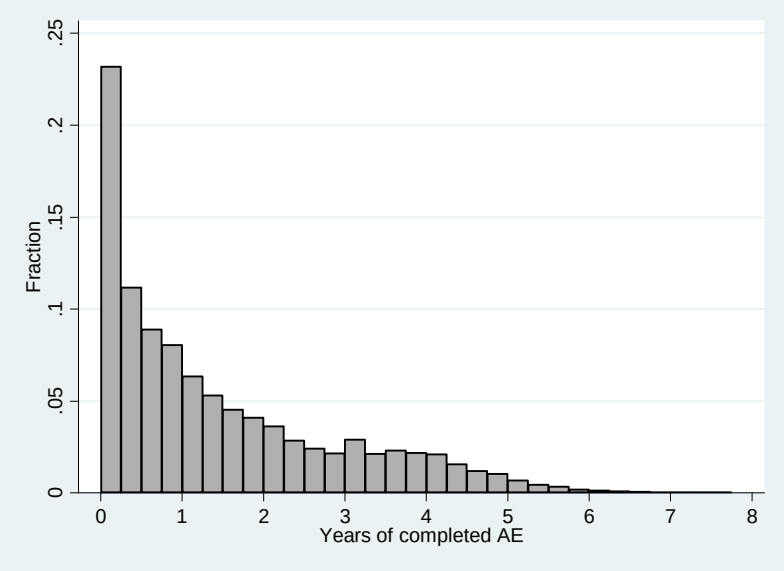


Note: SEK 2004 prices, € 1 is approximately SEK 9.70.
Standard deviation: 111,331.

Turning to the data on AE, as long as registration concerns credits at Komvux (compulsory and upper secondary levels), each course is linked to a number of lecture hours which is equal to its number of credits. The course credits of each individual are accumulated (1) within each semester and (2) across semesters. The total sum of credits is the number of *registered* course credits.[12] Adding the condition that a passing grade has been reported, the sum comprises the *completed* number of credits. As for higher education, the records of completed tertiary studies are added to generate the "Total years of completed AE" (expressed in years of full time studies). Figure 4 presents the distribution of completed AE among the treated, given at least one credit as recorded from 1994 to 2003.

[12] Following the Swedish National Agency for Education (2000), credits at Komvux are divided by 500 to express the amount of education in years. The records of Statistics Sweden do not contain information on upper secondary school diplomas attained via AE.

Figure 4. Distribution of completed AE 1994-2003, treated of the population sample.



Of those defined in the treatment group, 12 per cent completed zero credits, one-third completed courses representing less than .25 years of studies and 57 per cent less than one year. The overall small amounts of credits are plausibly related to the sensitivity of the enrolment decision discussed above, e.g. individuals who find jobs or opt out of AE as they find it more demanding than expected.

The contents of the studies are presented in Table 3, corresponding gender specific statistics are provided in Tables A.3 and A.4 in the Appendix. Of the course registrations at upper secondary level, slightly more than two thirds were completed; a statistic which is consistent across age-groups. The course subjects are mainly traditional; Swedish, English, mathematics and social science, while vocational studies represent less than 10 per cent. When including vocational educations classified as tertiary level, the proportion grows to 24 per cent. Regarding higher education, Statistics Sweden separates seven study directions (not displayed) which reveal strong gender patterns as more than one-third of the females are in health-related education, about 20 per cent study pedagogy, another 20 per cent social sciences but less than 5 per cent study in each of the other categories; services, human sciences and the natural sciences. Among the males, one-third study technical subjects but they are otherwise more evenly dispersed with fractions between 4 and 14 per cent.

Table 3: Accomplished formal education 1994-2003 among treated and control groups.

	Population sample		**Sibling sample**	
	AE	Controls	AE	Controls
N	29236	781885	13021	19335
Share in adult schooling until 2003	1.00	.196	1.00	.217
Compulsory level				
Fraction registered	.254	.022	.275	.029
Registered compulsory credits (years)	.142	.020	.167	.028
Completed compulsory credits (years)	.056	.006	.064	.009
Upper secondary level				
Fraction registered	.822	.144	.810	.157
Registered upper secondary credits (years)	.993	.203	.993	.228
Completed upper secondary credits (years)	.685	.124	.680	.138
Frequency of upper secondary subjects				
Mathematics	.486	.058	.473	.069
English	.490	.058	.475	.066
Swedish	.470	.060	.461	.072
Social sciences	.639	.095	.638	.107
Natural sciences	.292	.028	.284	.035
Human sciences	.143	.020	.133	.021
Computer sciences	.498	.094	.502	.102
Health sciences	.247	.042	.263	.047
Vocational course	.095	.021	.089	.022
Fraction with higher education until 2003	.268	.024	.238	.029
Fraction completed less than 1 year	.047	.004	.048	.004
Fraction completed 1-2 years	.054	.008	.045	.010
Fraction completed 2-3 years	.042	.005	.036	.006
Fraction completed 3-4 years	.106	.007	.092	.008
Fraction completed 4 years or more	.019	.000	.016	.001
Completed years of higher education	.546	.043	.472	.053
Total years of completed AE	1.286	.173	1.216	.200

4 Empirical method and results

The empirical model used to estimate the impact of a year of AE on annual earnings is presented below. The main results are outlined in Section 4.2 and in Section 4.3 follow estimates which explore heterogeneous effects.

4.1 Empirical model

To identify causal effects of AE on annual earnings, the strategy is to rely on OLS regressions of difference-in-difference-in-differences models which include family fixed effects. To be explicit, let enrollment in AE be indicated by a binary variable *D* which takes the value one for participation and zero otherwise. With the first enrolment in AE occurring

at time t, let subscripts $t+$ and $t-$ denote observations pre- and post-AE respectively, and further subscripts denote individual i and family j, so that:

$$\Delta Y_{ijt+} = \alpha + \beta' X_{ijt-} + f_j + \gamma D_{ijt} + \varepsilon_{ij} . \qquad [1]$$

The dependent variable is the difference in annual earnings Y compared pre- and post treatment, defined as $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$. This framework takes into account individual time consistent unobservable characteristics which influence earnings. The vector X_{ijt-} contains observable explanatory variables including e.g. the pre-program earnings change 1990-1992, hence the reference to the model as difference-in-difference-in-differences (DDD). It also includes public transfers such as sick-leave, early retirement pensions and social welfare benefits to reflect health and labor market marginalization.[13] The family fixed effects, f_j, capture time invariant family characteristics (discussed in detail below), including elusive variables such as parental ability and neighborhood effects. Conditional on the control variables, the parameter γ in [1] estimates the average earnings effect of AE participation. A proportional effect of completed AE can be obtained by interacting D_{ijt} with the variable "Total years of completed AE" (see Table 3), denoted E_{ij};

$$\Delta Y_{ijt+} = \alpha + \beta' X_{ijt-} + f_j + \gamma (D_{ijt} * E_{ij}) + \varepsilon_{ij} . \qquad [2]$$

The parameter γ in [2] is the earnings effect of a year of AE, comparable to estimates presented in the returns to schooling literature. Conditional on the explanatory variables in X_{ijt-}, the coefficient γ is now identified not only by the variation in participation (D_{ijt}) between siblings, but also between siblings with different amounts of AE, reflected in E_{ij}.

The inclusion of f_j is only made when the sibling sample is used and it is, as mentioned, intended to reduce omitted variable bias in the estimate of γ. There is ample evidence that family background is associated with characteristics such as educational attainment and labor market outcomes, including the probability to withdraw from the labor market (e.g. Solon 1999, Mazumder 2008).[14] Using the sample of siblings is by itself also likely to reduce bias as the characteristics of the treated and controls to a greater extent overlap (e.g. Imbens and Wooldridge 2008, Heckman *et al*. 1999, section 8.2), both in terms of observable variables as displayed in Section 3, and in terms of unobservable family-specific characteristics. However, the approach also entails some potential problems (Griliches,

[13] To be specific, X_{ijt-} encompasses earnings change 1990-1992, its square, family birth-order, birth year dummies, age squared and cubic, regional employment 1993, age at immigration (< 7), foreign born dummy variables if born in Scandinavia, if outside Scandinavia, dummy if Stockholm resident in 1993, if in the inland of Norrland 1993, if zero earnings 1992, dummy variables of education prior to enrolment, five dummies indicating the number of children at home, six dummies of different age-spans of the children. Each public transfer is represented by two variables; the received amount in 1992 and a dummy indicating if amount was above zero. The transfers are unemployment benefits, sick-leave, pensions, social welfare, and parental leave benefits 1991 and 1992 (including amount squared). In the full sample regressions, all variables are interacted with gender dummies. Complete results are available on request.

[14] To influence γ, family fixed effects must also significantly contribute to explain the amount of completed AE of the treated. Regressing $E_{ij} = \alpha+f_j+\varepsilon$, a standard F-test indicates that this is so (p-value .000).

1979, Bound and Solon, 1999). First, coefficient estimates obtained with the sibling sample are not necessarily representative of the treatment group as individuals from single-child families are excluded and large families are ascribed greater weights. Second, a well-known drawback with family fixed effects is that measurement bias is aggravated, meaning that the estimate of γ tends to underestimate a true earnings impact. Third, reducing endogeneity bias in the estimate of γ hinges on that the proportion of the variation in AE, which is endogenous, is smaller within families than in the overall sample. It is not possible to determine whether this is the case or not. To summarize, the family fixed effects model is no panacea, but it has interesting qualities which could help us better understand the relationship between AE and earnings.[15]

4.2 Basic results

Table 4 presents estimation results which cover both the average and the proportional effects of AE discussed above. The first two columns show estimates obtained with the population sample, with and without the explanatory variables X_{ijt}. The sibling sample estimates follow in two separate parts where family fixed effects are introduced in the segment to the far right (for gender specific estimates, see Tables A.5 and A.6 in the Appendix). The estimates indicate an overall positive relationship between AE and earnings, but generally larger when based on the sibling sample compared with the population sample. The most elaborate model of the sibling sample, containing X_{ijt} and family fixed effects, yields a proportional estimate of SEK 7,734 which represents about €800.

Table 4. Estimates of average and proportional earnings effects of AE (SEK 2004 prices).

Dependent variable: Earnings difference $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$

	Population sample		**Sibling sample**		**Sibling sample**	
Average effect (D_{ijt})	10523***	5374***	12144***	7382***	10689***	5937***
	(663)	(639)	(1256)	(1254)	(1310)	(1355)
Including X_{ijt}	No	Yes	No	Yes	No	Yes
Including f_j	No	No	No	No	Yes	Yes

	Population sample		**Sibling sample**		**Sibling sample**	
Proportional effect (D_{ijt}*E_{ij})	9032***	6465***	10948***	8699***	9564***	7734***
	(342)	(329)	(582)	(574)	(711)	(717)
Including X_{ijt}	No	Yes	No	Yes	No	Yes
Including f_j	No	No	No	No	Yes	Yes

Notes: *** significant at the 1 % level. ** at the 5 % level. * at the 10 % level.

[15] Evaluations of public training programs based on non-experimental data seem to avoid the major sources of bias, *on average*, if the design includes a regression framework, a locally matched, large, sample and a control for pre-program earnings (Glazerman *et al*., 2003, Heckman *et al*. 1999, Smith and Todd, 2005).

Table 5 summarizes the main results of the estimates above and the gender specific estimates in the Appendix. To make parameter values intelligible, they are also expressed in percentage terms relative to the earnings level in 2004 of the respective treated samples. The estimates in the first row range from 3.7 per cent (population sample) to 5.0 per cent (sibling sample, no f_j) which is reasonably close to the 3.5 to 4.5 per cent payoff reported in Swedish returns to schooling literature (Isacsson 1999, Kjellström 1999, and Meghir and Palme, 2000). Further down, the coefficients pertaining to male samples are lower both in absolute numbers and in percentage terms. The male-female difference is further elaborated in Section 4.3.

Table 5. Estimates of earnings effects of AE (SEK 2004 prices).

Dependent variable: Earnings difference $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$

	Population sample		**Sibling sample**		**Sibling sample**	
Proportional effect (D_{ijt}*E_{ij})	6465***	3.7 %	8699***	5.0 %	7734***	4.4 %
	(329)		(574)		(717)	
Including f_j	No		No		Yes	
	Males		**Brother sample**		**Brother sample**	
Proportional effect (D_{ijt}*E_{ij})	4507***	2.1 %	5423***	2.5 %	4810***	2.3 %
	(624)		(1427)		(1803)	
Including f_j	No		No		Yes	
	Females		**Sister sample**		**Sister sample**	
Proportional effect (D_{ijt}*E_{ij})	7434***	4.7 %	8997***	5.8 %	7979***	5.1 %
	(342)		(855)		(1079)	
Including f_j	No		No		Yes	

Notes: *** significant at the 1 % level. ** at the 5 % level. * at the 10 % level.
All specifications include X_{ijt}-. Percentages express the coefficient value in relation to average earnings in 2004 of the respective treated samples with non-zero accomplished AE.

The larger estimates of the sibling sample seem to originate mainly from two sources. One is that individuals with siblings have higher average returns to AE compared with the treated in the population sample with no siblings. Introducing an interaction variable between the completed AE of treated and "no siblings"; their returns are found to be significantly lower by .9 percentage points. As they make up 55 per cent of the treated, it would explain about .5 (or 40 per cent) of the difference between the population and the sibling samples. The second explanation is related to the issue of overlap in terms of observable attributes between treated and controls. To get an idea of how it affects the estimates, one may leave the adjustment of the sibling sample control group undone, so that a regression is run with the treatment group of the sibling sample and *all* non-treated of the population sample. The estimate then represents 4.2 per cent which is .8 percentage points below the 5.0 in Table 5. Thus, lack of overlap appears to induce a downward bias in the population

sample estimate while the exclusion of individuals with no siblings generates an upward bias in the sibling sample parameter.[16]

Turning to the family fixed effects estimate, omitted variable bias declines and overlap is improved compared with the population sample estimation. The upward bias of the sibling sample parameter without f_j is here mitigated by the exacerbated measurement error bias which goes in the opposite direction. It reduces the probability that we consider an exaggerated estimate of the earnings impact.

The estimates may still be difficult to interpret if a large proportion of the treated were in AE in 2004 or in the preceding year(s). As was discussed in Section 3, treated individuals tend to return for further studies and 21.6 per cent were registered in AE in 2002 or later (20.2 per cent of the treated siblings). Also among controls, the fractions enrolled in AE post 2001 was 8.6 per cent (9.7 per cent in the sibling control group).[17] In order to check if the estimates in Table 5 are sensitive to the timing of the evaluation, separate regressions of equation [2] were run with 2003 as the last year of observation, then 2002 and so forth back to 1999. The measures of the earnings differences were accordingly adjusted as was "Total years of completed AE". Table A.7 in the Appendix shows that had 2001 been the evaluation year, or earlier, the coefficient values are far from those reported in Table 5. As average earnings tend to be higher once the enrolment period is over, future estimates could hypothetically continue to rise even though Figures 2, A.1 and A.2 indicate that the earnings gain has slowed to a halt. Data obviously sets a limit for the possibilities to pursue this issue.

4.3 Heterogeneous effects

A Age, gender, prior education or prior earnings

To test for heterogeneous effects of AE on earnings, separate regression models are augmented with interaction terms between the amount of AE among treated and variables indicating age 24-33, female, no prior upper secondary education or low earnings prior to enrolment, defined as below SEK 100,000 in 1992 (the 45th percentile of the treated). The estimates are displayed in Table A.8 in the Appendix. The clearest result is that low earners in 1992 have markedly higher earnings returns. The earnings impact of AE works through increases in the number of hours worked and in hourly wages, and low earners

[16] To examine the importance of attaching greater weights to large families, as is the case in the sibling sample estimates, regressions were run based on samples where one individual from each family was randomly chosen. The estimates vary within a range of +/- .5 in percentage terms, but out of 50 estimates, the averages are close to identical to the ones presented in Table 5 for siblings, brothers and sisters.

[17] One might argue that a variable $(1-D_{ijt})*E_{ij}$, where the timing of first enrolment is 1996 or later, should be included in the regressions. Such a specification has no bearing on the overall implications but the estimates slightly increase when based on siblings, brothers and sisters, and slightly decrease in the total, male and female population samples.

presumably have more incentives and/or possibilities to increase working hours compared with employees who are close to full-time work. Thus, even though low earnings prior to AE enrolment may signal that participants constitute a negative selection in terms of motivation, health and/or self-esteem, it also signals substantial "room for improvement" in terms of the number of hours worked. The result is stable to a number of changes, e.g. excluding those with the very lowest earnings below 25,000 (or below 75,000) and also explains the positive AE estimates reported for long-term unemployed in Stenberg and Westerlund (2008).[18] With access to data on both hourly wages and earnings; Jacobson *et al.* (2005) reported about two-thirds of the earnings impact to originate from more hours worked and one-third to consist of hourly wage increases. This differs from the findings in the returns to schooling literature, which imply that the wage increases represent about two-thirds (Card, 1999). It is not possible to decompose the effects with the present data, but one may note that if all "low earners" in 1992 are excluded, the coefficient estimate (with family fixed effects) is significant, 4,685, and represents a 2.3 per cent earnings impact.

The estimates in Table A.8 further imply significantly higher earnings effects of AE for females and individuals with low initial skill levels. The latter is in line with what has been found in evaluations of GED acquisition (Murnane, Willett and Boudett, 1999, Murnane, Willett and Tyler, 1999). However, regressions only including "low earners" in 1992 do not reject equal returns between gender groups and, when the family fixed effects model is applied; initial skill level also has no impact on the returns (both skill levels are represented in 25 per cent of the families). Hence, the diverging returns appear to at least partly be driven by differences in initial earnings levels. Finally, the results in Table A.8 show no significant differences between age groups, corroborating Jacobson *et al.* (2003), who found the payoff to community college was similar between young and old (aged 35 or above).

B Nonlinear specification

The estimates so far presume a linear relation between AE and earnings. To explore if this is a reasonable assumption, Table 6 presents coefficient estimates from a step function of binary variables, indicating yearly intervals of completed AE among treated. The sibling sample results are consistent with theory in that the parameters of the binary variables rise monotonically. The relatively high payoff of the 3-4 year group of AE reflects

[18] An objection is that the estimate reflects an Ashenfelter's dip prior to enrolment but earnings are recorded in 1992, at least one year before first enrolment, pre-program earnings dynamics are controlled for and regressions on the earnings change 1990-1992 show no signs of AE being associated with an earnings dip. The limit value is based on Antelius and Björklund (2000) who estimated Mincer like regressions on annual earnings (register data) and on hourly wages (survey data), finding that as low earners gradually were excluded, the education-earnings estimate converged to the education-wage estimate.

that a large fraction completed a third year of higher education, generally equivalent to a Bachelor's degree and a higher mean response to education (Manski and Pepper, 2000). However, there are other irregular patterns and the population sample coefficients are even non-monotonic. A tempting explanation for this finding, supported by the sample means, is that the last year of registration in AE occurs later for each interval. By excluding those registered in AE in 2002 or after, one violates the conditional mean independence assumption, but such a regression yields a smoother linear pattern, indicating that some of the non-linear returns in Table 6 relate to re-enrollments in AE.[19]

Table 6: Estimates allowing for non-linear returns to AE.

Dependent variable: Earnings difference $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$

	Population sample		**Sibling sample**		
	N^{AE}		N^{AE}		
Zero completed credits [a)]	3,379	- 13147***	1,583	- 13506***	- 14701***
		(1811)		(2749)	(3462)
< 1 year of AE [a)]	12,870	2740***	5,850	3969**	2246
		(939)		(1870)	(1870)
1-2 years [a)]	5,266	- 2616*	2,476	4773**	5647*
		(1473)		(2302)	(2889)
2-3 years [a)]	2,876	6988**	1,214	10067***	9385**
		(2007)		(3171)	(4082)
3-4 years [a)]	2,544	32796***	989	40163***	35656***
		(2122)		(3492)	(4545)
4 years or more [a)]	2,301	38336***	909	45078***	44064***
		(2351)		(3799)	(4988)
Including f_j		No		No	Yes

Notes: ***significant at the 1 % level. **at the 5 % level. *at the 10 % level.
All specifications include X_{ijt-}.
N^{AE} = Number of treated in each stated interval of studies.
[a)] Dummy variables indicating the stated interval of studies of treated individuals.

Unrelated to the last year of AE registration, a disturbing result in Table 6 is that the treated with zero accomplished credits are associated with large negative effects. [20] Scrutinizing the zero credit group, the proportions which in 1992 registered zero earnings (.235) or received social welfare (.287) are more than twice as high compared with treated who completed only a few course credits. The proportions among those with less than .25 years of AE are .111 (zero earnings) and .128 (social welfare), which in turn closely resemble the groups of treated with less than one year, 1-2 years and 2-3 years of AE. It seems implausible that zero credits would have a causal negative effect on earnings and, realistically, the result is driven by unobservable attributes.[21] A not too far fetched

[19] The family fixed effects estimates yield parameter values from 2,800 to 50,300 which increase by between 8,400 and 9,200 for each interval, except 3-4 years which is 21,500 higher than 2-3 years.
[20] When estimating the proportional estimates, the group with zero credits is part of the controls. Excluding them reduces the estimate obtained in Table 5 by about .05 per cent.
[21] Adding explanatory variables based on social welfare and zero earnings (interactions, squared etc.) does not change the estimate; neither does "thick support" propensity score matching (interpreting zero credits as a binary event), which only considers observations in the middle third of the propensity score distribution

interpretation is that the group with zero completed credits partly consists of individuals who enrolled in AE in order to escape dismal employment prospects and/or to consume education. 15.3 per cent belong to the plausibly troubled group who received social welfare in 1994-1995 but no study allowance (see Section 2), compared with 5.6 per cent among treated with less than .25 years of completed AE.

C Effects by type of credit

Heterogeneous effects of specific studying paths are awkward to disentangle as course subjects are combined in numerous ways, but it is straightforward to single out studies at tertiary level by using interaction terms of the different study directions defined by Statistics Sweden. In separate regressions, the returns to AE for those in human sciences are significantly lower compared with average whereas it is significantly higher for individuals with educations in health related subjects or technical subjects (not displayed). Those with vocational education at tertiary level were also singled out but estimates did not indicate a different earnings payoff of AE.[22]

5 Comparing costs and benefits to society

The above estimated benefits on future earnings streams can be set in relation to the direct and indirect costs of AE. From a policy perspective, a comparison of this kind is vital to assess the consequences of the public investments, but it requires additional assumptions and should be interpreted with caution (see Appendix II for details of the calculations).

The direct costs of AE are approximated by multiplying the average amount of registered studies with the numbers in the treatment group and the reported average costs of a full time student, including premises and administrative costs. Further baseline assumptions are that *i*) the yearly earnings return is 2.3 per cent for males and 5.1 per cent for females (see Table 5, family fixed effects), *ii*) the impact on earnings represents a production increase, with negligible crowding out effects (Dahlberg and Forslund, 2005), *iii)* earnings measures (including those related to the indirect costs) are multiplied by 1.4 to include payroll taxes and better represent a production value *iv*) the yearly discount rate is 3 per cent and *v*) retirement occurs at age 65. This last assumption means that, as the oldest cohort is 53 in 2004, the yearly benefits gradually decrease by the fraction turning 66 from the 14th year and become zero in the 33rd year, when the youngest cohort has reached 66 years of age.[23] The present value of the benefits covers the direct costs of AE within nine

(Black and Smith, 2004). The basic idea is to reduce the bias caused by unobservable characteristics which, under certain assumptions, is larger in the tails of the distribution.

[22] In contrast, as an active labor market program, upper secondary level AE has been found less efficient compared with vocational education (Stenberg 2007, Stenberg and Westerlund, 2005).

[23] de Luna *et al*. (2008) find no evidence that AE in Sweden influences the timing of retirement.

years. However, adding indirect costs in terms of foregone production value, which for the moment is assumed to equal the imputed foregone earnings, raises the costs by 250 per cent. The benefits after 32 years then only cover 61 per cent of the total costs. This proportion varies by less than 5 percentage points if one alters the length of the working life by +/- 2 years or the discount rate by +/- 1 per cent. In contrast, if one assumes the yearly earnings return is on average 6.3 per cent, total costs are equal to the present value of the benefits after exactly 32 years. Put differently, the returns to society need to exceed the private returns by a factor of 1.63.

A rather strong reservation against the above calculation is that the foregone production value, in the absence of plant level data, is approximated by the imputed foregone earnings. The loss to society is thereby overestimated if non-treated individuals fill the vacancies generated by participation in AE among treated.[24] A possible proxy of the average job-finding rate is the employment rate, which hovers around .7 among the low skilled population aged 25-64. However, if the replacements are non-employed with a lower job-finding rate, the probability of .7 would be an upper bound. Following the baseline assumptions above, a probability of .54 (and no loss of productivity per hour) allows the benefits of AE to cover the total costs after 32 years. There are additional indirect costs of AE which arise from deadweight losses, as taxes are raised to finance AE, and from that the demand for teachers in AE reduces teacher quality in regular upper secondary school (Björklund *et al*. 2005). Let us assume the deadweight loss is .5 of the total direct costs (Jacobson *et al*. 2005, Duflo 2001, who also used .2 as an alternative). In such a case, for the benefits of AE to equal the total costs, the required probability that non-treated individuals fill vacant work hours is .74, i.e. slightly above the upper bound and stretching the necessary assumptions for private returns to cover total costs. The probability is reduced to .62 if one uses a deadweight loss of .2. An arguably valid interpretation of the above exercise is that the costs are equal to or slightly higher than the present value of the private returns to AE. To a policy maker, covering the costs is only a necessary condition to justify program expenses, not a sufficient one as there may be more efficient alternative uses. The main point to emerge is thus that if total benefits to society are to exceed the total costs by any significant amount, it would hinge on the social returns to AE.

The social returns to education encompass a large number of effects which are typically difficult to quantify. Albrecht *et al.* (2008) assessed the general equilibrium effects of AE in Sweden from 1997 until 2006. Their model inferred that those who remain low skilled

[24] Standard in the evaluation literature is the stable unit treatment value assumption (SUTVA). It presumes that foregone earnings are an appropriate measure of foregone production as there is no change in the number of hours worked of the non-treated. Of course, this is a very strong assumption. At the other extreme, foregone production becomes zero if one follows Johnson and Layard (1986) and assumes a queue of non-treated low skilled unemployed who replace *all* vacant hours.

suffer economic losses, but a general equilibrium "multiplier effect" makes the aggregate effect larger than the effect of the treatment on the treated, by a factor between 1.5 and 2. This follows from changes in job composition and spillover effects on medium and low skilled. Their argument is thus related to that of externalities of education. Moretti (2004) find support for such spillover effects, as do Kirby and Riley (2008) by a factor of about 1.5, but no or only small effects are reported in Acemoglu and Angrist (2000), Ciccone and Peri (2006) and Isacsson (2005). Other studies imply that education improves the labor market outcomes of offspring (Black *et al*. 2005, Björklund *et al*. 2006), economic growth (Krueger and Lindahl, 2001), democracy (Putnam, 2001, Milligan *et al*. 2004) and health (Arendt, 2005, Lleras-Muney, 2005). Computations in Cutler and Lleras-Muney (2006) suggest that health effects alone increase the total returns to education by between 1.15 and 1.55 and Milligan *et al*. (2004) support that education has a positive influence political interest and involvement, although evidence is elusive on voter turnout. Social and economic equality following from AE may also be beneficial from a society's point of view (Dominicis *et al*. 2008, Krueger, 2002), and access to AE could reduce tension between groups in society as it offers low skilled a way to respond to e.g. increased competition from immigration and/or structural changes.[25] To sum up, it seems likely that the social returns to education are above zero, but whether they are of economic importance is a matter of debate. Several studies report no or small effects but the task of capturing social returns is potentially difficult due to measurement errors, data demanding identification strategies and/or that the true underlying effects *are* small as focus is kept to limited parts of the social returns. Of course, there are also studies suggesting an increase in the total returns by a factor of 1.5.

6 Summary and discussion

Public investments in upgrading low skilled potentially has important implications for the flexibility of the work force, economic growth, equality of opportunity, social cohesion and other economic and social indicators. This paper provides a rare evaluation of the earnings effects of public provision of formal education for low skilled. The study is based on register data from Sweden where the institutional set-up impels large numbers to participate in free-of-charge adult education (AE) at compulsory and upper secondary level, possibly also in higher education. In regressions of difference-in-difference-in-differences models which include family fixed effects, a year of AE is found to increase earnings by 4.4 per cent. The result lends support to the view that public provision of formal education for low skilled is a sensible policy. However, the costs associated with AE are substantial. One reason for this is that AE credits are accomplished slowly over

[25] There is rather convincing evidence that education for youths decreases criminality (Lochner and Moretti, 2004), but the role of AE is in this respect not clear-cut as most criminals are males below age 24.

time and that only about half of the treated, completing at least one year of AE, drive the positive estimates. It requires 7-8 years from first enrolment before the beneficial effects emerge in average earnings. Within another nine years, i.e. at least 16 years after first enrolment, the present value of the benefits covers the direct costs of providing AE. Computations of the indirect costs are sensitive to the underlying assumptions, but the main point to emerge is that the total private returns to AE, as counted until all treated are retired, only roughly cover the total costs. It implies that the social returns to AE determine to what extent total benefits might exceed the total costs. Unfortunately, the economic importance of the social returns to education is difficult to pin down. The lack of convincing evidence in the existing literature makes negligible social returns to education a valid argument against AE. However, empirical studies of social returns are by nature only partial, as data can not embrace all aspects. The assumption of small social returns to education is therefore far from settled, and one might even say increasingly under attack as data quality improves. All things considered, the analysis of this study calls for a balanced discussion on the efficiency of AE as a policy tool to upgrade low-skilled. The results partly run counter to the inherent optimism expressed at most political levels, from local committees to the European Union's Lisbon strategy for growth and jobs and the OECD strategy for "active ageing".

It must be emphasized that this is one of the first studies to evaluate upgrading low-skilled's formal education. Further evaluations of AE from other economic environments and other educational systems would obviously help us better understand the consequences of publicly provided AE for low skilled. Ideally, future implementations would also allow researchers to explore how study allowances influence the average returns to AE, the participation rates, the foregone earnings and the foregone production value. These are important issues as it is likely that some form of financial support is necessary if one wishes to attract low skilled into completing a significant number of AE course credits.

Appendix I

Table A.1. Descriptive statistics of male AE enrollees and control groups of population sample and brother sample.

	Population sample		**Brother sample**	
	AE	Controls	AE	Controls
N	10696	464480	2917	3919
Age 1994	30.05*	33.09	30.89*	32.09
Family birth order	1.79*	1.93	2.40	2.36
Years of schooling	10.46*	10.31	10.40*	10.29
− Less than compulsory school (< 9 years)	.012*	.031	.017*	.028
− Compulsory school (9 years)	.242*	.293	.264*	.308
− 1-year upper secondary school (10 years)	.019*	.014	.022*	.011
− 2-year upper secondary school (11 years)	.728*	.662	.698*	.652
Earnings 1992 [a)]	135.4*	159.6	137.5*	147.2
Earnings change from 1990 to 1992 [a)]	- 9.0	- 7.8	- 13.3	- 10.5
Zero annual earnings 1992	.133*	.115	.141	.136
Child(ren) at home 1992	.855*	1.09	.946*	1.09
Parental leave transfer 1992 > 0	.088*	.095	.102	.100
− amount if above zero [a)]	15.9*	13.3	16.0	14.5
Unemployment insurance benefits 1992 > 0	.246*	.184	.250*	.212
− amount if above zero [a)]	55.2	55.8	57.9	57.5
Active labor market prog. benefits 1992 > 0	.208*	.113	.193*	.142
− amount if above zero [a)]	31.0	32.3	35.0	32.5
Sick-leave and rehabilitation 1992 > 0	.244*	.174	.259*	.192
− amount if above zero [a)]	27.7*	23.2	29.8*	22.8
Pension 1992 > 0	.011*	.021	.011*	.020
− amount if above zero [a)]	66.2	68.0	74.8	68.1
Social welfare 1992 > 0	.151*	.080	.158*	.130
− amount if above zero [a)]	15.5*	12.5	14.5	15.0
Regional employment 1993	.725*	.722	.724	.723
Stockholm County 1993	.183*	.141	.158	.153
Inland of Norrland 1993	.047*	.062	.055	.055
Foreign born	.024*	.019	.025	.025

Notes: * Indicates difference compared with control group is significant at a 5 per cent level.

[a)] SEK 2004 prices in thousands, € 100 is approximately SEK 970.

[b)] Inland of Norrland is a sparsely populated area in the north of Sweden with permanently higher than average unemployment rates. Stockholm County hosts 20 per cent of the population and the overall employment level is higher there than elsewhere in Sweden.

Table A.2. Descriptive statistics of female AE enrollees and control groups of population sample and sister sample.

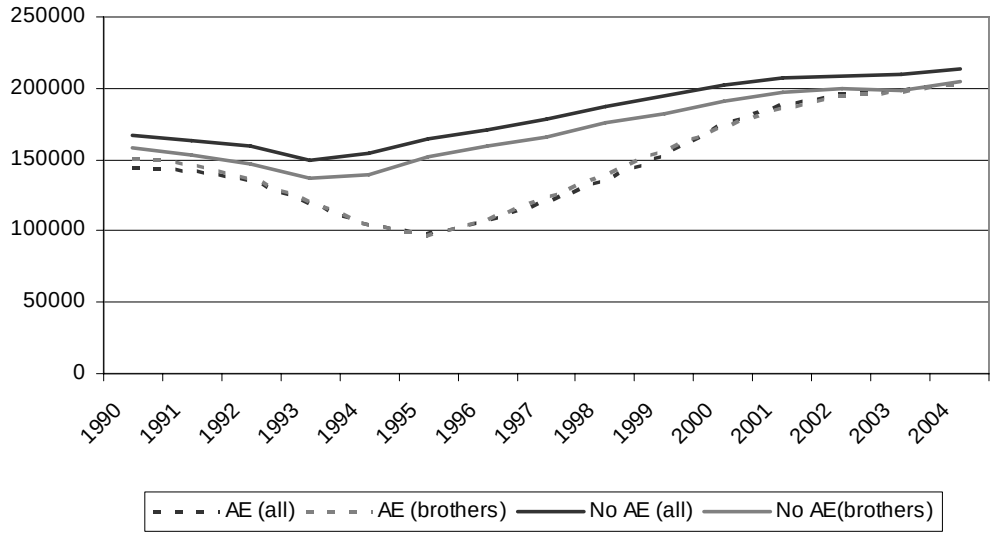
	Population sample		**Sister sample**	
	AE	Controls	AE	Controls
N	18540	317405	4469	5290
Age 1994	31.15*	33.29	31.77*	32.51
Family birth order	1.84*	1.94	2.44	2.48
Years of schooling	10.35*	10.29	10.26	10.24
− Less than compulsory school (< 9 years)	.008*	.020	.008*	.017
− Compulsory school (9 years)	.247	.248	.286	.284
− 1-year upper secondary school (10 years)	.136*	.152	.142	.142
− 2-year upper secondary school (11 years)	.609*	.580	.563	.557
Earnings 1992 [a)]	93.6*	104.2	90.9*	98.5
Earnings change from 1990 to 1992 [a)]	- 3.4	- 1.8	- 2.7	- .5
Zero annual earnings 1992	.134*	.115	.141	.131
Child(ren) at home 1992	1.51*	1.47	1.69*	1.56
Parental leave transfer 1992 > 0	.343*	.295	.365*	.325
− amount if above zero [a)]	40.1*	38.9	39.2	39.5
Unemployment insurance benefits 1992 > 0	.209*	.141	.208*	.156
− amount if above zero [a)]	33.8	34.1	33.5	34.2
Active labor market prog. benefits 1992 > 0	.124*	.071	.117*	.083
− amount if above zero [a)]	31.0	32.3	29.1	30.3
Sick-leave and rehabilitation 1992 > 0	.293*	.247	.300	.275
− amount if above zero [a)]	17.3	17.3	17.7	17.5
Pension 1992 > 0	.009*	.032	.007*	.031
− amount if above zero [a)]	58.6	61.8	58.6	61.0
Social welfare 1992 > 0	.142*	.082	.147*	.112
− amount if above zero [a)]	9.8*	9.1	9.6	9.9
Regional employment 1993	.724*	.723	.723	.722
Stockholm County 1993	.178*	.142	.149	.136
Inland of Norrland 1993	.055	.055	.059	.060
Foreign born	.023*	.019	.028	.027

Notes: * Indicates difference compared with control group is significant at a 5 per cent level.

[a)] SEK 2004 prices in thousands, € 100 is approximately SEK 970.

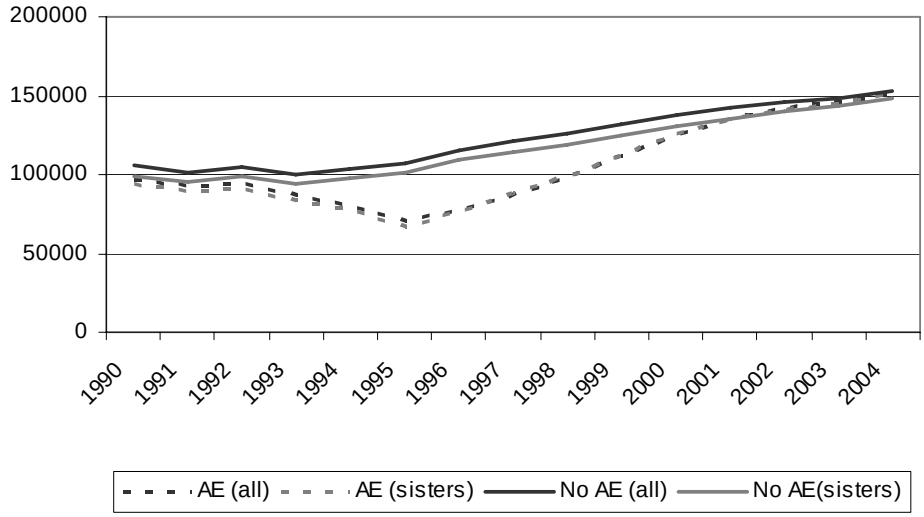
[b)] Inland of Norrland is a sparsely populated area in the north of Sweden with permanently higher than average unemployment rates. Stockholm County hosts 20 per cent of the population and the overall employment level is higher there than elsewhere in Sweden.

Figure A.1. Male and brothers annual earnings (SEK 2004); AE enrollees 1994-95 and control groups.



Note: SEK 2004 prices, € 1 is approximately SEK 9.70.

Figure A.2. Female and sisters annual earnings (SEK 2004); AE enrollees 1994-95 and control groups.



Note: SEK 2004 prices, € 1 is approximately SEK 9.70.

Table A.3. Male accomplished formal education 1994-2003.

	Population sample		**Brother sample**	
	AE	Control group	AE	Control group
N	10696	464480	2917	3919
Share in adult schooling until 2003	1.00	.117	1.00	.140
Compulsory				
Fraction registered	.214	.011	.239	.016
Registered compulsory credits (years)	.131	.012	.166	.018
Completed compulsory credits (years)	.048	.003	.058	.005
Upper secondary				
Fraction registered	.777	.078	.740	.095
Registered upper secondary credits (years)	.803	.098	.740	.123
Completed upper secondary credits (years)	.547	.056	.503	.071
Frequency of upper secondary subjects				
Mathematics	.475	.031	.439	.046
English	.444	.029	.414	.040
Swedish	.408	.028	.386	.041
Social sciences	.525	.042	.499	.051
Natural sciences	.277	.014	.260	.023
Human sciences	.105	.007	.089	.010
Computer sciences	.440	.050	.428	.061
Health sciences	.119	.009	.113	.011
Vocational course	.128	.018	.123	.020
Fraction with higher education until 2003	.270	.014	.237	.017
Fraction completed less than 1 year	.048	.003	.044	.003
Fraction completed 1-2 years	.061	.004	.054	.005
Fraction completed 2-3 years	.048	.003	.042	.006
Fraction completed 3-4 years	.091	.003	.078	.002
Fraction completed 4 years or more	.023	.000	.018	.000
Completed years of higher education	.538	.022	.459	.028
Total years of completed AE	1.132	.081	1.020	.103

Table A.4. Female accomplished formal education 1994-2003.

	Population sample		**Sister sample**	
	AE	Control group	AE	Control group
N	18540	317405	4469	5290
Share in adult schooling until 2003	1.00	.311	1.00	.341
Compulsory				
Fraction registered	.277	.038	.299	.048
Registered compulsory credits (years)	.149	.031	.179	.042
Completed compulsory credits (years)	.061	.011	.070	.014
Upper secondary				
Fraction registered	.848	.240	.832	.260
Registered upper secondary credits (years)	1.103	.355	1.114	.397
Completed upper secondary credits (years)	.765	.223	.757	.245
Frequency of upper secondary subjects				
Mathematics	.492	.098	.479	.115
English	.517	.101	.497	.111
Swedish	.507	.106	.491	.125
Social sciences	.705	.173	.700	.196
Natural sciences	.300	.050	.288	.057
Human sciences	.164	.039	.149	.039
Computer sciences	.530	.159	.528	.169
Health sciences	.322	.091	.342	.098
Vocational course	.076	.026	.073	.028
Fraction with higher education until 2003	.266	.040	.226	.044
Fraction completed less than 1 year	.047	.006	.048	.005
Fraction completed 1-2 years	.050	.013	.039	.013
Fraction completed 2-3 years	.038	.008	.031	.009
Fraction completed 3-4 years	.115	.013	.096	.015
Fraction completed 4 years or more	.016	.001	.014	.002
Completed years of higher education	.550	.073	.451	.085
Total years of completed AE	1.376	.308	1.278	.344

Table A.5. Male estimates of average and proportional earnings effects of AE (SEK 2004).

Dependent variable: Earnings difference $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$

	Population sample		**Brother sample**		**Brother sample**	
Average effect (D_{ijt})	13765***	5012***	5990**	2609	3786	1601
	(1170)	(1143)	(2945)	(2916)	(3044)	(3106)
Including X_{ijt-}	No	Yes	No	Yes	No	Yes
Including f_j	No	No	No	No	Yes	Yes

	Population sample		**Brother sample**		**Brother sample**	
Proportional effect (D_{ijt}*E_{ij})	9227***	4507***	9009***	5423***	5932***	4810***
	(640)	(624)	(1428)	(1427)	(1787)	(1803)
Including X_{ijt-}	No	Yes	No	Yes	No	Yes
Including f_j	No	No	No	No	Yes	Yes

Notes: ***significant at the 1 % level. **at the 5 % level. *at the 10 % level.

Table A.6. Female estimates of average and proportional earnings effects of AE (SEK 2004).

Dependent variable: Earnings difference $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$

	Population sample		**Sister sample**		**Sister sample**	
Average effect (D_{ijt})	8840***	5584***	9844***	5869***	8110***	3436*
	(743)	(686)	(2045)	(1915)	(2143)	(2030)
Including X_{ijt-}	No	Yes	No	Yes	No	Yes
Including f_j	No	No	No	No	Yes	Yes

	Population sample		**Sister sample**		**Sister sample**	
Proportional effect (D_{ijt}*E_{ij})	9048***	7434***	10868***	8997***	10294***	7979***
	(371)	(342)	(911)	(855)	(1145)	(1079)
Including X_{ijt-}	No	Yes	No	Yes	No	Yes
Including f_j	No	No	No	No	Yes	Yes

Notes: ***significant at the 1 % level. **at the 5 % level. *at the 10 % level.

Table A.7. Total family fixed-effect estimates of AE (SEK 2004), conditioning on final year of observation.

Dependent variable: Earnings difference $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$ [a)]

Final year	**Population sample**		**Sibling sample** Without f_j [a)]		**Sibling sample** With f_j [a)]	
2004	6465***	3.7 %	8699***	5.0 %	7734***	4.4 %
	(329)		(574)		(717)	
2003	5372***	3.2 %	7284***	4.3 %	6447***	3.8 %
	(328)		(570)		(715)	
2002	3942***	2.4 %	5893***	3.6 %	6219***	3.8 %
	(343)		(590)		(741)	
2001	466	.3 %	2478***	1.6 %	2956***	1.9 %
	(373)		(615)		(773)	
2000	- 8117***	- 5.6 %	- 6269***	- 4.4 %	- 6520**	- 4.5 %
	(414)		(718)		(897)	
1999	- 18171***	- 14.3 %	- 15471***	- 12.2 %	- 16443***	- 12.9 %
	(446)		(783)		(975)	

Notes: ***significant at the 1 % level. **at the 5 % level. *at the 10 % level.
All specifications include X_{ijt-}.
[a)] Family fixed effects.

Table A.8. Interaction variable estimates based on age, education, gender and earnings prior to enrolment.

Dependent variable: Earnings difference $\Delta Y_{ijt+} = (Y_{2004} - (Y_{1992}+Y_{1991}+Y_{1990})/3)$

	Population sample			
Proportional effect (D_{ijt}*E_{ij})	7527***	5886***	4507***	1065**
	(694)	(364)	(570)	(430)
Interaction variable * (D_{ijt}*E_{ij})	Age 24-33	Low educ.[a)]	Female	Low earnings[b)]
	- 1370*	3172***	2935***	12876***
	(788)	(848)	(698)	(662)
	Sibling sample			
Proportional effect (D_{ijt}*E_{ij})	9885***	7836***	6483***	1333*
	(1133)	(640)	(998)	(759)
Interaction variable * (D_{ijt}*E_{ij})	Age 24-33	Low educ.[a)]	Female	Low earnings[b)]
	- 1591	4325***	3309***	15762***
	(1310)	(1416)	(1219)	(1069)
	Sibling sample - Family fixed effects			
Proportional effect (D_{ijt}*E_{ij})	9487***	7128***	5068***	2133**
	(1446)	(806)	(1302)	(930)
Interaction variable * (D_{ijt}*E_{ij})	Age 24-33	Low educ.[a)]	Female	Low earnings[b)]
	- 2359	3028*	3981**	13414***
	(1691)	(1840)	(1623)	(1426)

Notes: ***significant at the 1 % level. **at the 5 % level. *at the 10 % level.
All specifications include X_{ijt-}.
[a)] "Low educ." refers to compulsory school or less; "High educ." to some upper secondary school.
[b)] "Low earnings" refers to earnings below SEK 100,000 in 1992.

Appendix II – Estimating costs and benefits

Direct costs of providing AE:

Compulsory and upper secondary education at Komvux; the average yearly cost of a full-time student is SEK 37,500 (Swedish National Agency for Education).

1. Male number (2,382) * Male average (1.04 years) * 37,500 = 92.5 million.
2. Female number (4,025) * Female average (1.39 years) * 37,500 = 210.4 million.

Tertiary education; the average yearly cost of a full-time student is SEK 44,000 (Swedish National Agency for Higher Education). The total amount of accomplished tertiary education is divided by .75 to give a proxy of courses *registered*.

3. Male number (692) * Male average (1.94 years /.75) * 44,000 = 78.6 million.
4. Female number (1,010) * Female average (2.00 years /.75) * 44,000 = 118.3 million.

The sum of 1-4 above is the **total direct costs: 499.8 million SEK**.

Indirect costs of AE:

The earnings ratio of treated compared with untreated (brother and sister samples) only diverges by about .005 in the years 1990-1992. Foregone earnings are calculated by assuming that earnings of treated is a constant fraction of untreated earnings 1990-2004.

Figure A.3 below illustrates the principle. The distance between the dotted line (actual average earnings of treated) and the thin line (counterfactual earnings of treated) is the calculated foregone earnings. The amount appears reasonable considering the average amount of AE, which exceeds one year, and the average earnings levels recorded.

Calculated foregone earnings are multiplied by 1.4 to include payroll taxes and better reflect an inherent production value.

Foregone earnings for males: 688.5 million. Females: 573.6 million.
In total SEK 1.262 billion.[26]

Total costs: Direct costs + Indirect costs: 1.262 + .4998 = **1.762 billion SEK**.

Total revenues/benefits

As with the foregone earnings, the estimated earnings effects are multiplied by 1.4.
[.023 * (male average earnings 2004) * (number of males)*1.4] + [.051 * (female average earnings 2004) * (number of females)*1.4] = revenue first year = SEK 61.3 million.

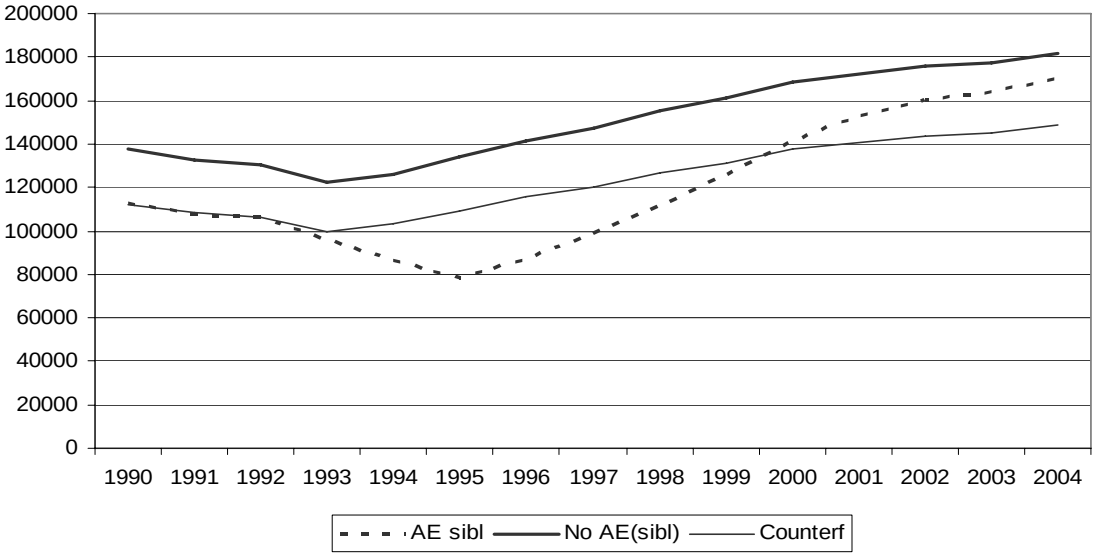
From year 14, individuals born 1951 are aged 65 and excluded. In year 33, benefits cease as the youngest cohort born 1970 turns 65 years old.

Total revenues after 32 years: **1.079 billion SEK** (3 per cent discount rate).

Revenues represent 61.2 per cent of the total costs (1.079 / 1.762).

[26] Using matching on the propensity score to calculate foregone earnings gives a 10 per cent higher estimate. Regression based calculations of the foregone earnings are not straightforward since there are no records of course registration at tertiary level.

Figure A.3. Annual earnings of AE enrollees 1994-95, control group and hypothetical foregone earnings of participants had they not enrolled.



Note: SEK 2004 prices, € 1 is approximately SEK 9.70.

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