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Effects of college choice on incomes in Sweden

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Foreword

ITPS is continuously working with new evaluation methods with the aim to strengthen the evaluation design and to obtain better quality in results and conclusions. For this purpose ITPS co-operate with universities and private consultants. This report is a result of a co-operation between ITPS and the department of statistics at Umeå university. Mathias Lundin has been author of this report.

The purpose of this paper is to contribute to the accumulation of knowledge on whether college choice in Sweden has an effect on earnings. Because this question can only be studied with non-experimental data, many studies must be carried out using different data sources and methods of estimation in order to gain confidence in the results. In particular, we use flexible nonparametric regression applied to Swedish register data.

A generalised additive model approach controlling for the propensity score, is used to estimate these wage premiums. The propensity score, the probability of a college type choice given the covariates, is a scalar summary of the covariates which is sufficient to control for instead of all the covariates.

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Östersund, July 2008

Håkan Gadd

Head of the evaluation department

Table of Content

Summary

In this paper we evaluate effects on incomes from choice between one of the six oldest and the newer universities in Sweden. A nonparametric regression approach is used to estimate the effects. Selection bias is dealt with by controlling for the propensity score in the analysis. Several databases are used for the analysis and we find evidence that students graduating from old colleges get higher initial wages on the average than do graduates from new colleges. The estimated premiums are 5.5 per cent two years after graduation and 6.3 per cent three years after graduation. On the other hand, students graduating from new colleges have a higher probability of an income higher than 100,000 SEK than graduates from old colleges both two and three years after graduation.

1 Introduction

The effects of college choice on incomes are interesting for individuals as well as for society. An individual might want to know if his/her college choice can affect later earnings and for society the question is if graduates from different colleges differ in productivity in the labour market.

In recent years, a number of studies have been published which estimate the effect of college choice/quality on earnings. Recent studies in the United States that evaluate effects of college quality on subsequent earnings include Brewer et al. (1999) and Dale and Krueger (2002) who use the Barron's ratings, that are based on students characteristics and the colleges percentage of students admitted, to classify the colleges qualities. Brewer et al. report a large premium from attending an elite private institution compared to a bottom rated public institution while Dale and Krueger find that students attending more selective colleges earned about the same as students of comparable ability who attended less selective colleges. Black and Smith (2004) use average faculty salary, average SAT score and students retention rate as measures of college quality. Their results show that attending high-quality colleges rather than low-quality colleges increases wages by about 12 per cent for men and 7 per cent for women. In the United Kingdom Chevalier and Conlon (2003) report an effect on earnings of 0–6 per cent from choosing a Russell Group university instead of a Modern university. Studies of the relationship between college choice and earnings on the Swedish labour market include Gustafsson (1996), Lindahl and Regnér (2003) and Gartell and Regnér (2005). Lindahl and Regnér report 2.5–8.4 per cent higher average earnings for graduates from old colleges than graduates from new colleges. Gartell and Regnér give estimates of -11 to +6 per cent from choice between different Swedish universities with Lund as reference.

The purpose of this paper is to contribute to the accumulation of knowledge on whether college choice in Sweden has an effect on earnings. Because this question can only be studied with non-experimental data, many studies must be carried out using different data sources and methods of estimation in order to gain confidence in the results. In particular, we use flexible nonparametric regression applied to Swedish register data.

We investigate whether there is a wage premium from choosing to obtain a degree in business or economics from one of the six oldest Swedish universities instead of one of the newer universities/colleges. Whether this classification based on a university's age is correlated with the quality of the education is an open question. We compare students from old and new colleges with a three year business or economic degree using Swedish register data. The sample consists of the cohort of students graduating from senior high school 1990-1996 and then leaving college with a three year economic degree before 2001. We find evidence that students graduating from old colleges get higher initial wages on the average than do graduates from new colleges. The estimated premiums are 5.5 per cent two years after graduation and 6.3 per cent three years after graduation. On the other hand, students graduating from new colleges have a higher probability of an income higher than 100,000 SEK than graduates from old colleges both two and three years after graduation. A generalised additive model approach (Hastie and Tibshirani, 1990), controlling for the propensity score, is used to estimate these wage premiums. The propensity score, the probability of a college type choice given the covariates, is a scalar summary of the covariates which is sufficient to control for instead of all the covariates (Rosenbaum and

Rubin, 1983). This conditional probability is also modelled with a generalised additive model. We choose this additive model strategy to relax the linearity assumptions needed when using ordinary regression models and generalised linear models.

Section 2 describes the register data and the sample used in the analysis. In Section 3 the models for estimating the propensity scores and the treatment effects are presented. In Section 4 the results from the estimations of the models are presented.

2 Data

For this study, several databases have been used. From the database LOUISE[1], information regarding individuals education, income and labour market status is extracted. The LOUISE tables are longitudinal with starting year 1990 and contain information about each person older than 15 years living in Sweden. From RTB[2] (Total Population register), data about age, gender and the parents identities are collected. Information about senior high school grades and graduation year is obtained from the Senior High School register[3]. Individuals college starting year, type of college degree, graduation year and from which college the individual has graduated are extracted from the College register[4].

The individuals included in the study are those that graduated from senior high school during the period 1990–1996 (after 1996 the grading system in senior high school was changed) and then graduated from college with an economic degree before 2001. Each individual is then classified as having a degree from an old college or a new college. The universities in Stockholm, Gothenburg, Lund, Uppsala and Umeå as well as Stockholm School of Economics[5] are referred to as old colleges while the other colleges included in the study are referred to as new colleges. We use the same classification as Lindahl and Regnér (2003) to be able to compare the results.

Table 2-1 Sample descriptives.

	Collage type		Missing	
	Old	New	Old	New
Total	3 334	3 413		
Women, %	48.9	59.6	0	0
Born outside Sweden, %	3.2	2.7	0	0
Average grade in senior high school	3.95	3.77	0	0
Average age at college start	20.6	20.7	0	0
Average time from college start to graduation	5.1	4.3	0	0
At least one parent born outside Sweden, %	14.0	10.5	49	50
Family's median disposable income, SEK	87 600	80 200	107	279
Max. of parents education level, %*			27	32
1 (six years elementary school)	2.3	4.9		
2	2.9	4.1		
3	13.3	22.3		
4	14.1	18.1		
5	17.2	20.4		
6	44.9	28.5		
7 (graduate education)	5.2	1.6		
Median income two years after graduation	260 450	231 800	203	116
Median income three years after graduation	293 600	257 00	262	135

** Swedish educational classification (SUN, svensk utbildningsnomenklatur), from six year elementary school graduate education in ascending order.*

[1] *Longitudinell databas för utbildning, inkomst och sysselsättning.*
[2] *Registret över totalbefolkningen.*
[3] *Avgångna från gymnasieskolan.*
[4] *Universitets- och högskoleregistret.*
[5] *Handelshögskolan.*

Demographic and socioeconomic variables that are observed for each unit of study are gender, year of birth, country of birth, parents country of birth, parents education level and family income. Individuals capabilities to assimilate college education are measured by the average grade when graduating from senior high school. The outcome variable in the study is annual income before tax.

Descriptives for the units in the sample are presented in Table 2-1. The time from college start to graduation is the time from the year and term a student was first registered in the college system until the year and term of the graduation. Some students may start their college studies at one university and graduate from another. A students college type is classified as old or new based upon from which type of college he or she graduated. The families disposable incomes are measured the year the student graduated from senior high school and is weighted with respect to the family size. The parents level of education is measured by the parent who has the highest level.

Students in old colleges spent, on average, almost a year longer at college than students in new colleges. The percentage of women is higher in new colleges and the parents level of education is, on average, higher for students in old colleges and the old college group also has a higher percentage of parents born outside Sweden.

3 Evaluation of a treatment effect

In this section we describe the methods and models used to compare the effects of graduation from new (treatment 0) and old colleges (treatment 1) on income.

3.1 Rubin's framework and generalised additive models

We use Rubin's framework for causal inference in observational studies (Rubin, 1974, Holland, 1986) with a generalised additive models approach.

Let Y_{0i} and Y_{1i} be the potential outcomes for individual i if he/she receives treatment 0 (Z_i = 0) or treatment 1 (Z_i = 1). For each unit i, we observe the treatment indicator Z_i, the covariates x_i and either of Y_{0i}, Y_{1i}, depending on which of the treatments the individual received. The response observed for unit i is therefore $Y_i = Y_{1i}Z_i + Y_{0i}(1 - Z_i)$.

In a randomised trial, the potential outcomes Y_{0i} and Y_{1i} are independent of Z_i (denoted Y_{0i}, $Y_{1i} \perp\!\!\!\perp Z_i$) and the average treatment effect $E(Y_{1i} - Y_{0i}) = E(Y_{1i}| Z_i = 1) - E(Y_{0i} Z_i = 0)$ can be estimated from the observed data by taking the difference between the average outcome for the units with $Z = 1$ and the average outcome for the units with $Z = 0$.

In an observational study, Y_{0i} and Y_{1i} are generally not independent of Z_i because of self-selection into treatments. However, suppose that Y_{0i} and Y_{1i} are independent of Z_i, given a set of covariates x_i (Y_{0i}, $Y_{1i} \perp\!\!\!\perp Z_i \,|x_i$) and that $0 < p(x_i) < 1$, where $p(x_i) = P(Z_i = 1| x_i)$ is called the propensity score. Rosenbaum and Rubin (1983, theorem 3) show that under these assumptions Y_{0i}, $Y_{1i} \perp\!\!\!\perp Z_i \,|p(x_i)$ and hence

$$\begin{aligned} E(Y_i|Z_i, p(\mathbf{x}_i)) &= Z_i E(Y_{1i}|p(\mathbf{x}_i)) + (1 - Z_i)E(Y_{0i}|p(\mathbf{x}_i)) \\ &= E(Y_{0i}|p(\mathbf{x}_i)) + Z_i(E(Y_{1i}|p(\mathbf{x}_i)) - E(Y_{0i}|p(\mathbf{x}_i))). \end{aligned}$$

This conditional expectation is estimated with a regression model for the response Y given Z and $p(x_i)$:

$$Y_i = \alpha + \beta(p(\mathbf{x}_i)) + \tau_0 Z_i + \tau_1(p(\mathbf{x}_i))Z_i + \varepsilon_i \qquad (1)$$

where α and τ_0 are constants, $\beta(\cdot)$ and $\tau_1(\cdot)$ are smooth functions and ε_i is a random variable with $E(\varepsilon_i) = 0$ and $\varepsilon_i \perp\!\!\!\perp \varepsilon_j \forall i \# j$. The conditional treatment effect is $\tau_0 + \tau_1\,(p(x_i))$ and $\alpha + \beta\,(p(x_i)) = E(Y_{0i}\,|p(x_i))$.

Model (1) is an additive model (Hastie and Tibshirani, 1990) of the form $Y = \alpha + \Sigma f_j(x_j) + \varepsilon$, where the f_j:s are smooth functions. The functions can be fitted nonparametrically using the gam function (Generalised Additive Models) in the mgcv package in R, where the smooth terms are represented using penalised regression splines, see Wood and Augustin (2002) for a presentation of the basic mathematical and numerical approaches to gam:s implemented in the package.

3.2 Wage restriction

In our study, we want to estimate the wage premium for education at old colleges ($Z = 1$) compared to education at new colleges ($Z = 0$). The annual income is measured two and three years after graduation. We split the outcome into Y_i, the log of income given that income is higher than 100,000 SEK, and $R_i = I(\text{Income} > 100,000)$. The income restriction of 100,000 SEK has been shown to give a good correspondence to hourly earnings which is a measure of productivity in the labour market (Antelius and Björklund, 2000). It would, however, not be meaningful only to estimate the effect of college choice on Y_i and therefore we also estimate the probability of having an annual income higher than 100,000 SEK given Z_i and p(x) using the model

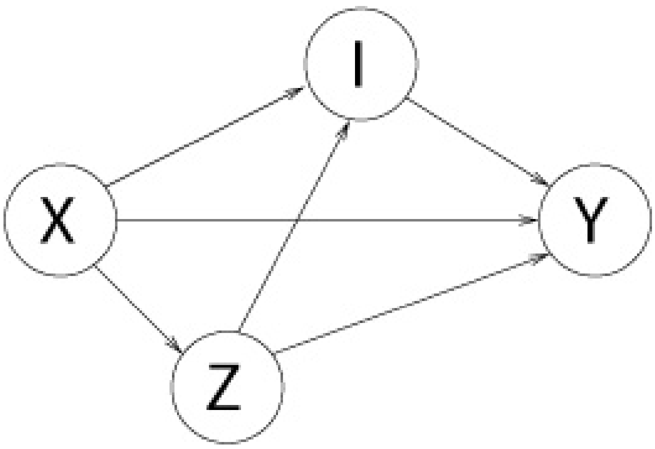
$$log\left(\frac{P(R_i = 1|Z_i, p(\mathbf{x}))}{1 - P(R_i = 1|Z_i, p(\mathbf{x}))}\right) = \delta_0 + \delta_1(p(\mathbf{x}_i)) + \gamma_0 Z_i + \gamma_1(p(\mathbf{x}_i))Z_i \quad (2)$$

where δ_0 and γ_0 are constants and $\delta_1(\cdot)$ and $\gamma_1(\cdot)$ are smooth functions. Model (2) is a generalised additive model (Hastie and Tibshirani, 1990).

3.3 Covariates and propensity score

We wish to control for all variables affecting both the treatment, Z, and the response, Y. A graphical representation (Cox and Wermuth, 2004) of the general dependence between the response variable Y and the treatment (Z), background (X) and intermediate (I) variables is shown in Figure 3-1. An intermediate variable, I, is observed after treatment but before outcome, Y. In our study we have not controlled for any intermediate variables (e.g. geographical labour market after graduation) because they may be affected by the treatment, thereby carrying a part of the effect. This is, however, sometimes done in the literature; see e.g. Lindahl and Regnér (2003).

Figure 3-1 Graphical representation of variables.



The propensity score, $p(\mathrm{x}_i)$, included in models (1) and (2) is typically unknown in an observational study and has to be modeled and estimated. The observed covariates included in the propensity score model in this study are: gender (x_1), country of birth (binary) (x_2), parents country of birth (binary) (x_3), parents level of education (ordinal) (x_4), family's disposable income (x_5), average grade in senior high school (x_6), age at college start (years) (x_7), number of years at college (x_8) and an indicator if the individual lived in a county with an old university when graduating from senior high school (x_9). A generalised additive model for the propensity score is

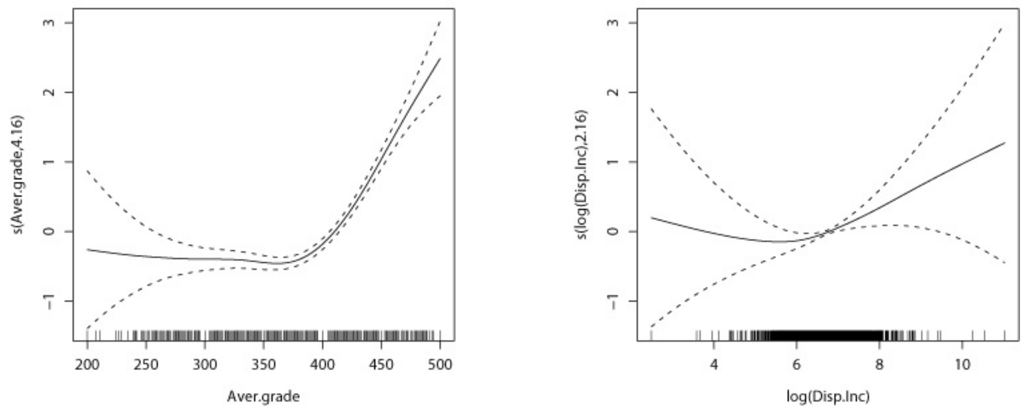
$$
\begin{aligned}
\log\left(\frac{p(\mathbf{x}_i)}{1-p(\mathbf{x}_i)}\right) &= \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \mathbf{x}_{4i}\boldsymbol{\beta}_4 + f(\log\, x_{5i}) \\
&+ g(x_{6i}) + \beta_7 x_{7i} + \beta_8 x_{8i} + \beta_9 x_{9i} \qquad (3)
\end{aligned}
$$

where $f(\cdot)$ and $g(\cdot)$ are smooth functions. Models (2) and (3) can also be estimated using the gam function.

4 Results

The estimation of the propensity score model (3) is shown in Table 4-1. The estimated propensity to choose an old university is higher for men than for women, and also higher for individuals with highly educated parents or with parents born outside Sweden. The propensity to choose an old university also increases with an individuals age. In Figure 4-1, the effects of average senior high school grade and family income on the propensity score can be seen. For average grades above 380 the estimated score starts to increase. The effect from family income (log scale) is not very obvious but between 6 and 8 there is an upward trend in the propensity score. For incomes lower than 6 and higher than 8 we have few observations and consequently the confidence bands are wide. The fitted propensity scores have approximately common support for old and new colleges (Figure 4-2), giving evidence for the assumption $0 < p(x_i) < 1$. Indeed, the latter implies that Figure 4-2 should show common support.

Figure 4-1 Smooth terms in the estimated propensity score model.



a) Average grade

b) Disposable income

Model (1) was estimated for the income effect two and three years after graduation from college and the results can be seen in Table 4-2 and Table 4-3. The interaction term between $p(x_i)$ and Z_i, was not significant in the two estimated models and was therefore omitted. Old colleges have an estimated wages premium of 5.5 per cent (exp(0.0533)) two years after graduation and 6.3 per cent (exp(0.0614)) three years after graduation given the propensity score. The effect on income of the propensity score is significantly nonlinear with a positive slope over the whole range (Figure 4-1).

The results of the estimation of Model (2) which are shown in Table 4-4 and Table 4-5 suggest that the probability of having an income higher than 100,000 SEK are higher for units graduating from new colleges both two and three years after graduation. The interaction term between $p(x_i)$ and Z_i was not statistically significant and has been omitted. We want to control for propensity score when comparing the college groups and therefore we have chosen to keep the propensity score term in the model even though it is not significant.

Finally, Figure 4-3 shows the estimated wage premiums when each college is excluded from the analysis, one at a time. The largest change in effect occurs when Stockholm University is excluded from the Old colleges group. The estimate of the wage premium is then lowered but still significantly greater than zero. This is not surprising, since about 1 000 of the 3 343 individuals in the Old college group graduated from Stockholm University. The solid and dashed lines indicate the estimated wage premium with confidence limits when all universities are included in the analysis.

Table 4-1 Estimated propensity score model.

	Estimate	std. err	t ratio	Pr (>ItI)
(Intercept)	-2.061	0.289	-7.14	0.000
Gender (male=1)	0.340	0.062	5.50	0.000
Country of birth (abroad=1)	0.169	0.232	0.73	0.466
Parents country of birth (abroad=1)	0.186	0.097	1.91	0.056
Parents level of education				
1 (six years elementary school)				
2	0.252	0.227	1.11	0.226
3	0.111	0.176	0.63	0.528
4	0.147	0.178	0.83	0.408
5	0.207	0.176	1.18	0.238
6	0.621	0.170	3.65	0.000
7 (graduate education)	0.895	0.245	3.65	0.000
County (old university=1)	1.617	0.061	26.4	0.000
Age at college start				
-20				
20-22	0.267	0.067	3.98	0.000
22-	0.329	0.108	3.04	0.002
Years at college				
-4				
4.5-6	0.859	0.065	13.2	0.000
6.5-	1.446	0.047	14.8	0.000

Smooth terms	edf	chi.sq	p-value	
s(Aver.grade)	4.162	302.5	0.000	
s(log(Disp.Inc))	2.162	10.4	0.007	
n=6264				

Table 4-2 Estimated treatment effect two years after graduation.

	Estimate	std.error	t ratio	Pr(>ltl)
(Intercept)	7.83	0.007	1186	0.000
Z	0.053	0.010	5.26	0.000
Smooth term	edf	chi.sq	p-value	
s(p.sc)	4.91	363.6	0.000	
n=5342				

Table 4-3 Estimated treatment effect three years after graduation.

	Estimate	std.error	t ratio	Pr(>ltl)
(Intercept)	7.93	0.007	1131	0.000
Z	0.061	0.011	5.67	0.000
Smooth term	edf	chi.sq	p-value	
s(p.sc)	6.17	323.3	0.000	
n=5294				

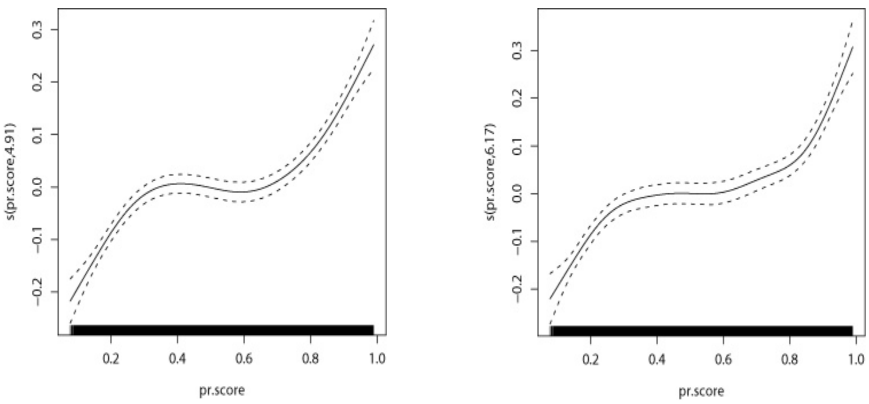
Table 4-4 Estimated probability of income >100,000 SEK after two years.

	Estimate	std.error	t ratio	Pr(>ltl)
(Intercept)	2.275	0.068	33.6	0.000
Z	-0.247	0.099	-2.48	0.013
Smooth term	edf	chi.sq	p-value	
s(p.sc)	1	0.223	0.636	
n=5968				

Table 4-5 Estimated probability of income >100,000 SEK after three years.

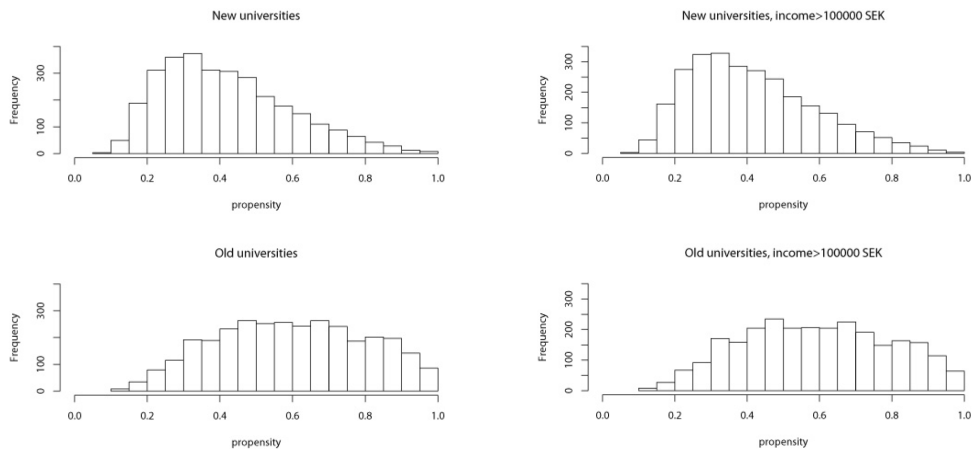
	Estimate	std.error	t ratio	Pr(>ltl)
(Intercept)	2.278	0.069	32.9	0.000
Z	-0.172	0.103	-1.67	0.095
Smooth term	edf	chi.sq	p-value	
s(p.sc)	1	3.35	0.067	
n=5968				

Figure 4-1 Smooth terms in the estimated income effect model.



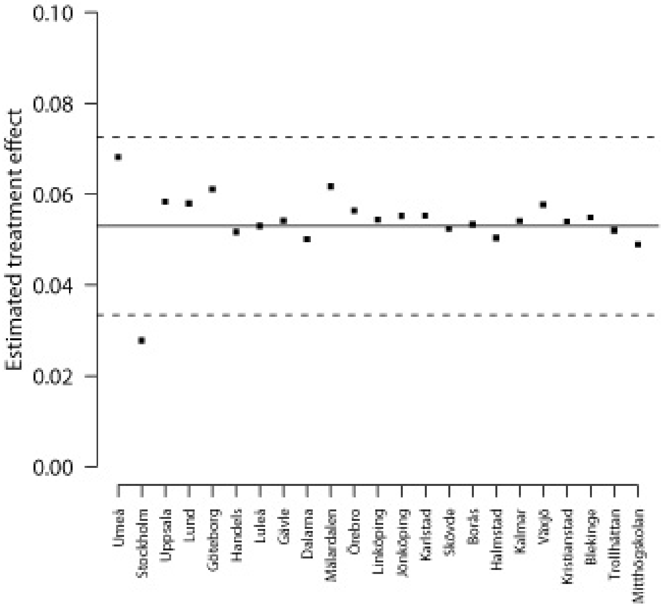
a) Two years after graduation   b) Three years after graduation

Figure 4-2 Support of fitted propensity scores.



a) All units   a) Incomes >100,000 SEK

Figure 4-3 Homogeneity of college groups.



5 Discussion

The purpose of this paper has been to investigate the effects of college choice on labour market earnings in Sweden. Differences in earnings could be due to differences in quality of education (e.g. quality of teachers) and/or that employers screen employees based on the type of the college they graduated from.

We use flexible generalised additive modeling to avoid parametric assumptions. These models have seldom been used in evaluation studies based on the propensity score; see however Johansson and Martinson (2000) for an exception. The estimated earnings premiums from choosing an old college are 5.5 per cent and 6.3 per cent, two and three years after graduation. This is in accordance with Lindahl and Regnér's (2003) results, when they do not adjust for intermediate variables. According to our results, a student who graduated at a new college and two years later had an income of 231,800 SEK (the median income two years after graduation from new colleges) would have made about 12,700 SEK more that year if he/she had chosen an old college instead. On the other hand, there is a higher probability for a student choosing a new college of having an income higher than 100,000 SEK two years after graduation, the effect three years after is not significant.

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