

Sorting out the sorting vs. human capital debate

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Abstract

We use data from Finnish polytechnic reform to distinguish between human capital and signaling theories of the value of education. The polytechnic reform took place gradually over the 1990s eventually upgrading all vocational colleges to polytechnics. The reform extended the length of education and created a completely new set of degree titles distinguishing the polytechnic graduates from the earlier graduates from the same schools. While both human capital and signaling theories predict that earnings are higher for those with higher level of education, their predictions differ in respect to what happens to those who graduate from schools that still are vocational colleges after polytechnics graduates start entering the labor market.

We find that the reform decreased the relative earnings of vocational college graduates as predicted by the signaling model. We also reject the predictions of “pure” signaling model, and conclude that education has both human capital and signaling value. According to our best estimates, approximately 56 percent of the return to additional education due to the polytechnic reform reflects the effect of education on productivity and the remaining 44 percent its signaling value.

1. Background

One of the oldest controversies in economics of education literature is the debate between human capital and signaling or screening theories of education. The former claims that education affects wages because it increases productivity of the workers. The latter explains the wage differences between those with different levels of education by the correlation of education and unobserved ability. In this case education is only a signal that identifies high ability workers. The controversy is difficult to resolve since both theories have in most cases identical predictions. In particular, both theories predict that earnings rise with higher education. However, the policy conclusions are very different. According to the human capital theory the increase in the education level has had important effects on productivity and economic growth. According to the pure signaling theory education has no effects on productivity and, even though investments in education may be profitable for the individuals pursuing education, they are, in general, not beneficial for the whole society.

A number of empirical studies under 1990s have proven that education has a causal effect on earnings. Under the assumption that earnings differences reflect productivity differences the debate would be solved. However, these studies make no claims whether that the reason behind the effect of education on earnings is the effect of education on productivity or only the effect of education on the employer perception of productivity.

Most 1990s estimates are based on natural experiments that lower the cost of schooling for a particular group (e.g. Card 1995) or induces a specific small group to continue their education at a higher level. (e.g. Angrist and Krueger, 1991, 1992). These studies identify the local treatment effect i.e. the effect of education on earnings among those who because of the instrument are induced to get more education (Imbens and Angrist 1994). As long as the affected group is relatively small this has only a small effect on the average innate productivity levels by the level of education. Hence, the fact that some small group gets higher earnings as a result of an exogenous change in their education level does not imply that the reason between the earnings differentials is the effect of education on productivity. Signaling explanation fits the facts equally well. If most individuals make their education choices based on the expected costs and benefits that depend on their ability, the employers can still use education to infer the ability levels of workers with different levels of education.

To illustrate the point, assume that pure signaling model (Spence 1973) holds and education does not affect productivity. Suppose that the productivity distribution is a uniform (0,1) distribution and that in a separating equilibrium all those with productivity levels over 0.5 get into higher education because the costs of education decrease with productivity. Now the average productivity (and wage) in high education group equals 0.75 and the average productivity in the low education group 0.25.

Now let an exogenous event induce the most able in the low education group to get into higher education. Suppose this fraction equals 0.1 so that eventually the top 60% of the cohort get into higher education and the bottom 40% remain in the low education group. If the level of education is the only information on productivity, the employers will estimate that the average productivity the high education group equals 0.7 and that the average productivity in the low education group equals 0.2; and set wages accordingly. Even though education has no impact on productivity, the group that was induced into higher education will experience 0.5 wage growth. In this case both the cross-section estimate on the effect of education on earnings and the an IV-estimate based on an exogenous change in the cost of education both indicate that education increases earnings by 0.5.

The previous empirical literature has tried to distinguish between the screening and human capital theories in a number of ways. The early approaches compared the wage distribution in occupations where screening could be important to the occupations where it should play a smaller role (eg. Riley 1979). A few interesting papers evaluated the responses to individuals to the changes in minimum school leaving age (Lang and Kropp 1986, Chevalier et. al 2003) or access to education (Bedard 2001). In both cases the changes in schooling level change the incentives of the individuals, who are not directly affected by the reform, to signal their productivity by altering their schooling choices. Closest to our approach, Kroch and Sjöblom (1994) distinguish between signaling and human capital explanations by including both absolute and relative measures of education in the earnings function. Finding that the relative position of an individual in the distribution of education for his cohort had an effect on earnings would be evidence in favor of the screening hypothesis.

The balance of evidence from the previous studies supports the human capital theory. Only Lang and Kropp (1986) and Bedard (2001) clearly reject the predictions of the human capital theory by showing that reforms of the education system that affect only some specific groups by extending compulsory education or by increasing university access, also affect educational choices of groups not directly affected by the reform. Such behavior is inconsistent with the pure human capital model but consistent with the signaling story.

In this paper we use a large scale schooling reform that took place gradually between 1992 and 2000 in Finland as a natural experiment that can be used for distinguishing between the human capital and signaling theories. This reform transformed a number of schools from vocational colleges to polytechnics by upgrading the level and extending the length of education in these schools. The changes in the content and duration differed across different fields. In this study we focus on business programs where the changes were most substantial. According to both signaling and human capital theories, the reform should increase the earnings and employment prospects of polytechnics graduates compared to the graduates from the same schools before the reform. However, the theories differ in their predictions on what happens to the earnings of the vocational college graduates when the new polytechnics graduates enter into the labor market. We use these differences to test human capital and signaling models. We reject both theories in their pure form, and conclude education has both signaling and human capital value.

In the following we first describe the essential features of the Finnish school system and the polytechnics reform. We then specify our empirical strategy and describe our data sources. The baseline empirical estimates are in section five. Section six concludes.

2. The Finnish education system and the polytechnics reform

2.1. The Finnish school system in brief¹

Finnish students begin school at the age of seven. Compulsory comprehensive school lasts for nine years. After comprehensive school about 55 percent of the students continue in the upper secondary school that lasts for three years and ends with a matriculation examination. The other 45 percent enter into various vocational schools and vocational colleges that last for two to three years.

Vocational schools and colleges were a diverse group of schools in the beginning of 1990s. The length of education and entry requirements varied between schools. Some took most students directly from comprehensive schools and provided them with two or three years of vocational education. In some vocational colleges most students had completed upper secondary school before

¹ An up to date English language overview of the Finnish education system can be found from the country background report for the OECD thematic review of tertiary education in Finland. (Ministry of Education, 2005)

entering vocational college For example, a business degree from vocational college (merkonomi) typically required three years of schooling after comprehensive school or two years of schooling after upper secondary school. Engineering degree from technical college required that the students had either vocational school or upper secondary school degree before entering. Education at technical college typically took four years to complete. In nursing school most students had completed upper secondary school before entering, and vocational college lasted for three years.

Highest education in Finland is provided by state universities. The students are accepted directly to a Master's program that takes, on average, five to six years to complete. Vast majority of students enter university after completing upper secondary school, but it is also possible to apply with a vocational college degree.

Education is free at all levels. State financed student aid and subsidized loans make possible to pursue education irrespective of financial circumstances of the family. Good employment prospects for graduates and reasonably high monetary returns to education have kept the demand for education high. The supply is controlled by the Ministry of Education through its decisions on the number of study places at universities and through its funding decisions to other schools. As a consequence the number of applications to universities and to most popular vocational colleges exceed the number of places by a factor of 4². Entrance exams and/or previous grades are used to select students to most schools at all levels.

2.2. The polytechnics reform

The goal of the polytechnics reform was to improve the quality of vocational education and to respond to the growing demand for skilled workers. The aim was to channel the increase in higher education provision to more practical education at polytechnics rather than to more scientific education at universities.³ Other objectives included pooling resources in vocational schooling to larger units and making Finnish education system more comparable to other countries.

² According to KOTA database by the Ministry of Education 108 615 applications were sent to the Finnish universities in 2003. Only 28 159 students were admitted. Even though many students applied to several universities, the excess demand for university education is substantial.

³ Despite of this some polytechnics have recently started calling themselves "universities of applied sciences".

The first 22 polytechnics were established under a temporary license in 1991. These polytechnics were created by joining several vocational colleges and vocational schools, often operating at several sites. Seven new temporary licenses were granted over the 1990s so that currently there are 29 polytechnics. The experimental phase was judged to be successful and starting in 1996 the temporary polytechnics have gradually become permanent.

The first graduates from the new polytechnics entered into labor market in 1994. The number of graduates grew rapidly and by 2000 the number of new polytechnics graduates exceeded the number of new university graduates. The three largest fields were business and administration, social and health care (typically nursing), and technical and transport (typically engineers). Each year, between eighty and ninety percent of all polytechnics degrees were granted from these three fields.

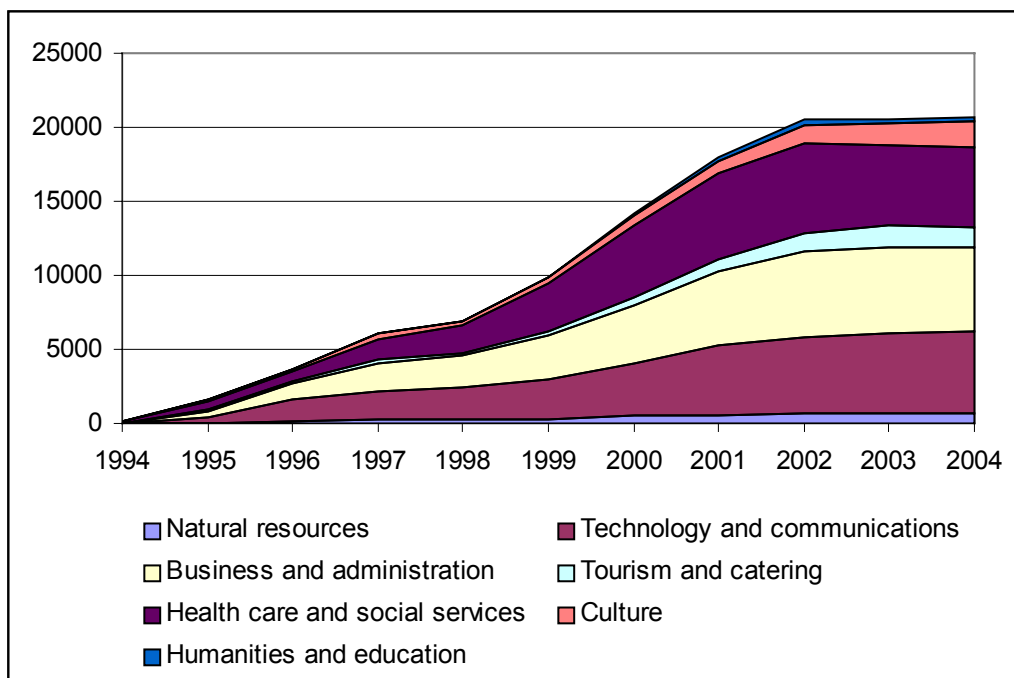


Figure 1 Polytechnics degrees by field 1990 – 2004

Sources AMKOTA database, Oppilaitostilastot 1997, SVT Koulutus 1997:5; Ammatilliset oppilaitokset 1996, SVT Koulutus 1996:11; Ammatilliset oppilaitokset 1995, SVT koulutus 1995:11

In this study we compare the students who graduate from the vocational colleges before and after the polytechnics reform. Since the timing of the reform differed across schools, we can also control for other macroeconomic changes and general changes in the return to education by comparing the

performance of the polytechnics graduates to the performance of vocational college graduates who graduated at the same time, and to control for both time and school fixed effects at the same time. The latter point is important because the economic circumstances that affect the employment prospects of new graduates were very volatile in the 1990s. Finnish economy experienced its largest peacetime recession in the beginning of 1990s. The unemployment rate increased from 3.3 percent in 1991 to 16.6 percent in 1994. Rapid recovery from recession took place in the period from 1994 to 2002 when the average GDP growth rate was close to four percent. The average polytechnics graduates clearly entered the labor market under much better demand conditions than those who graduated from the same schools in the early 1990s.

The reform changed the curriculum to different extent in different fields. Our impression based on discussions with the school administrators and officials from the Ministry of Education is that the changes in the engineering and nursing education were relatively minor. Also the average length of studies in these fields was unchanged. In our previous evaluation study (Böckerman, Hämäläinen & Uusitalo 2006) we compared earnings of polytechnics graduates in these fields to the earnings of graduates from the same schools before the reform and found that, after controlling for changes in student composition, the reform had no effect on earnings in either engineering or nursing. With almost unchanged content and duration this is hardly surprising.

In contrast, there were substantial changes in the business education. The average length of studies increased from two years to three and a half years. The graduates received new degree titles (*tradenomi*) that distinguished them from earlier graduates from these schools (*merkonomi*). In our earlier study we found that both employment rates and earnings of post-reform graduates were significantly higher when compared to pre-reform graduates from the same schools. This finding is naturally consistent with both the human capital and the signaling model.

As mentioned earlier the polytechnics were created by upgrading vocational colleges into polytechnics. Universities continued their operation during the reform period without major changes. Looking across all fields, also the number of graduates from secondary-level vocational education remained rather stable. These changes are reflected in Figure 2 that reports the number of degrees by the level of education between 1990 and 2000. The number of university degrees have increased over time and the number of vocational school degrees in the end of 1990s. However, the main change in the distribution of the degrees is the gradual decrease in the number of vocational college degrees and the corresponding increase in the polytechnics degrees.

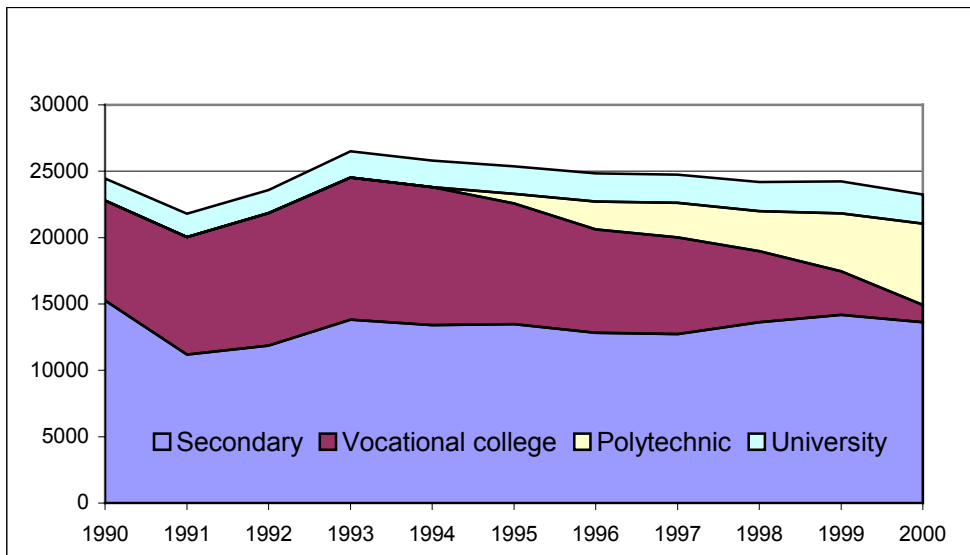


Figure 2 Degrees completed by level of education

Source: Own calculation based 50 % random sample from Register of Degrees and Examinations

The changes in the degree structure within the business education were a fair bit more complicated. Also there the changes in the university-level education were small. The main change that took place involved the transformation of vocational college education (*merkonomi*) to polytechnic education (*tradenomi*). In most schools the programs, where the entry requirement prior to the reform was completing senior secondary school, were upgraded to the polytechnic level by extending the program length from two to three and a half years. However, changes occurred also at the secondary-level. Up to 1998 the basic vocational business degree (*merkantti*) took two years to complete and required only comprehensive education as an entry requirement. In 1995, the basic vocational program was upgraded to a three-year program that confusingly now granted degrees titled *merkonomi*. The first graduates from these programs entered the labor market in 1998. After 1999 most graduates from basic vocational business program had completed a three-year-course. In the official classification these degrees were still classified to the secondary-level, but it is unclear whether these degrees should be compared to earlier basic vocational programs or earlier vocational college programs.

Finally, the total number of graduates was also affected. This was due to two factors. First the extension of program length due to the polytechnic reform temporarily reduced the number of graduates. Secondly, the financial resources were limited and the increase in teaching resources required by extension of the program length were partly financed by reducing the intake.

In Table 1 we report these changes in the distribution of business degrees during the 1990s. As can be read from the table the number of polytechnic graduates increased rapidly from 1995 onwards. This increase was accompanied with a decrease of degrees from the lower tertiary level, mainly from programs where entry requirement was completing upper secondary school.

Table 1 The number of business degrees by level of education from 1990 to 2000

Degree title	Merkatti	Merkonomi	Merkonomi	Yo- Merkonomi	Tradenomi	MBA	
ISCED code	331102	331101	531	531	631	732	
Level	Upper secondary	Upper secondary	Lowest tertiary	Lowest tertiary	Polytechnic	University	
Entry requirement	Lower secondary	Lower secondary	Lower secondary	Upper secondary	Upper secondary	Upper secondary	
Length after compulsory schooling	2	3	3	3+2	3+4	3+6	
Number of graduates							Total
1990	1546	0	1875	2758	0	613	6792
1991	1263	0	1852	3131	0	580	6826
1992	1274	0	1869	3256	0	512	6911
1993	1436	0	2260	3194	0	638	7528
1994	1534	0	2299	2069	0	616	6518
1995	1324	0	2350	1961	189	647	6471
1996	1226	0	2096	1937	625	638	6522
1997	1624	9	1969	1846	920	637	7005
1998	1341	1020	870	1295	1022	645	6193
1999	264	1589	462	644	1482	771	5212
2000	51	2179	202	357	1900	689	5378
Total	12883	4797	18100	22448	6138	6986	71356

Figure 3 clarifies the change in the degree structure. The main changes that took place in the second half of 1990s were the transformation upper-secondary-school based two-year merkonomi programs to three and half year polytechnic programs, and the creation of a new three-year secondary-level business program. The latter was formed from two-year secondary-level programs and from three-year programs in vocational colleges.

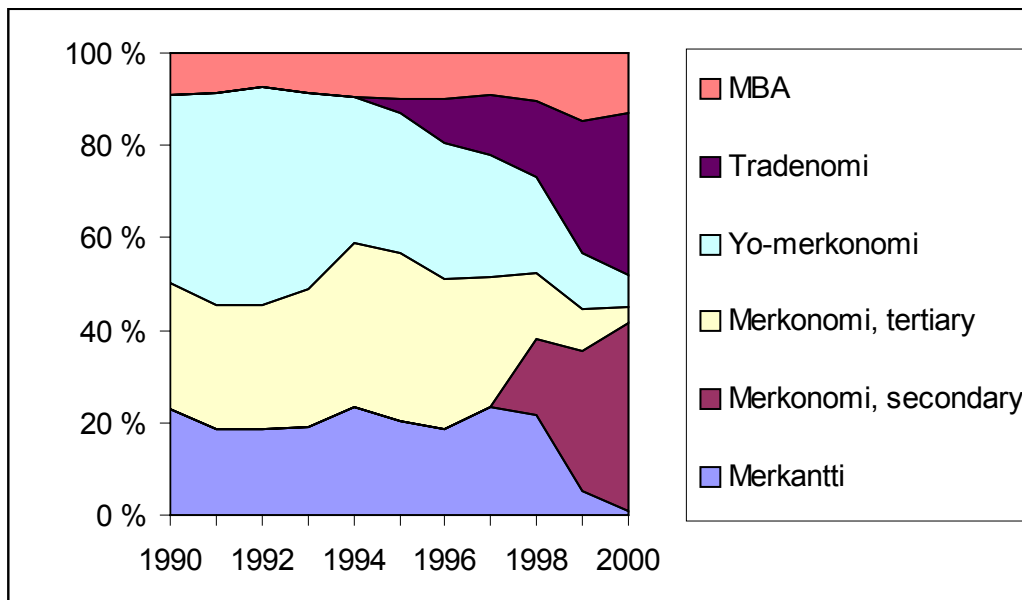


Figure 3 Distribution of completed degrees by graduation year and level of education

3. How the Finnish polytechnics reform can be used to sort out the sorting vs. human capital controversy

Both human capital and signaling models would predict that the graduates from the polytechnics would receive higher earnings than graduates from the same schools before the reform. According to the human capital explanation this increase is due to higher productivity resulting from an extension in the length, and perhaps an improvement in the quality, of education compared to that in the vocational colleges. Human capital theory also would also predict that the relative earnings of the polytechnics graduates compared to university graduates and the graduates from the secondary level vocational schools would increase. The signaling model creates similar predictions for the polytechnics graduates. If the most able of those, who before the reform would have entered into vocational colleges, now enter polytechnics, the average ability of the polytechnics graduates is

higher than the average ability of vocational college graduates before the reform. The polytechnics graduates can easily signal this to the employers with their new titles.

The crucial difference between human capital and signaling models is their prediction on what happens to those who graduate from the vocational colleges after some schools have went through the reform, but before their own college is upgraded to a polytechnic. According to the human capital theory their earnings are not affected because they get exactly similar education as before. Also their relative position compared to university graduates and the graduates from the secondary level vocational schools should not be changed.

In contrast, the signaling hypothesis would predict that those who graduate from the vocational colleges after the reform would suffer earnings losses. If the most able of those who before the reform would have graduated from the vocational colleges now enter polytechnics, the average ability of those who remain in vocational colleges after the reform decreases. If this is how the employers perceive the sorting process, also the average earnings of the vocational college graduates decrease. In fact, a pure signaling model would predict that if one combines polytechnics and vocational college graduates, the earnings losses of vocational college graduates as large as the earnings gains of polytechnics graduates, so that the average earnings of the combined group are not affected by the reform.

Another way to describe the predictions of the two competing theories is to use the concepts from Kroch and Sjöblom (1994) and note that the reform increased education level of polytechnics graduates - compared to the graduates from the same schools before the reform - in both absolute terms, and relative to the other graduates of the same cohort. The reform had no effect on absolute education level of those graduating from vocational colleges after the reform, but it decreased their relative education level.

To sum up the pure human capital model predicts that the earnings of the polytechnics graduates increase as a result of the reform but the earnings of the vocational college graduates remain unchanged. The pure signaling model implies that the earnings of the polytechnics graduates increase and the earnings of the vocational college graduates decrease so that the average earnings of these two groups remain unchanged. The third possibility is that the reform does not increase productivity nor do employers perceive any changes. In this case there will be no changes in earnings for either vocational college graduates nor polytechnics graduates. Both these will be equal to the earnings of the vocational college graduates before the reform.

3.1. Formal test

A simple test to distinguish between human capital and signaling hypothesis follows the logic described above. As the reform involves a gradual decrease in the number of vocational college graduates and the gradual increase in the number of polytechnics graduates, it is natural to measure it by the *share of polytechnics graduates of all graduates from vocational colleges and polytechnics*. Under the null hypothesis that the wage differentials are purely human capital the emergence of polytechnics graduates into the labor market will have no effect on the earnings of vocational college graduates. Hence, the interaction effect of the share of polytechnics graduates and a dummy variable identifying the vocational college graduates should be zero in a regression where earnings are explained by the level of schooling and the year effects. Under the alternative hypothesis that education has also signal value, this interaction effect would be negative.

Similarly, under the null hypothesis of that wage differentials arise from the pure signaling model, the share of polytechnics graduates has no effect on the average earnings of vocational college and polytechnics graduates combined. Hence the interaction effect of the share of polytechnics graduates and a dummy variable that indicates that student graduated from either polytechnic or vocational college, should be zero in a similar regression model. Under an alternative that the increase in the share of polytechnics graduates increases average productivity in this aggregated group, this interaction effect should be positive.

4 Data

Our empirical work is based on a fifty percent sample of all individuals who received a degree from any post-compulsory school in Finland between 1990 and 2000. The primary source of data is the Register of Degrees and Examinations maintained by the Statistics Finland. Schools report all degrees granted directly to Statistics Finland and hence register has universal coverage of all degrees from all schools in Finland. Information in the register is stored at the student-level and include person id, school code, type of school and program, degree title and year granted. The register also includes a history file that allows tracking schools when several schools are merged into one. This allows creating a link that helps to identify which vocational colleges formed each polytechnic. For confidentiality reasons the school id's were re-coded so that the individual schools can no longer be identified, but the link between pre-reform and post reform school codes was kept in data.

These data have been merged using common person identifiers to Employment Statistics (ES) that is essentially an annual population census. ES contain information of all employment and unemployment spells from pension insurance funds and unemployment registers, as well as, annual earnings based from tax records. The individuals can be followed over time. Time series data on individuals also allows calculating various employment history measures at the individual-level. We use this to calculate work experience at the time of graduation and to include information on all previous degrees in the data. Our observation window includes years 1987 to 2002.

Finally, we obtained data on the matriculation examination results for the persons who graduated from upper secondary school between 1988 and 1997. The matriculation examination is a compulsory final exam taken by all students who graduate from upper secondary school. The exam takes place simultaneously in all schools. The answers in each test are first graded by teachers on the scale from 1 to 6 and then reviewed by associate members of the Matriculation Examination Board outside the schools. In early 1990s the exam included four compulsory and two optional tests. In the data that is provided by the Matriculation Examination Board all grades in all tests are reported. In this paper we use the average of four compulsory tests as a measure of student ability.

In most cases we examine effects on outcomes in the year following the graduation year ($t+1$), so that we avoid the need to adjust for the different graduation dates, but observe the students as soon as possible after graduation. As an outcome measure we use both annual earnings in year $t+1$, employment in the end of the year $t+1$ and monthly wage imputed based on annual earnings and months worked. We include in the regression models all graduates after 1994 when the first polytechnics graduates enter the labor market. We exclude students who are still enrolled in some school in the year after graduation.

We focus on business education which is one the three largest fields in the polytechnics and where the changes in the content of education were largest. When comparing polytechnic and vocational college graduates to other education levels, we select comparable fields from universities and vocational schools. Hence we compare business degrees from polytechnics to MBA degrees from universities. We also create similar comparison groups by field from secondary level vocational education. This is slightly more complicated since the degree structure in the secondary level has also changed. Last graduates from secondary level business degrees (merkantti) entered the labor market in 1999 and most secondary level qualifications after that are granted within adult education system.

5. Results

Figure 4 provides a first glance to the post graduation outcomes in business education, the field where the reform caused largest changes to the content and the length of education. The figure plots real median annual earnings in the year after graduation by the education level and the year of graduation. These median earnings reflect both differences in the employment rates and hours of work and the differences in the wage level.

The drop in the real earnings in the beginning of the decade reflects the effects of recession on employment rates and wages. After 1993 earnings in all education levels start to increase. When measured in euros, the increase are largest in higher levels of education, but in relative terms the differences are smaller. Some rapid changes in the figure are due to a small number of observations and changes in the composition. For example, very few graduated with lowest business degree (*merkantti*) or with comprehensive school-based *merkonomi* degree after 1998.

The most interesting developments occur in the earnings of vocational college and polytechnics graduates. The earnings of these two groups clearly diverge and the earnings of the polytechnics graduates approach the earnings of university graduates (at least in relative terms), as predicted by both human capital and signaling models. It also seems that those who graduate from vocational colleges after the reform have suffered. The growth rate of their earnings halts after the polytechnics graduates start entering the market. This would be evidence of signaling effect, but could naturally also be caused by other changes in the quality of students or quality of schools. To control for these differences we will proceed to regression analysis.

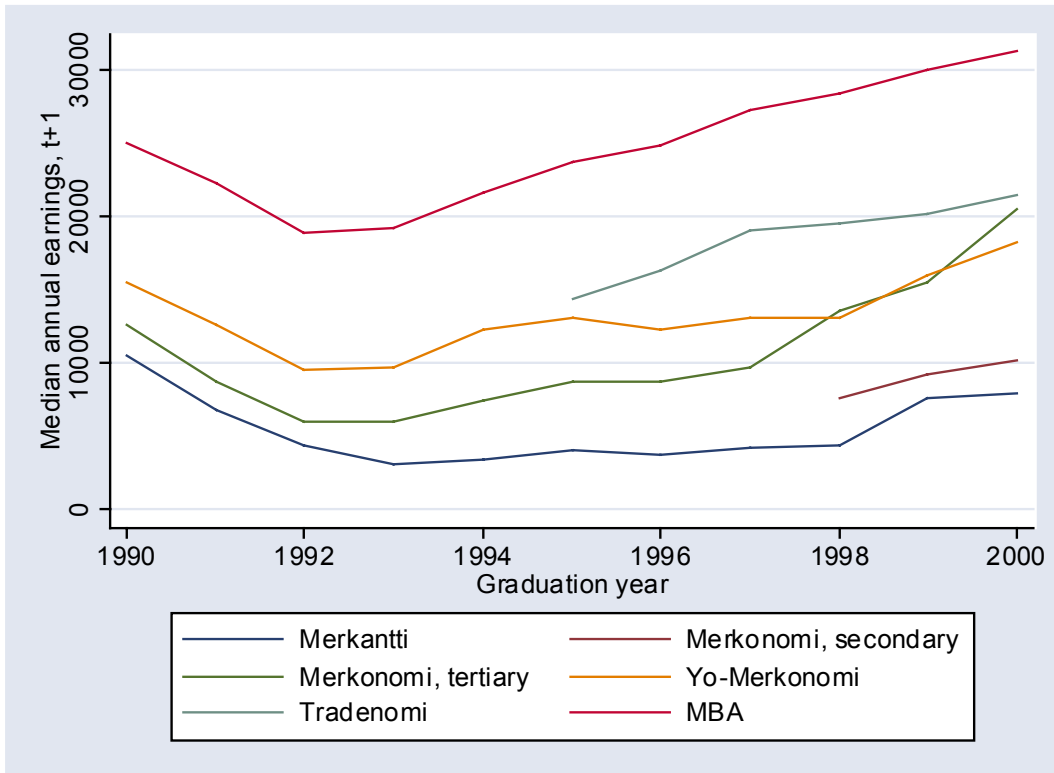


Figure 4 Median annual earnings in year after graduation by level of education and year of graduation

We first replicate the procedure used by Kroch & Sjöblom and explain the earnings of the graduates with both relative and absolute measures of education. We allocate each level of education the number of years of schooling as listed in Table 1. We then regress earnings on both absolute years of education and the relative rank of individual in the graduating cohort. We include year dummies to account for the business cycle effects. The basic empirical model is the following

$$\ln(y_{it}) = \beta_0 + \beta_1 S_y + \beta_2 S_r + \Phi X_{it} + \Omega D_t + \varepsilon_{it} \quad (1)$$

where y_{it} indicates earnings of individual i graduating in year t . S_y indicates years of education and S_r individual's rank in the distribution of education for his cohort. X_{it} is a vector of other control variables and D_t a full set of year dummies. A pure signaling model would imply that $\beta_1 = 0$ and a pure human capital model that $\beta_2 = 0$.

The results are reported in columns 1 and 2 of Table 2. The dependent variable in all equations is log annual earnings during the next calendar year after graduating. We use data from years 1994 to 2000 and include all individuals who are employed during the year. Students enrolled in some educational institution during the fall term and those with very low earnings (less than 1000 euros per year) are excluded. In the first column only years of schooling, relative rank within graduating cohort and year of observation are included as explanatory variables. In the second column also controls for sex, age, work experience and native language are included. In the bottom of each column we also report the coefficients of the schooling variables when rank is not included in the model.

According to the estimates both years of education and rank within cohort have significant effects on earnings. The magnitude of the estimates appears to be quite sensitive to the inclusion of control variables. This is not very surprising given that these control variables are highly correlated with the level of education. Including the rank variable reduces the coefficient of schooling, though this reduction is barely significant in column 2 where control variables are included.

Equation (1) provides reliable estimates for the human capital and signaling effects if the effects of years of education and rank in the education distribution are linear. However, there is little reason to impose such restrictive assumptions on the effect of education on earnings. If the effect of years of education is nonlinear, the rank variable may pick some of these nonlinear effects even if no signaling effect exist. We therefore estimate equation (1) also using dummy-variables for each level of education (omitting the lowest category). Since the equation also includes year dummies, the coefficient of the rank variable is identified from the changes in the relative number of individuals in each level of education.

These estimates are reported in columns 3, 4 and 5. In Column 3, no control variables are included. Column 4 includes the same set of controls as Column 2. Finally, Column 5 includes also 119 school dummies. The pattern of the results is not changed from linear schooling specification. Also here the rank variable has a significant and positive coefficient in all cases. Measures of schooling levels indicate significant returns to each additional year of schooling. These estimates are substantially smaller than corresponding estimates when rank is not included in the model.

Table 2. Earnings functions with absolute and relative measures of education

	(1)	(2)	(3)	(4)	(5)
Rank within cohort	0.783 (0.078)**	0.250 (0.073)**	0.846 (0.111)**	0.379 (0.103)**	0.276 (0.103)**
Years of education	0.056 (0.010)**	0.101 (0.010)**			
Years = 3			0.206 (0.030)**	0.174 (0.028)**	0.212 (0.029)**
Years = 5			0.169 (0.062)**	0.258 (0.057)**	0.274 (0.058)**
Years = 6.5			0.261 (0.079)**	0.376 (0.074)**	0.479 (0.074)**
Years = 8.5			0.466 (0.101)**	0.659 (0.094)**	0.921 (0.146)**
Female		-0.079 (0.009)**		-0.072 (0.009)**	-0.063 (0.009)**
Work experience		0.014 (0.001)**		0.014 (0.001)**	0.013 (0.001)**
Experience squared/100		-0.006 (0.001)**		-0.005 (0.001)**	-0.005 (0.001)**
Age		0.030 (0.005)**		0.029 (0.005)**	0.030 (0.005)**
Age squared/100		-0.031 (0.007)**		-0.031 (0.007)**	-0.031 (0.007)**
Swedish-speaker		0.058 (0.019)**		0.033 (0.019)	0.004 (0.027)
Language other		0.061 (0.042)		0.053 (0.042)	0.023 (0.044)
Observations	24064	24027	24064	24027	23987
R-squared	0.21	0.33	0.22	0.33	0.35
Effects when rank not included					
Years of education	0.159	0.134			
Years = 3			0.402	0.261	0.276
Years = 5			0.620	0.459	0.421
Years = 6.5			0.849	0.638	0.670
Years = 8.5			1.223	0.996	1.175

All estimated equations include dummy variables for the year of graduation. Column 5 also 119 school dummies. Standard errors in parentheses * significant at 5%; ** significant at 1%

To focus on the effects of the polytechnic reform we continue to test whether the entry of polytechnic graduates to the labor market reduces the earnings of graduates from vocational colleges. In Table 3 we estimate equations where we explain the earnings in the year after graduation with dummy variables for each level of schooling and interact the dummy for vocational college graduates with the fraction of polytechnic graduates. As noted before, we have a problem in choosing an appropriate comparison group. Therefore, we first use the lowest business degrees (*merkantti*) as a comparison group but use data only up to 1998 when this group still exists. In column 2 we use all programs where the entry requirement is comprehensive school as a comparison group by pooling data for education codes 331, 33101 and 531. We also include the same set of control variables as in the previous table and impose same restrictions to the sample. In columns 3 and 4 we merge the vocational college graduates and the polytechnic graduates and add an interaction term between this merged group and fraction of polytechnics graduates. As before, the omitted comparison group is lowest business degree in column 3 and pooled comprehensive school-based programs in column 4.

The most interesting results in Table 3 are the coefficients of interaction terms labeled as “signaling test” and “HC test”. According to the estimates in columns 1 and 2 the increase in the fraction of polytechnics graduates reduces the earnings of vocational college graduates, hence rejecting the pure human capital model and providing support for the signaling hypothesis. The size of the effect does not depend on the choice of the comparison group: in both columns 1 and 2 the estimate is close to -0.1 implying that a reform that transformed almost all vocational colleges to polytechnics reduced the earnings of the remaining vocational college graduates by about 10 percent.

In columns 3 and 4 we test the pure signaling hypothesis by examining how the increase of the fraction of polytechnic graduates affected the average earnings of vocational college and polytechnic graduates. The estimate is positive and significant implying that the reform increased the earnings of the polytechnics graduates by more than it reduced the earnings of the vocational college graduates. Since the average rank of these groups were not affected the result rejects the pure signaling hypothesis and provides evidence of significant human capital effects.

Table 3 Test of signaling and human capital models

	(1)	(2)	(3)	(4)
Education				
Merkonomi (331101)	0.166 (0.031)**		0.171 (0.031)**	
Merkonomi (531)	0.248 (0.015)**		0.243 (0.015)**	
Yo – merkonomi (532)	0.448 (0.021)**	0.261 (0.015)**	0.417	0.247
Tradenomi (631)	0.595 (0.019)**	0.384 (0.011)**	(0.021)**	(0.014)**
MBA (732)	0.944 (0.019)**	0.739 (0.013)**	0.934 (0.019)**	0.733 (0.013)**
Signaling test	-0.105 (0.051)*	-0.109 (0.036)**		
HC test			0.165 (0.046)**	0.108 (0.025)**
Female	-0.055 (0.010)**	-0.083 (0.008)**	-0.059 (0.010)**	-0.087 (0.008)**
Work experience	0.011 (0.001)**	0.013 (0.001)**	0.011 (0.001)**	0.013 (0.001)**
Experience squared/100	0.000 (0.001)	-0.004 (0.001)**	-0.001 (0.001)	-0.005 (0.001)**
Age	0.021 (0.005)**	0.037 (0.004)**	0.026 (0.005)**	0.040 (0.004)**
Age squared/100	-0.021 (0.007)**	-0.041 (0.006)**	-0.027 (0.007)**	-0.046 (0.006)**
Swedish speaker	0.034 (0.020)	0.033 (0.017)*	0.024 (0.020)	0.026 (0.017)
Language other	0.069 (0.045)	0.055 (0.037)	0.063 (0.046)	0.048 (0.037)
Observations	17172	23756	17172	23756
R-squared	0.33	0.35	0.33	0.35

All estimated equations include dummy variables for the year of graduation. Standard errors in parentheses * significant at 5%; ** significant at 1%

According to the results education has both human capital and signaling effects. One way to quantify the relative magnitude of the effects is to compare the positive effects on the polytechnics graduates to the negative effects of the remaining vocational college graduates. A rough measure that indicates the fraction of the increase in the earnings of the polytechnic graduates that can be attributed to the human capital effects, can be computed using the following formula

$$\text{Relative HC effect} = \frac{(w_{pol} - w_0) - \frac{1-p}{p}(w_{voc} - w_0)}{(w_{pol} - w_0)},$$

where w_{pol} indicates the post-reform earnings of polytechnic graduates, w_{voc} the post-reform earnings of vocational college graduates and w_0 earnings of both of these groups before the reform and p is the fraction graduating from polytechnics. This measure equals one if the earnings of vocational college graduates are not affected ($w_{voc} - w_0 = 0$), and schooling has only human capital effects. The measure equals zero if change in the weighted average earnings of these two groups is unchanged and schooling only provides a signal that helps employers to distinguish the most able from this group. Using the estimates from column 2 and calculating the fraction at the point where half of the schools have been reformed ($p=0.5$) yields a value of 0,56 indicating that 56 percent of the increase in the earnings of polytechnics graduates is due to human capital and the remaining 44 percent to an improvement in the signaling value.

5.1. Remaining concerns

Even though we believe that the results reported in the previous section are roughly accurate there are a number of robustness checks that we have performed or intend to perform before completing the paper.

So far we have focused on annual earnings. This is a useful measure that incorporates both the effects on employment prospects and wages if employed. Still it is interesting to decompose the effect to the employment and wage effects. Unfortunately wages are not available in our data. The closest to estimating wage effects we can get is to include number of months employed as one of

the explanatory variables. This is problematic given that employment spells are measured with substantial measurement error in our data. In our preliminary analysis where we have compared employment the effects on employment probabilities to annual earnings conditional on employed, we have found that the effects on employment appear to be larger.

We have reported results concerning annual earnings during the calendar year after graduation so that our estimates reflect the value of schooling, not the value of work experience. It might be useful to measure outcomes also somewhat later in the career when most graduates would have more permanent employment. We have tried this for the second year after graduation without qualitative changes in the results.

A more important point has to do with selectivity effects. Signaling model is a model of imperfect information. If the employers have more information on the quality of recent graduates and use this for hiring decisions and if these qualities are correlated with the level of schooling our estimates could reflect these selection effects. The problem can be reduced by including more information on the graduates to the estimated models, though there are naturally limits on how well we can do this. However, we have information on the matriculation examination grades that are used by schools to select the students and intend to add that information to the models. We will eventually be able to also control for the differences across schools by including a full set of fixed school effects to the equations.

In our analysis we find that the return to different levels of education is affected by the relative number of individuals at each level of education. We interpret this finding as evidence in favor of signaling model. Of course, the signaling model is not the only reason why relative size of skill groups would affect the return to skill. If the workers with different levels of education are imperfect substitutes in production, one would expect that a decrease in supply of a particular group would increase its wages. Therefore, a decrease in the number of vocational college graduates would drive up their wages. However, we find exactly the opposite. The larger the fraction graduating from polytechnics and hence the smaller the fraction graduating from vocational colleges, the lower is the wage of vocational college graduates.

6 Conclusion

A school reform that extends the length of education is likely to improve the employment prospects and wages of those who graduate from these programs. The private return to individuals may be substantial. However, when evaluating the benefits of the reform to the whole society one needs to account for the external effects that the increase in the education level has on graduates from other programs. If schooling is only a signal of the quality of the graduates the negative external effects on other graduates may be substantial. In assessing the benefits of the reform these negative external effects should be weighted against the positive effects on the graduates from reformed programs.

In this paper we have provided evidence that a large scale school reform decreases earnings of the graduates from the schools that were not yet reformed. We attribute this finding as evidence on the signaling role of education. However, the reform clearly benefits those who graduate from the schools after reform and these benefits outweigh the losses due to external effects. The average earnings of graduates from both reformed and not yet reformed schools increase. This increase is due to the increase in the average level of schooling and implies that schooling also has productive value.

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