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234

SIGNALING OR HUMAN CAPITAL: EVIDENCE FROM THE FINNISH POLYTECHNIC SCHOOL REFORM

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Signaling or human capital: Evidence from the Finnish polytechnic school reform

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Tiivistelmä

Tutkimuksessa käytetään aineistoa ammattikorkeakoulu-uudistuksesta koulutuksen signalointivaikutusten ja tuottavuutta lisäävän inhimillisen pääoman kasvun vaikutuksen erottamiseen. Ammattikorkeakoulu-uudistus muutti 1990-luvun aikana asteittain aikaisemmat ylioppilaspohjaiset opistotason tutkinnot ammattikorkeakoulututkinnoiksi. Kaupan alalla uudistus pidensi koulutuksen kestoa ja loi uuden tutkintonimikkeen, tradenomi, joka erottaa amk-tutkinnon suorittaneet aikaisemmin samoista oppilaitoksista valmistuneista merkonomeista.

Sekä inhimillisen pääoman teoria että signalointimalli ennustaa, että uudistuksen pitäisi kasvattaa tradenomien tuloja merkonomien tuloihin verrattuna. Sen sijaan mallit eroavat sen suhteen, miten merkonomien palkoille käy kun tradenomeja alkaa ilmestyä työmarkkinoille.

Tutkimuksen mukaan ammattikorkeakoulu-uudistus alensi merkonomien tuloja, kuten signalointimalli ennustaa. Tulokset eivät kuitenkaan ole sopusoinnussa myöskään ”puhtaan” signalointimallin kanssa vaan tukevat hypoteesia jonka mukaan koulutuksella on sekä tuottavuus- että signalointivaikutusta.

Abstract

We use data from the Finnish polytechnic reform to distinguish between human capital and signaling theories of the value of education. We find that the reform increased earnings of the polytechnic graduates compared to those graduating from the same schools before the reform, as predicted by both the human capital and the signaling models. However, we also find that the relative earnings of vocational college graduates decrease after polytechnic graduates start entering into the labor market. This finding is inconsistent with the pure human capital model and can be interpreted as evidence supporting the signaling model.

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 the 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 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 on returns to education 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, and pay the workers according to expected productivity.

To illustrate the point, assume that pure signaling model (Spence 1973) holds and education does not affect productivity. Suppose that the productivity is 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 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 the general 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. Even closer 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 has 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 in Section 2. We then specify our empirical strategy in Section 3 and describe our data sources in Section 4. The baseline empirical estimates are in section 5. Section 6 concludes.

2. The Finnish education system and the polytechnics reform

2.1. The Finnish school system in brief[1]

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 the entry requirements varied between schools. Some took most students directly from the 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 entering vocational college. For example, a business degree from a vocational college (*merkonomi*) typically required three years of schooling after the comprehensive school or two years of schooling after the upper secondary school. Engineering degree from technical college required that the students had either a vocational school or an upper secondary school degree before entering. Education at technical college typically took four years to complete. In the nursing schools 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 (eg. Uusitalo 1999) have kept the demand for education high. The supply is controlled by the Ministry of Education through its decisions on the number of students admitted

[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)

to the universities and through its funding decisions to other schools. As a consequence the number of applications to the universities and to the most popular vocational colleges exceeds the number of places by a factor of 4[2]. 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 the Finnish education system more comparable to that of other EU-countries.

The first 22 polytechnics were established under a temporary license in 1991. These polytechnics were created by merging 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 the 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)

[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”.

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. We can also control for any permanent differences across schools by adding school fixed effects to the equations that we estimate. Especially the former point is important because the economic circumstances that affect the employment prospects of the new graduates were very volatile in the 1990s. The average polytechnics graduates 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 the 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 share of university degrees has increased over time and the

share 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)

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 1995 the basic vocational business degree (*merkantti*) took two years to complete and required only comprehensive education as an entry requirement. Starting 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 the extension of the program length was partly financed by reducing the student intake. However, also the number of potential applicants was reduced as the small age cohorts born in the early 1970s came to typical college entry ages. For example, the number of 20 – 24 year-olds decreased by about 10 percent between 1990 and 1995.

In Table 1 we report the 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)

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 the polytechnic programs lasting 3.5 years, 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)

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

Both the 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 the 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. According to the signaling model the employers use the polytechnic degree as a signal that distinguishes the best workers from the applicant pool.

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 predicts that those who graduate from the vocational colleges after the reform 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 would be as large as the earnings gains of polytechnics graduates, so that the average earnings of the combined group would not be 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.

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 a gradual increase in the number of polytechnics graduates, it is natural to measure the reform 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 signaling 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 the register has universal coverage of all degrees from all schools in Finland. Information in the register is stored at a student-level and include a 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 person id's and the school id's were re-coded so that the individual students or individual schools can no longer be identified. Still, the link between the pre-reform and the post-reform school codes was kept in data. These data have been merged to Employment Statistics (ES) that is essentially a register-based annual population census. ES contain information on all employment and unemployment spells from the pension insurance funds and unemployment registers, as well as, annual earnings from the 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 from 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 national compulsory final exam taken by all students who graduate from the upper secondary school. The exam takes place simultaneously in all schools. The answers are first graded by teachers and then reviewed at the national level by the associate members of the Matriculation Examination Board outside the schools. The exam scores are standardized so that their distribution is the same every year. 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.

We examine effects on outcomes in the year following the graduation year (t+1) in order to avoid the need to adjust for the different graduation dates, but to observe the students as soon as possible after graduation. As the main outcome measure we use the annual earnings in year t+1. 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 educational institution 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 the largest. When comparing the polytechnic and the 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 two-year secondary level business programs (merkantti) entered the labor market in 1999.

5. Results

Figure 4 provides a first glance to the post-graduation outcomes after a business degree. 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, as well as, the differences in the wage level.

The drop in the real earnings in the beginning of the decade reflects the effect of recession on the employment rates and wages. After 1993 earnings in all education levels start to increase. When measured in euros, the increase is largest in the 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 polytechnincs 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 the quality of schools. To control for these differences we will proceed to regression analysis.

(Figure 4)

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 the absolute years of education and the relative rank of individual within the graduating cohort. We include year dummies to account for the business cycle effects. The basic empirical model is the following

$$\ln(y_{it}) = b_0 + b_1 S_y + b_2 S_r + \Phi X_{it} + \Omega D_t + e_{it}, \quad (1)$$

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 $b_1 = 0$ and a pure human capital model that $b_2 = 0$.

The results are reported in Columns 1 and 2 of Table 2. The dependent variable in all equations is log annual earnings during the calendar year after graduating. We use data from years 1994 to 2000. Students enrolled in some educational institution during the fall term and those with very low earnings (less than 500 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 the rank is not included in the model.

According to the estimates both the years of education and the 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 the 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 exists. 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)

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 an interaction of the indicator for the vocational college graduates and 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 for the first three years up to 1997 where the distribution of lower business degrees remains roughly constant (See Figure 3). 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 (Detailed description in Table 1). We include the same set of control variables as in the previous table but also attempt to control for potential changes in student quality by including matriculation examination scores and an indicator taking a value of one if the student has not completed a high school and hence has no matriculation exam score to be included. 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 all comprehensive school-based programs in Column 4.

The most interesting results in Table 3 are the coefficients of interaction terms labeled as “signaling effect” and “HC effect”. 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 coefficient in the first column is rather large (-0.171). In the second column that uses all years and perhaps better control group the estimate is substantially lower (–0.088) but statistically significant due to a smaller standard error. The point estimate would imply that a reform that transfers almost all vocational colleges to polytechnics would reduce the earnings of the remaining vocational college graduates by about 9 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 merged together. The estimate is positive and of roughly similar magnitude in both Columns 3 and 4 but only the estimate in Column 4 is statistically significant. The result implies 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 was not affected the result rejects the pure signaling hypothesis and provides evidence of significant human capital effects.

(Table 3)

According to the results education has both human capital and signaling value. 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

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

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. 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 the earnings gain to polytechnic graduates is equals the loss

to the vocational college graduates so that 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 our preferred estimates from Column 2 and yields a value of 0,29 indicating that 29 percent of the increase in the earnings of polytechnics graduates is due to an increase in human capital and the remaining 71 percent to the signaling value.

5.1. Robustness checks

The crucial question regarding the validity of the results reported above is whether the decrease in earnings of vocational college graduates reflects a decrease in the signaling value of education or a decrease in student quality. We tried to deal with this by including matriculation exam scores to the equations that we estimated, but this may be only a partial solution to the problem if the employers have other information on the quality of recent graduates and if they use it in hiring decisions.

The options of performing more convincing tests of the signaling hypothesis using data on the polytechnics reform are rather limited. One possibility is to examine the changes in the fraction of the vocational college graduates that continue their studies after graduation. We found that this fraction increases after the reform relative to those graduating from lower schooling levels. Such a behavior would be consistent with a decrease in the signaling value but might also be due to improved access to further education, for example, in the new polytechnic schools. It would also be interesting to examine the changes in the drop-out rates in the vocational colleges (as in Bedard 2001) but in our data one can only observe graduation and not enrolment so we cannot identify the drop-outs.

We also estimated the effect of the entry of the polytechnics graduates to the market on those who graduated from the vocational colleges before the reform and who therefore were not sorted. We used data on those who graduated from vocational colleges between 1990 and 1994 and explained their earnings five years after graduation in 1995 – 1999 with the fraction of polytechnics graduates on the market. The estimates were negative effects but insignificant when work experience was included as a control variable. The test is naturally problematic also because those who have graduated five years earlier are not necessarily competing for the entry-level jobs with more recent graduates.

In our analysis we have implicitly assumed that workers with different qualifications are perfect substitutes with each other. Under this assumption the relative number of graduates at each level of education only affects return to different levels of education because the employers use education as a signal for ability. An increase in fraction proceeding to higher levels of education lowers the employer perception of ability of those remaining at lower levels. If the workers with different levels of education are imperfect substitutes in production, changes in relative shares will have also other effects. In particular, one would expect that a decrease in supply 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. Naturally, more complex patterns of relative substitutability could create different outcomes, but it would be difficult to come up with a simple supply story that could fully explain our findings.

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 new programs. The private return to individuals may be substantial. However, when evaluating the benefits of the reform for the whole society one needs to also 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 large. 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 the 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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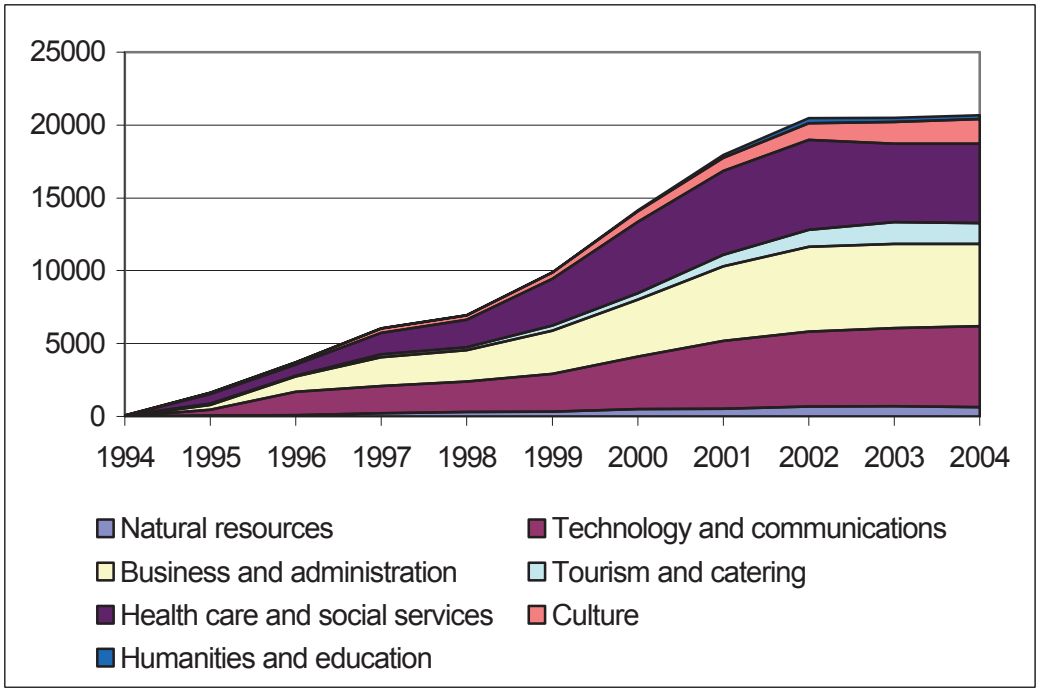
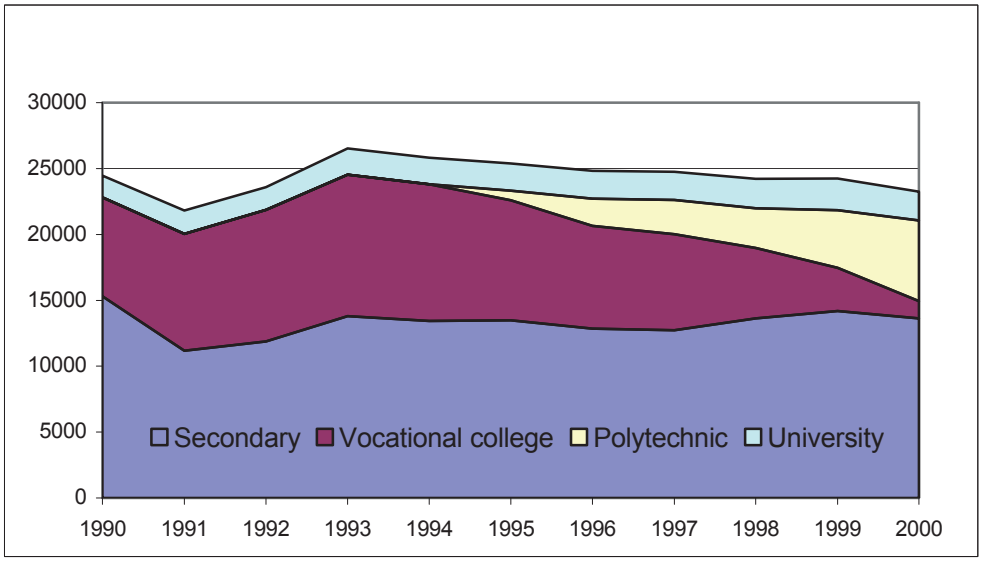
Figure 1. Polytechnics degrees by field 1994–2004.



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

Figure 2. Degrees completed by level of education.



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

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

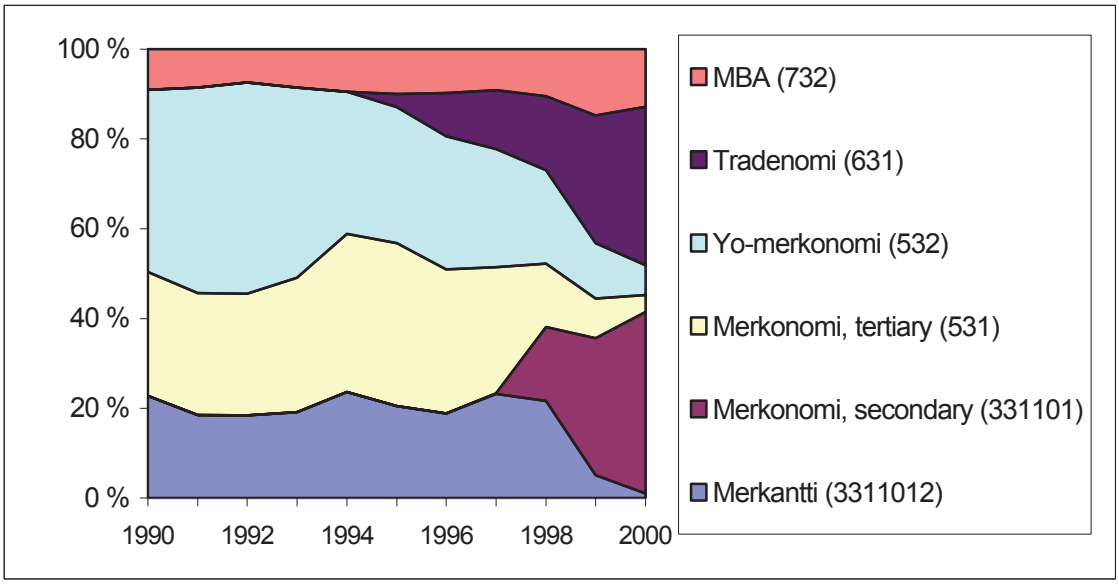


Figure 4 Median annual earnings in year after graduation by level of education and year of graduation.

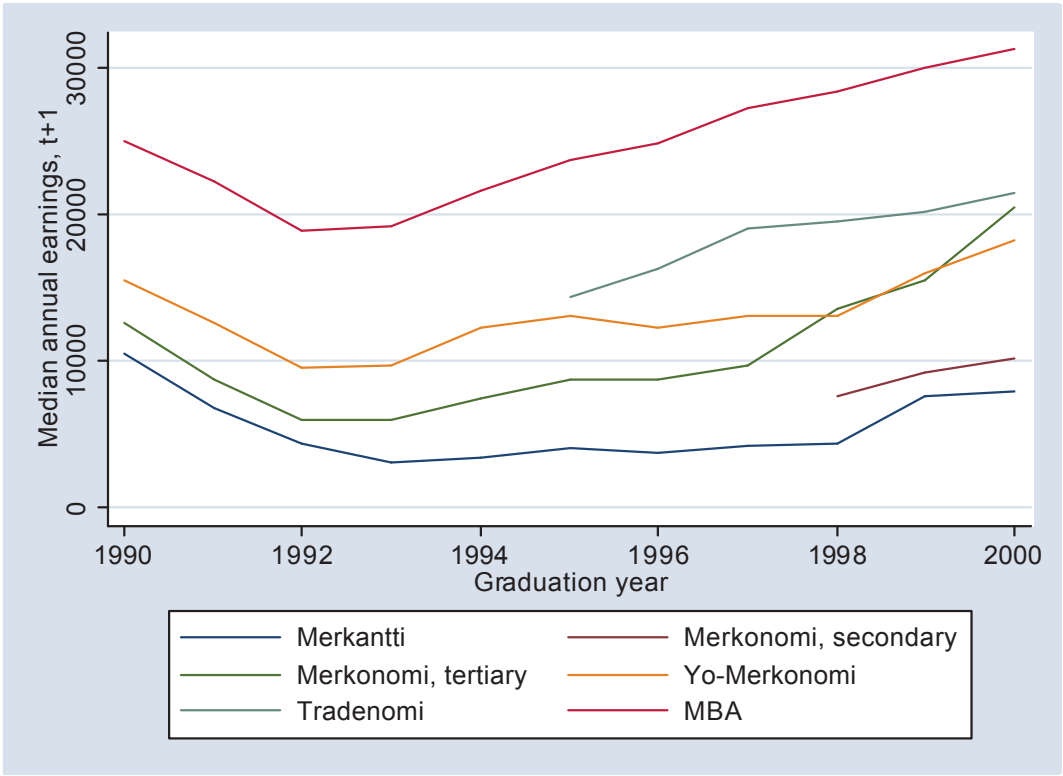


Table 1. The number of business degrees by level of education from 1990 to 2000.

Degree title	Merkatti	Merkonomi	Merkonomi	Yo-merkonomi	Tradenomi	MBA	
ISCED code	331102	331101	531	532	631	732	
Level	Upper secondary	Upper secondary	Lowest tertiary	Lowest tertiary	Polytechnic	University	
Entry requirement	Compr. school	Compr. School	Compr. school	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

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

	(1)	(2)	(3)	(4)	(5)
Rank within cohort	0.660	0.165	0.780	0.362	0.279
	(0.073)**	(0.069)*	(0.104)**	(0.096)**	(0.096)**
Years of education	0.067	0.107			
	(0.010)**	(0.009)**			
Years = 12			0.183	0.150	0.179
			(0.028)**	(0.026)**	(0.026)**
Years = 14			0.164	0.230	0.235
			(0.057)**	(0.053)**	(0.053)**
Years = 15.5			0.255	0.346	0.426
			(0.074)**	(0.068)**	(0.069)**
Years = 17.5			0.467	0.624	0.694
			(0.094)**	(0.087)**	(0.240)**
Female		-0.083		-0.075	-0.068
		(0.009)**		(0.009)**	(0.009)**
Work experience		0.013		0.013	0.012
		(0.001)**		(0.001)**	(0.001)**
Experience squared/100		-0.004		-0.004	-0.004
		(0.001)**		(0.001)**	(0.001)**
Age		0.032		0.031	0.031
		(0.004)**		(0.004)**	(0.004)**
Age squared/100		-0.035		-0.034	-0.033
		(0.006)**		(0.006)**	(0.006)**
Swedish-speaker		0.055		0.031	0.001
		(0.018)**		(0.018)	(0.025)
Language other		0.059		0.051	0.028
		(0.039)		(0.039)	(0.039)
Observations	23946	23946	23946	23946	23946
R-squared	0.23	0.34	0.23	0.35	0.37
Effects when rank not included					
Years of education	0.154	0.129			
Years = 12			0.361	0.232	0.242
Years = 14			0.577	0.421	0.382
Years = 15.5			0.797	0.597	0.619
Years = 17.5			1.165	0.947	0.932

All estimated equations include dummy variables for the year of graduation. Column 5 also 119 school

Table 3 Test of signaling and human capital models.

	(1)	(2)	(3)	(4)
Education				
Merkonomi (331101)	-0.100		-0.092	
	(0.316)		(0.316)	
Merkonomi (531)	0.249		0.244	
	(0.018)**		(0.018)**	
Yo – merkonomi (532)	0.397	0.204		
	(0.027)**	(0.019)**	0.383	0.196
Tradenomi (631)	0.512	0.328	(0.027)**	(0.018)**
	(0.027)**	(0.014)**		
MBA (732)	0.864	0.647	0.852	0.633
	(0.026)**	(0.016)**	(0.026)**	(0.016)**
Signaling effect	**-0.171**	**-0.088**		
	(0.069)*	**(0.038)***		
HC effect			**0.075**	**0.105**
			(0.063)	**(0.027)****
Female	-0.042	-0.083	-0.045	-0.088
	(0.012)**	(0.009)**	(0.012)**	(0.009)**
Work experience	0.011	0.013	0.011	0.013
	(0.001)**	(0.001)**	(0.001)**	(0.001)**
Experience squared/100	0.002	-0.004	0.001	-0.004
	(0.002)	(0.001)**	(0.002)	(0.001)**
Age	0.029	0.044	0.033	0.048
	(0.006)**	(0.004)**	(0.006)**	(0.004)**
Age squared/100	-0.031	-0.049	-0.036	-0.055
	(0.009)**	(0.006)**	(0.009)**	(0.006)**
Swedish speaker	0.028	0.035	0.020	0.028
	(0.023)	(0.018)*	(0.023)	(0.018)
Language other	0.013	0.052	0.006	0.045
	(0.058)	(0.039)	(0.058)	(0.039)
No high school degree	0.060	0.070	0.119	0.118
	(0.046)	(0.032)*	(0.045)**	(0.032)**
Matriculation exam score	0.010	0.011	0.013	0.013
	(0.002)**	(0.002)**	(0.002)**	(0.002)**
Observations	13976	23946	13976	23946
R-squared	0.31	0.34	0.31	0.34

"Signaling effect" refers to the coefficient of the interaction term between dummy variable for "Yo-merkonomi" and the fraction of polytechnic graduates. "HC-effect to the coefficient of the interaction between a dummy variable for either "Yo-merkonomi" or "Tradenomi" and the fraction of polytechnic graduates. All estimated equations include dummy variables for the year of graduation. Standard errors are in parentheses. * indicates statistical significance at 5% and ** at 1% percent level.