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HUMAN CAPITAL AND REGIONAL GROWTH IN FINLAND

ABSTRACT: Recent investigations of regional growth have paid great attention to convergence of per-capita income. These studies have shown human capital to be a significant factor in addition to labour force, capital and technical progress when explaining economic growth. This paper examines the impact of human capital on regional growth in Finland. We estimate a standard neoclassical growth model extended by human capital accumulation.

The regional growth for nine sectors of the Finnish economy is analysed on the basis of data comprising 12 provinces during the period 1970-1995 and 84 subregions during the period 1988-1995. Human capital is measured by the education level of the labour force and by the regional indicator of the educational level.

1. Introduction

The basic neoclassical model of Solow (1956) and Swan (1956) has been the workhorse of economic growth theorists. The Solow-Swan model has been augmented by including accumulation of human as well as physical capital. In this basic model it is assumed that diminishing returns to scale to both types of capital prevails.

In endogenous growth theories capital is widely understood to include both human and physical capital. In this case there are no diminishing returns to capital, but this is achieved by invoking some externality that offsets any propensity to diminishing returns. Endogenous growth theories have emphasized that externalities produced by human capital may be important. Recent literature highlights human capital as one of the main factors behind differentiating rates of economic growth. Thus according to endogenous growth theory it is possible that when the wealthiest regions own more human capital they have better possibilities also in future to remain wealthy. Hence differences in income across regions are not necessarily convergent, but divergent. This convergence/divergence problem has been studied widely across countries and regions in recent years (e.g. Barro and Sala-i-Martin 1991 and 1997). In these studies convergence has usually been defined as the tendency of poor economies to grow more rapidly than rich economies.

In this paper we are not interested in the convergence problem, but we will test the regional growth model with Finnish data by using the Mankiw-Romer-Weil model (Mankiw-Romer-Weil 1992). In particular we consider the effects of human capital on regional growth rates in 12 Finnish provinces in 1970-95 and 84 subregions in 1988-95. As is known, human capital is hard to measure and so we have three different proxies that have been used in our estimations. Our proxies for the rate of human capital accumulation are firstly the share of college-educated employed persons, secondly the share of university-educated employed persons, and thirdly the education level index.

Our paper is organised as follows. In section 2 the significance of human capital as a factor for economic development is considered and also the model is presented. In section 3 our empirical results are presented, and section 4 includes some of our conclusions and some implications for the future work on this topic.

2. Human capital as a factor for regional economic development

Goodfriend and McDermott (1995) have determined four fundamental processes for long term regional economic development:

- i) the exploitation of increasing returns to specialisation
- ii) the transition from household to market production
- iii) knowledge and human-capital accumulation
- iv) industrialisation

In our paper we exclude the effects of specialisation and industrialisation but we will focus on the role of human capital as an important factor of regional growth in Finland. There are several authors who pay attention to human capital as a meaningful economic investment (e.g. Mankiw 1995). School education is one way how a society increases its human capital. Furthermore, education is a means through which the individual can improve access to high-wage sectors of the economy. Moreover, on-the-job training is one part of human capital.

The emphasis given to this factor can be reinforced if we see education as a good investment, as Albin (1970) suggests. But the richness of this factor does not stop here. It is a redistributive process as Albin also argues. The concentrated investment in this sector by the government permits poorer people to get jobs in high-wage sectors of the economy. On the other hand, the education barrier may be an artificial obstacle to meaningful economic investment (Albin 1970), because people will find it more difficult to work on new jobs and have less work opportunities. However, Lucas (1988) argues that human capital increases productivity of both labour and physical capital according to the law of increasing marginal returns, independent of the level already attained. He assumes that although there are decreasing returns to physical-capital accumulation when human capital is held constant, the returns to all reproducible capital (human and physical) are constant. Lucas refers to the law of increasing marginal returns as a crucial property of human capital. This is an important difference between human capital and physical capital that several authors emphasize. Viewed as a single, closed economy the marginal product of physical capital tends to be constant. Some authors have argued that the marginal returns of physical capital are decreasing.

Thus we can see that these two kinds of capital differ considerably, especially in the long-run, because human capital has increasing returns. It's external benefits enhance this idea.

Goodfriend and McDermott (1995) introduce two concepts of human capital:

- i) family production
- ii) per capita accumulation.

Family production of human capital depends, in part, on effective learning time, and the productivity of learning time is enhanced by the degree of specialisation in the economy. The recognition of the externalities of human capital comes from the degree of specialisation, and the effects of specialisation on learning induce important external effects. This is one argument for increasing returns.

The open market for labour, goods and services allows us to work and buy things in different countries or regions. On the other hand, the wage rate of labour at any given skill level will increase with the wealth of the country or region in which one is employed. Thus, as Lucas argues, "if labour can move, it will move, flowing in general from poor countries or regions to wealthy ones" (Lucas 1988). We know that human capital accumulation has a specific influence on the production of particular goods. This kind of capital is acquired at school or on the job through learning by doing. Furthermore, this fact attracts other specific services and productions of middle products.

Our analysis is based on the Mankiw, Romer and Weil (1992) growth model, which is an augmented neoclassical Solow (1956) model. Human capital is included in our model and we consider its effects on regional growth in Finland. We assume that the production function is a Cobb-Douglas production with constant returns to scale

$$(1) \quad Y(t) = K(t)^\alpha H(t)^\beta (A(t)L(t))^{1-\alpha-\beta},$$

where $Y(t)$ is production at time t , K is physical capital, H human capital, L labour force and A is a technical parameter of the economy. We assume, moreover that $\alpha + \beta < 1$, which means decreasing returns to both types of capital. The labour force and the technology level

are assumed to grow exogenously at rates n and g :

$$(2) \quad L(t) = L(0)e^{nt}$$

$$(3) \quad A(t) = A(0)e^{gt}.$$

The number of effective units of labour, $A(t)L(t)$, grows at the rate $n + g$.

As in the Solow-Swan model, the saving ratios are assumed to be exogenously determined either by saver (s) preferences or by government policy. Defining k as the stock of physical capital per effective unit of labour ($k = K/AL$), h as the stock of human capital per effective unit of labour ($h = H/AL$), and y as the level of output per effective unit of labour ($y = Y/AL$) the evolutions of k and h are defined by

$$(4a) \quad \dot{k} = s_k y(t) - (n + g + \delta)k(t) \quad \text{and}$$

$$(4b) \quad \dot{h} = s_h y(t) - (n + g + \delta)h(t),$$

where $\dot{k} = dk(t) / dt$ and $\dot{h} = dh(t) / dt$ are net investment of physical and human capital and $\delta > 0$ is the rate of depreciation, which is assumed to be the same for both types of capital.

Equations (4a) and (4b) imply that the economy converges to its steady-state value:

$$(5a) \quad k^* = [(s_k^{1-\beta} s_h^\beta) / (n + g + \delta)]^{1/(1 - \alpha - \beta)}$$

$$(5b) \quad h^* = [(s_k^\alpha s_h^{1-\alpha}) / (n + g + \delta)]^{1/(1 - \alpha - \beta)}.$$

The steady-state physical and human capital-labour ratios are related positively to the savings rates and negatively to the rate of population growth.

Substituting (5a) and (5b) into production function (1) we find that steady-state income per capita is

$$(6) \quad (Y/L)^* = A(0)e^{gt} [(s_k^\alpha s_h^\beta) / (n + g + \delta)^{\alpha + \beta}]^{1 / (1 - \alpha - \beta)}.$$

Taking logs we get the equation

$$(7) \quad 1/T * \ln [(Y_T / L_T) / (Y_t)] = g + (1 - e^{-\beta(T-t)}) / (T - t) * \ln [(Y / L)^* / (Y_t / L_t)],$$

where we get our empirical specification

$$(8) \quad 1/(T - t) * \ln (y_{i,T} / y_{i,t}) = \Sigma (Z_{ik} * q_k) - x * \ln y_{i,t} + u_{it},$$

where Z_{ik} , $i = 1, \dots, K$, represents independent variables and q_k and x are parameters.

3. Data and results

The data are from Statistics Finland. The data sets include value added in basic values, employed persons, gross fixed capital formation and education by nine kinds of economic activity¹ in 12 provinces and 84 subregions. The data cover the period 1970-1995 every fifth year and the period 1988-1995 every year.

We use the following variables in our estimation:

- value added in basic values by sector and region in year T per employed persons by sector and region in year T divided by value added in basic values by sector and region in year t per employed persons by sector and region in year t (dependent variable)
- value added in basic values by sector and region in year t divided by the employed persons by sector and region in the same year (Y4),
- gross fixed capital formation by sector and region in year t divided by the employed persons by sector and region in the same year (INV)
- and three different proxies for the rate of human capital accumulation:
 1. the share of college-educated employed persons by sector and region in year t (ED1)
 2. the share of university-educated employed persons by sector and region in year t (ED2), and
 3. the education level index by sector and region in year t (EDI)².

3.1. Provinces

In the period 1970-95 the economic growth was quite steady, except the period 1990-95, and gross domestic product increased by 116.8%. The period included two recessions and during the periods 1975-80 and 1990-95 gross domestic product increased by only 16.7% and 1.8%.

The education level in Finland has increased during the last 25 years and the structure of education has changed, so it is not reasonable to use education levels in 1970 as an explanatory variable when estimating production growth in the 1990's and when studying the role of human capital as a factor of regional growth in Finland. Due to that, we estimate six different cases: 1970-75, 1975-80, 1980-85, 1985-90, 1990-1995 and 1970-1990.

Differences in education levels between provinces have been small in 1970-95 (figure 1 and 2), but variations have been bigger between sectors (figure 3 and 4). The correlation coefficient between the share of college-educated employed persons and the share of university-educated employed persons is approximately 0.94 in years 1970-95. However in manufacturing, the correlation coefficient has decreased from 0.99 (1970) to 0.87 (1990).

Figure 1: The percentage share of college-educated employed persons by provinces in 1970-1995

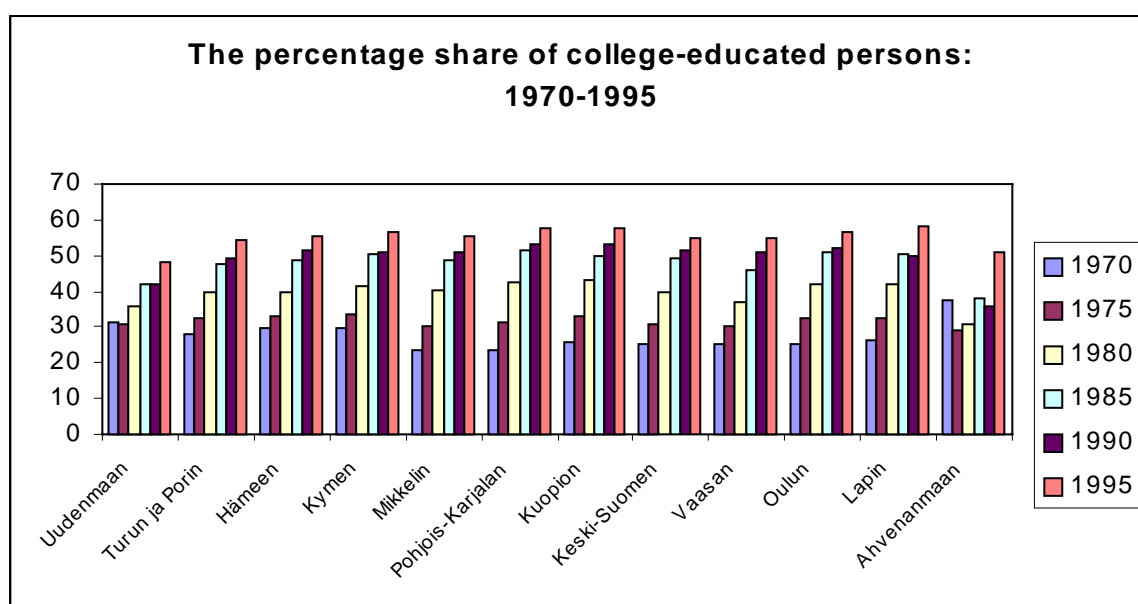


Figure 2: The percentage share of university-educated employed persons by provinces in 1970-95

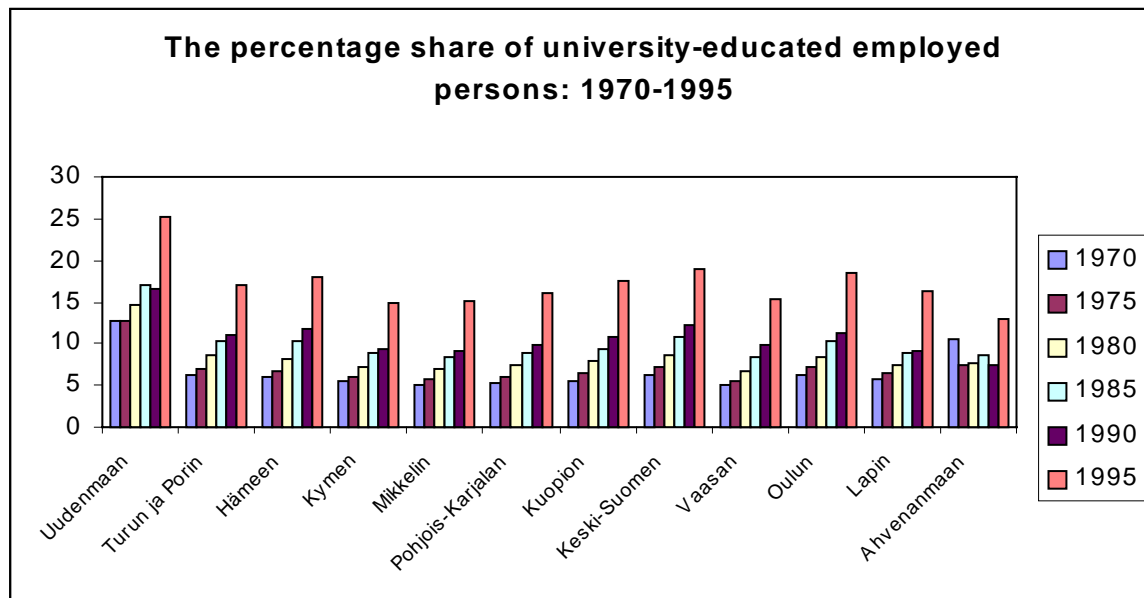


Figure 3: The percentage share of college-educated employed persons by sector in 1970-1995

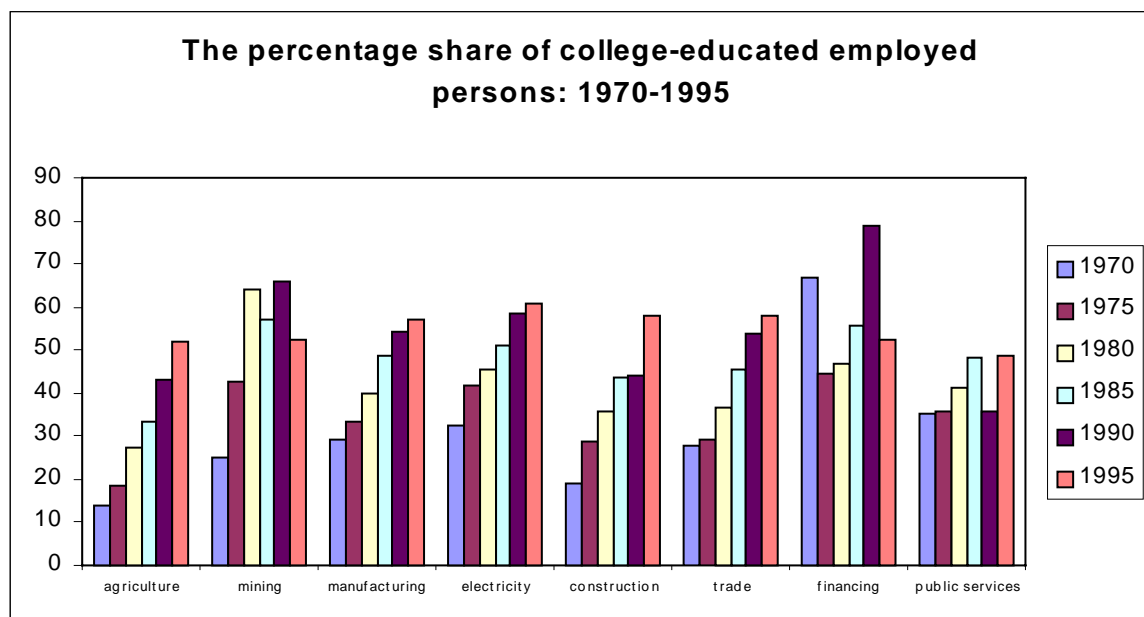
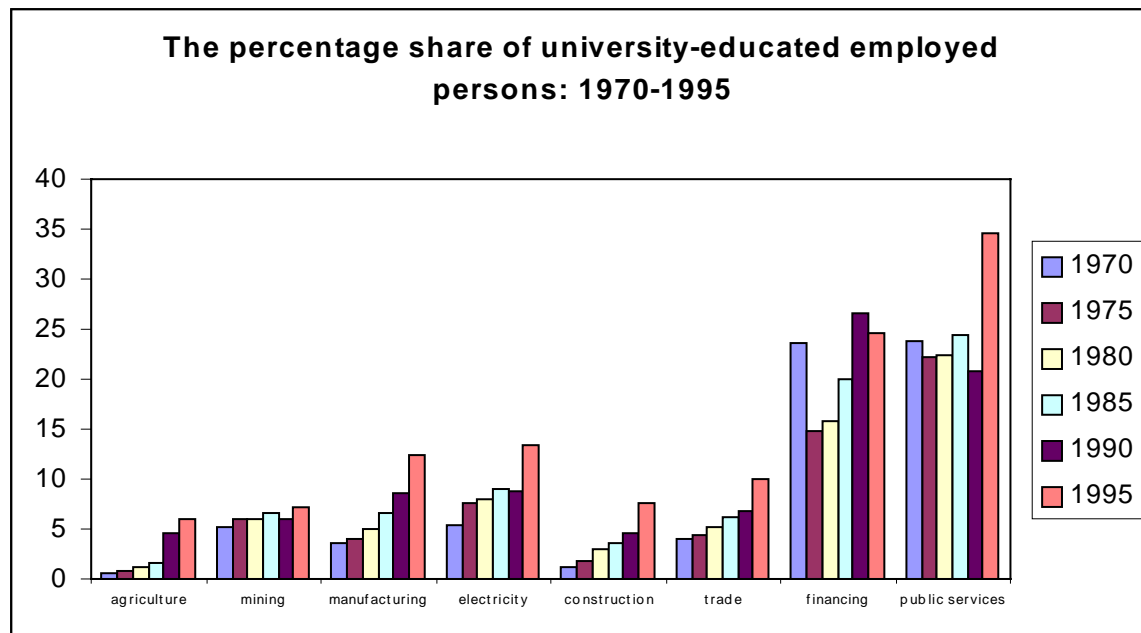


Figure 4. The percentage share of university-educated employed persons by sector in 1970-1995



We estimate equation (8) without constraints of the coefficients. Table 1 reports our results over years 1970-1990 and the tables below report our regression results every five years in all sectors and in manufacturing³. The results with the education level index are not reported because its coefficients did not prove to be significant with province data.

Table 1: Regression results in the period 1970-1990.

CONS	.4706
Y4	-.0390
ED1	.0324
ED2	.0169
R-Squared	.7038

CONS	.5287
Y4	-.0443
ED1	.0328
ED2	.2420
INV	1.20E-07
R-Squared	.27563

Note: Figures in bold are significant at 10% level.

In the case 1970-90, the only statistically significant explanatory variable is Y4, but the coefficients have expected signs and coefficient of determination is 0.71. This is not a surprise, because for example in the case of Spanish regions⁴ the human capital variables are usually not statistically significant, although in the paper by Seitz (1995) the human capital variable proves to be a statistically significant explanatory variable in some German data. To get a closer picture, we study five-year regional and sectoral growth rates.

When explaining the regional total value added, the most remarkable result is perhaps that the share of university-educated employed persons (ED2) is statistically significant with a positive sign in periods 1975-80 and 1990-95 (table 2). Both of these periods were recession periods in the Finnish economy and this result means that the recession was not so deep in regions with high academic human capital, and in the regions with lower academic human capital the recession was deeper than in the economy as a whole. Our other human capital variable, ED1, is a statistically significant explanatory variable in periods 1970-75 and 1990-95, but the sign of the coefficient in the period 1990-1995 is negative. This kind of negative sign is not so surprising, because for example De Long and Summers (1992) find in their cross country study that human capital has an insignificant negative coefficient. This kind of wrong sign may arise from, for example, a multicollinearity problem.

Table 2: Regression results in all sectors.

	<i>1970-75</i>	<i>1975-80</i>	<i>1980-85</i>	<i>1985-90</i>	<i>1990-95</i>

CONS	1.7544	1.4308	-.3960	.8795	1.3323
Y4	-.1578	-.1256	.0347	-.0720	-.1026
ED1	.3167	.1713	-.0097	.0345	-.1176
ED2	-.3326	.2234	.1625	.0333	.1077
R-Squared	.6549	.8181	.6859	.4085	.1681

CONS	1.6059	1.8528	-.5327	.8670	2.5386
Y4	-.1442	-.1632	.0481	-.0708	-.2114
ED1	.3157	.1326	-.0429	.0358	-.1726
ED2	.3140	.3439	.1162	.0340	.3881
INV	-.2594E-6	.5643E-6	-.1006E-6	-.4513E-7	1.84E-6
R-Squared	.6614	.8757	.7180	.4088	.8829

Note: Figures in bold are significant at 10% level.

In manufacturing (table 3) human capital (ED1 and ED2) seems to explain the regional economic growth in the 1970's, but in the 1980's and 1990's these variables are no longer statistically significant. One explanation for this phenomenon could be that there were fewer highly educated employees in the 1970's than in the 1980's and 1990's, so an educated employee was a more important factor of production to manufacturing in the 1970's. In the 1980's and 1990's there has been an oversupply of educated employees and educated employees have been forced to take job opportunities from a level that does not correspond to their education and so education does not explain regional economic growth in the 1980's and 1990's as well as in the 1970's.

Table 3: Regression results in manufacturing.

	<i>1970-75</i>	<i>1975-80</i>	<i>1980-85</i>	<i>1985-90</i>	<i>1990-95</i>

CONS	2.0160	3.6286	.1715	-.0141	1.3210
Y4	-.1843	-.3303	-.0058	.0009	-.0821
ED1	.3091	.5071	-.1566	.0714	-.3470
ED2	1.2285	1.4847	.1813	-.0787	-.2202
R-Squared	.9161	.4403	.4385	.0749	.3041

CONS	2.0039	4.5961	-.0436	-.9455	2.0817
Y4	-.1822	-.4171	.0148	.0864	-.1542
ED1	.2608	.4226	-.2967	.0136	-.3507
ED2	1.1665	2.1541	.0544	-.3803	.2297
INV	.1358E-6	1.53E-6	1.32E-6	-.1184E-5	1.55E-6
R-Squared	.9181	.8358	.6353	.4333	.6130

Note: Figures in bold are significant at 10% level.

3.2. Subregions

The period 1988-1995 was very exceptional in the Finnish economy. Economic growth was very strong in the end of the 1980's, but in the beginning of the 1990's Finnish economy drifted into the deepest recession since the Second World War. Gross domestic product increased by only 5.2% in 1988-1995 and decreased by 9.96% in 1990-93⁵.

The GDP growth rates were distributed among 84 subregions very unequally. GDP increased in only 44 subregions and decreased in other subregions. In subregions with positive economic growth the share of population was 65.2% of the total population. This means that subregions with positive economic growth had more inhabitants than the average subregion in Finland. The highest growth rate of 70.8% was in the subregion of Salo, which was mainly due to the location of Nokia's telecommunication production. In eight subregions GDP decreased by over 10%.

Regional economic growth in Finnish subregions seems to be in close connection with the growth of manufacturing. The remarkable share of manufacturing in regional GDP is typical of many subregions in which economic growth has been rapid. However, the same kind of connection has also been seen in subregions where the share of manufacturing in GDP is smaller than the average. The value added in manufacturing increased in 57 subregions and decreased in 27 subregions. The value added in manufacturing increased more rapidly than the total GDP. The correlation coefficient between these growth rates was 0.787, which shows the relationship between the growth of manufacturing and total regional growth.

The share of college-educated employed persons and the share of university-educated employed persons varied to a surprising extent in 1988-93 (figure 5 and 6). However, it is difficult to say if these variations were caused by an increase in the general education level or by changes in the labour market. The correlation coefficients between the share of college-educated employed persons and the share of university-educated employed persons differ from the coefficients with province data. In all sectors the correlation coefficient decreased from 0.15 (1988) to -0.33 (1990) and in manufacturing the correlation coefficient increased from -0.48 (1988) to -0.14 (1990)⁶. When comparing these coefficients to correlation coefficients with province data it can be seen how sensitive this kind of data is to different periods and different regions.

Figure 5: The percentage share of college-educated employed persons by sector in 1988-1993

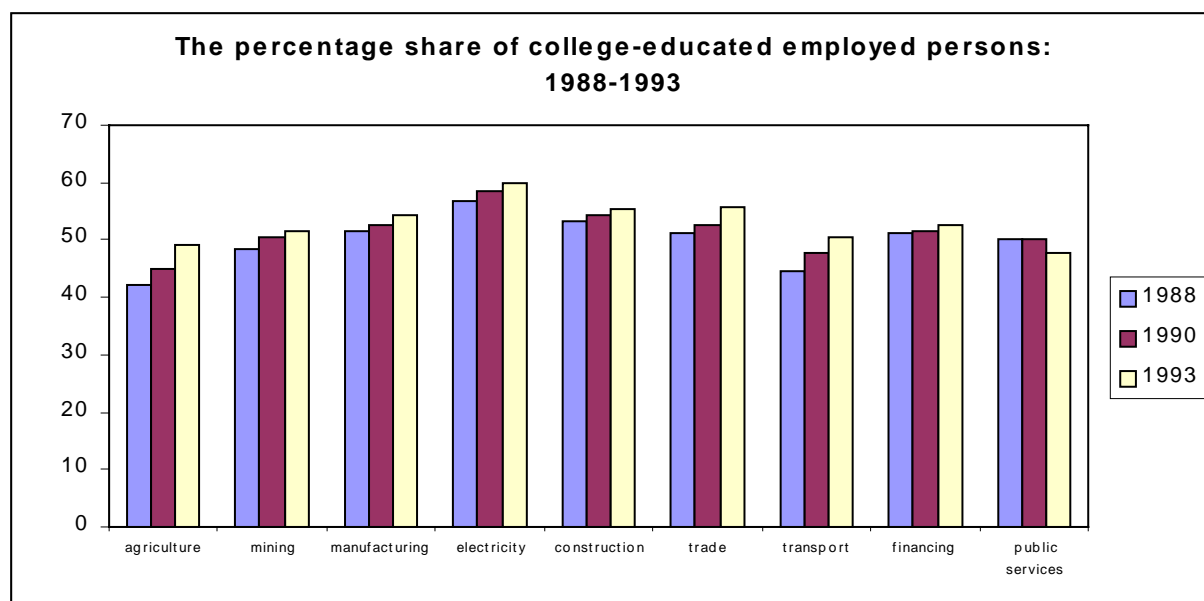
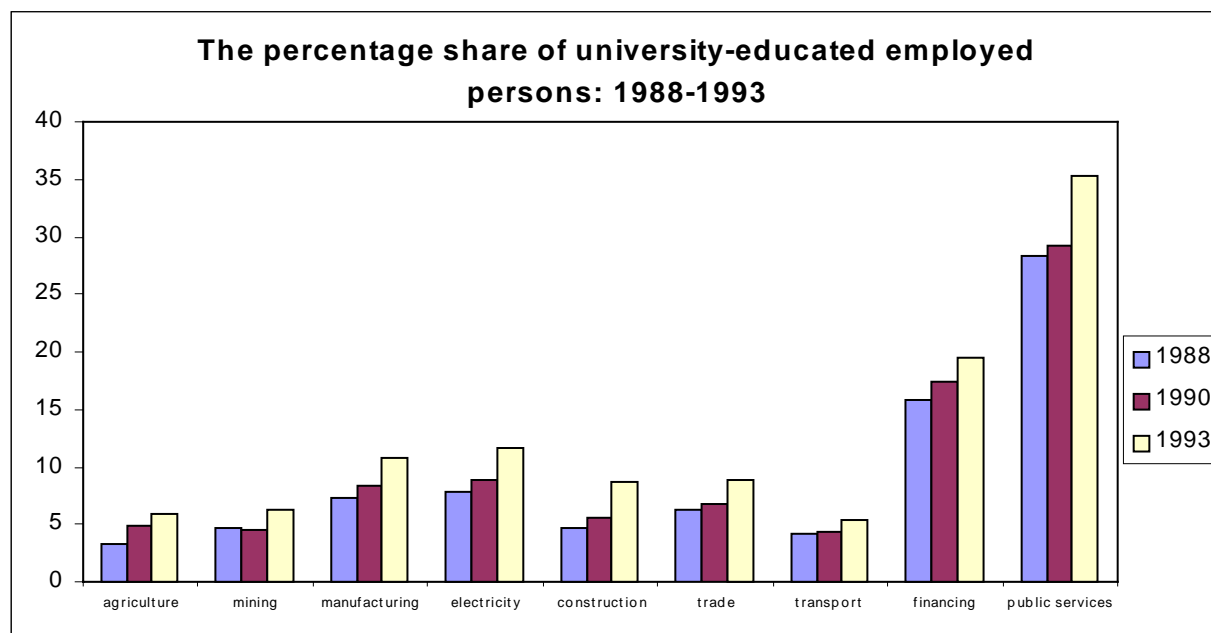


Figure 6: The percentage share of university-educated employed persons by sector in 1988-93



We estimate three different cases: 1988-95, 1988-90 and 1990-93. We do not estimate the period 1993-95 because the new boom was just about to begin. Table 4 reports regression

results in all sectors. In the period 1988-95 all education variables are statistically significant, but the coefficients of determination are only 0.06 and 0.27. The share of college-educated employed persons (ED1) has positive signs, but the other two education variables, the share of university-educated employed persons (ED2) and the education level index (EDI), have negative signs. The negative signs of EDI and ED2 may seem surprising because usually the coefficients of human capital are expected to be positive, and so they have been in many empirical studies. Perhaps this kind of unusual result can be explained by the role of manufacturing and public services. The share of university-educated employed persons is high in public services and low in manufacturing. Otherwise we know that the growth rate of manufacturing explains very strongly the growth of regional GDP. Hence our results shows that the share of university-educated employed persons has a negative effect on the regional growth rate. The positive sign of ED1 can be explained by the high share of college-educated employed persons in manufacturing.

Table 4. Regression results in all sectors.

	<i>1988-95</i>	<i>1988-90</i>	<i>1990-93</i>

CONS	.095669	-.28982	-.24449
Y4	-.2619E-3	-.14154	-.10261
EDI	.2333E-3	.3513E-3	.4354E-3
INV	-.018277	-.039260	-.084546
R-Squared	.060896	.093736	.21117

CONS	.029751	.30028	-.22901
Y4	-.2536E-3	-.079962	-.030409
ED1	.047700	-.81302	.45151
ED2	-.23901	.17009	-.13351
INV	-.026329	-.019099	-.063830
R-Squared	.27563	.57992	.47713

Note: Figures in bold are significant at 10% level.

The only statistically significant coefficients in 1988-90 and 1990-93 are ED1's coefficients with a negative sign in 1988-90 and a positive sign in 1990-93, but the coefficients of determination are higher than in 1988-95. The signs of the statistically significant coefficients mean that the share of college-educated employed persons has damped the influence of fluctuations on regional growth. Although the coefficients of ED2 are not statistically significant, it seems that the share of university-educated employed persons has reinforced

fluctuations.

Table 5. Regression results in manufacturing.

	<i>1988-95</i>	<i>1988-90</i>	<i>1990-93</i>

CONS	.073705	-.76888	.10535
Y4	-.0015325	-.20041	-.0049325
EDI	-.1158E-3	.0017768	-.1794E-3
INV	-.024209	-.12476	-.011598
R-Squared	.027691	.35355	.0024412

CONS	.032108	-.36319	.19641
TY4	-.0015120	-.21729	.0030919
ED1	.031426	-.036255	-.21439
ED2	-.13946	1.2155	-.077287
INV	-.024209	-.11685	.010292
R-Squared	.050746	.36844	.21242

Note: Figures in bold are significant at 10% level.

In manufacturing (table 5) the only statistically significant coefficients are ED2's and ED1's positive signs in 1988-90 and ED1's negative sign in 1990-93. Both statistically significant and insignificant coefficients support the results of all sectors with the exception of the negative sign of ED1 in 1990-93. The economic growth in manufacturing has been more rapid during the boom in regions which have a higher share of university-educated employed persons and the recession in manufacturing seems have been deeper in regions which have high share of college-educated employed persons.

4. Conclusions

In this paper we have studied how human capital affects economic growth. Our human capital variables seem to explain very poorly the regional growth in Finnish regions, although we found correlation between short run fluctuations and human capital.

This kind of data seems to be very sensitive to different regions and periods. The correlation coefficients between the growth rates of manufacturing and all sectors and the correlation coefficients between the education variables in province data differ from the correlation coefficients in subregion data. The signs of the statistically significant coefficients in province

and subregion data are opposite in the most of the cases, but the signs vary with short run fluctuations in both data. We got more statistically significant coefficients with subregion data than province data in the periods 1985-90 and 1990-95, but the coefficients of determination were higher in province data.

It is hard to say which data is better when explaining regional economic growth in Finland and so we are going to continue with both data. We are going to include specialisation in the model. In the future, we are going to also add more explanatory variables, which represent social and physical infrastructure, to the model to get a closer picture of regional economic growth in Finland.

Footnotes

¹ 1. Agriculture and forestry, 2. Mining, 3. Manufacturing, 4. Electricity, gas and water, 5. Construction, 6. Trade, restaurants and hotels, 7. Transport and communications, 8. Financing and other services, 9. Public services.

² $EDI = (\sum f_i x_i / \sum f_i) * 100$, where f_i = capita in region, x_i = education level and $i = 1, \dots, 8$.

³ The results in financing and other services and construction are reported in the paper of Pelkonen and Ylönen (1998)

⁴ Dolado, Paramo and Roldan (1994)

⁵ Niiranen and Pelkonen (1998) have studied more precisely the regional economic growth in Finland in 1988-95.

⁶ In 1993 correlation coefficients are in all sectors 0.03 and in manufacturing -0.33.

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