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Returns to Higher Education

– a regional perspective

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Returns to Higher Education
-a Regional Perspective

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Abstract

The returns to education have been thoroughly investigated and Sweden has shown to have a relatively low return compared to other countries in Europe. Nevertheless, few studies have combined the regional perspective with returns to education. Hence, the purpose of the paper is to analyze regional differences in their returns to higher education within natural science, engineering and medicine. We assume that individuals maximize expected utility; they will try to attain the highest expected return to education as possible. The regional sum of employment possibilities as well as unemployment shares may differ between regions. Therefore, it is plausible to believe that the regional return to education varies between locations which accounted for in the empirical part of the paper. The result shows that there are clear differences between regional classifications concerning returns to higher education. Central urban regions, except the three largest cities and ten largest universities have the highest return to education. These regions may need to compensate the individuals with a higher return. The three largest cities in Sweden have a relatively low return but have other amenities that attract individuals.

Keywords: returns to higher education, regional attractiveness, Sweden, Mincer equation

JEL classification codes: H52, I21, I22, J61, R11

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1 Introduction

Several studies indicate that Sweden has a relatively low return to education compared to other countries in Europe (Arai and Kjellström, 1991, Psacharopoulos, 2000). There are different aspects to return to education; a social, an individual and a regional level. The purpose of this paper is to investigate the returns to education, in this case higher education in natural science[1], engineering and medicine in Sweden, using a regional approach. This paper adds to the already extensive literature regarding returns to education since it uses a regional approach comparing the return to different regional classifications. The empirical analysis is based on individual data for the year 2000. The data allows one to extract individual information on location, educational level, work experience as well as income. The income instead of the wage is used since we then can incorporate not only the payment from their job but also from other sources that affect their total income, e.g. income from an active business and/or sick leave. Therefore, we are dealing with pecuniary income, *consisting of, or measured in money*.

Becker (1964) states that earnings of less educated individuals tend to be sensitive to economic fluctuations. Their employments and wages are more volatile than for those with higher education. Thus, individuals that decide to enter a higher education incorporate the possibility to earn a future higher income than compared to those not enrolling in a higher education.

The results indicate that the urban regions, Stockholm, Gothenburg and Malmö do not yield the highest return to education in a comparison with the other alternative regional classifications. These metropolitan have a wider variety of attractive factors e.g. entertainment, consumption, culture that compensate for the lower returns from higher education. This study also verifies previous empirical studies in the sense that men seem to have a higher return to their education. Individuals born abroad have a lower return to their high education compared to the native population in Sweden.

The importance of higher education has been acknowledged by the European Union through the Lisbon Strategy, which was posted in 2000. This strategy identified education and training as important factors in reaching the ambition for Europe to become the leading knowledge-based economy in the world. At least two per cent of the national GDP ought to be dedicated to higher education according to the strategy. Sweden along with the other Nordic countries, except Iceland, is moving towards this goal with a GDP share of approximately 1.5 per cent.

The regional categorization chosen in this paper is based on size and commuting patterns, accessibility to universities and accessibility to central urban regions. The regional classifications are urban regions comprising the three largest cities, the ten largest universities, peripheral urban region in a large functional region, peripheral urban region in a small functional region, the central urban region except the three largest cities and central urban region except the three largest cities and the ten largest universities. In Sweden urban regions corresponds to local government areas, of which there are 289. We have divided the sample into the regional classifications in order to distinguish variety between regions in their returns to education. We believe that the return to education will differ among locations since they offer different amenities and have different supply of highly educated labor.

[1] Including the subject's chemistry, biology, physics and geosciences.

The individual return to education could diverge with respect to region of residence for a number of reasons. First, certain regions are structured in such way that facilitates interaction between economic agents. This could be physical infrastructure such as roads and public transports. Also, it could be that the region has an economic milieu which enables economic agents to interact in formal and informal networks i.e. knowledge spillovers. Second, the industrial structure in regions could form a demand for specific groups of labor. Some industries have a lower employment intensity of highly educated labor than others why the demand for these should be lower per se. We have chosen to put emphasis on maximizing expected total income and in order to get this individuals move to a region where the income level is high.

One explanation to a low return to education could be the low direct financial costs for students related to higher education. Almost all educations at a higher level are free from tuition fees and it is easy to obtain loans to finance the living costs while studying. Another explanation could be small income differentials due to the Swedish history of egalitarian policies and strong labor unions. The low return to education could also be an outcome of individuals over-investing in education. Becker (1964) was one of the first to acknowledge that education is an investment in an individual's human capital. This investment can generate large differences in earnings between educational groups. Moen (1999) found that individual over-invest in education. The reason for this overinvestment is that education will give them a better position in getting a job compared to others. This leads to a chase between the unemployed where the participants try to surpass one another in terms of education. Thus, they see investment in education as a way to avoid unemployment.

When the educational level for 14 European countries is divided into low, medium and high, the least educated individuals tend to have a higher unemployment rate than the more educated individuals (Barceinas-Paredes et al., 2001). Thus, by becoming involved in higher education an individual can decrease the probability of becoming unemployed. For that reason, an individual has the incentives to attain an education since it reduces the risk of getting unemployed. After completing an education an individual faces another sort of uncertainty, it is not only important to get a job and thus avoid unemployment but it is also important to get a job in the right sector where the knowledge learned can be used. However, even if the individual get an occupation in the "wrong" sector it is plausible to believe that the occupation will be "sophisticated" enough where skills, such as information scanning, analyzing and solving problems, learned during the education will be valuable.

1.1 Education system in Sweden

The emphasis on education and lifelong learning has increased from politicians. This pattern can be seen in many countries. Sweden is no exception and established the goal that half of the young generation should obtain higher education supporting the common view that education and human capital is essential for an economy. The aim of the policy is to get higher enrolment rates in higher education for individuals below the age of 25 (Johansson et al., 2003b). Criticism towards the goal that half of the young generation should obtain higher education focus on that higher education has been too narrow-minded and are non-beneficial for those that wish to develop their occupational skills. Further, the difference between occupations with a high or low education rate widens[2].

[2]http://www.hsv.se/omhogskoleverket/pressrum/debattartiklar/debattartiklar/debattartiklar2003/halftenavdeungaforlorar.5.539a949110f3d5914ec800058672.html.

The enrolment rate in higher education has increased in Sweden until the year 2003 in line with the stated goal that half of the young population should engage in higher education. The enrolment rate can also reflect the state of the economy, in a recession where it is difficult to get a job more individuals tend to enroll in higher education to avoid unemployment since the job opportunities are limited. Likewise, when an economy experience a boom there are many job opportunities and an individual does not have to enroll in education in order to avoid unemployment.

In 1977 there were only 11 educational institutions, universities and technical institutions, with 14 affiliated colleges in Sweden. After 1977 the educational system was reorganized and new universities and colleges were born. The real expansion started in 1987 when a conscious spatial decentralization strategy of higher education was acknowledged. This process was motivated by several kinds of political, social and economic factors (Andersson et al., 2004). In total, there are today 61 educational institutions that provide higher education which are located all over Sweden. Out of these 61 there are 14 state universities, 22 state university colleges and 11 institutions have the right to give basic university education[3]. The presence of many educational institutions situated in the near region reduces the barrier to engage in higher education to retain a degree. As the supply of individuals with a degree increases this may decrease the returns to education.

The study allowances in Sweden are mainly for living expenditure since there are no tuition fees for higher education in Sweden. Nearly two thirds of all the participants in higher education apply for the study allowance and as a consequence the Swedish government paid out 2.25 billion Euros, in 2006. The study allowance in Sweden is shaped in such a way to give a high participation rate in higher education. The history of giving study allowance is also long; the first financial aid to students were given in 1919 and in 1957 a general financial aid was introduced. In the 1960's the student received tax-funded grants and parental support. Later in the 1960's a loan scheme with interest subsidies and mortgage repayments was implemented. A new student loan system were introduced in 1989 with large reforms such as increase in tax-funded student support, abolition of mandatory parental contribution, reduction in interest subsidies and an introduction of income-contingent repayments (Barr, 1993). The organization of the financial support changed during the 1970's, this transformation was heavily influenced by Ingmar Ståhl[4]. After 2001 the student loans were transformed into normal annuity loans.

The study allowance is separated into two parts: a larger part that is made up by a loan and a smaller subsidy. A student can get the study allowance for a maximum of six years. The borrower have normally 25 years to repay the loan, adjusted by a non-deductible interest rate. The university education must be approved in order to get the study allowance, which is the case for all universities and university colleges in Sweden (Regeringskansliet, 2007). While comparing the value of the study allowances with the wage for blue-collar worker one finds that the value of the study allowances have decreased. In 1990, the study allowance was 74 per cent of a blue-collar worker and in 2007 it had decreased to 52 per cent. This development is expected to continue and the relationship is predicted to be 45 per cent in 2015 (Andersson and Lindblad, 2008). The relatively lower study allowance compared to

[3] http://www.hsv.se/densvenskahogskolan.4.539a949110f3d5914ec800056443.html.
[4] And his book "U 74: en samhällsekonomisk analys av den högre utbildningen".

blue-collar wage ought to discourage individuals engaging in higher education unless their expected future income covers the income loss during the education period.

The financial support is designed to support the education policies by decreasing the importance of social, economical and geographical background when deciding on continuing into higher education (Regeringskansliet, 2007). Even so, there have been large differences in the enrolment rate among groups with different background. Factors such as the parent's educational level and social background influence the choice to engage in higher education. The gender aspect is twofold, on the one hand women have in general a higher enrolment rate but the reversed is true in more prestigious programs[5] (Andersson and Lindblad, 2008). Husén (1979) reason that the social background was the main factor in describing the variance in achievements and was more important than the school factors measured. Parents with a high education is also likely to have an income which enables them to support their children financially in higher education.

The financial support for students in Sweden has resemblances with other Nordic countries (Denmark, Norway and Finland). They all have high levels of annual expenditures per student. Most of the European countries, except the Nordic countries, charges tuition fees to some extent. The European countries does also show divergence when it comes to providing financial aid to students, which support devices that are used and how these are combined e.g. grants, loans, subsidies services, family allowances and tax breaks. A students in the Nordic countries are normally living away from home and a high share are benefiting from both subsideies and loans. The loans and grants in the Nordic countries are based on the student's own income, in many European countries it is based on the family income (Asplund et al., 2007). In the United States a large share of the students cannot afford to pay their tuition fee and have to rely on financial aid from their university, the federal government, institutions or from a private lender. The financial aid can be of several types; loan guarantees, subsidies, or tax benefits for students and parents. In 2002 to 2003 loans in the Unites States constituted 54 percent of total aid, grants 40 percent, work one percent, and education tax credits 5 percent (The College Board, 2003).

The combination of no tuition fees and a generous study allowance leads to a high enrollment rate in higher education. Educational programs such as art and law both guarantee study allowances. Some students will enroll in education where the unemployment rate is high and the overall income level is low, e.g. acting. Hence, this will lower overall return to education. In those occupations where there is a high risk of getting unemployed it is possible that there are other factors than expected earnings that are driving the individual, such as the occupational activity itself.

1.2 Wage equalization policy

Sweden has a history of strong unions which has partly led to wage equalization. Between the middle of the 1950s and until the beginning of the 1980s, the entire blue-collar labor force in the private industry was covered by detailed wage agreements, where the wages were specified. The solidarity wage politic was formed by Gösta Rehn and Rudolf Meidner, both economists at LO[6]. The agreements were settled by two bargaining organizations; LO for blue-collar workers and SAF[7] for employers. Similar egalitarian objectives did also dominate

[5] The study analyzed enrolment rate for younger people, age 20-24.
[6] The Swedish Trade Union Confederation.
[7] The Swedish Employers' Confederation.

among white-collar unions within TCO[8]. One goal for the unions was that the wage level for the same job should be equivalent. Wage equalization was in place between industries and within industries; across occupations and skill grades. Until the breakdown of central wage formation in the beginning of the 1980s the variance of wages for blue-collar workers diminished sharply. Less focus was put on wage equality when the bargaining was done at the industry and firm-level instead (Hibbs and Locking, 2000). After the middle of the 1980's there were a gradual increase in the wage differential for the white-collar labor force organized in SACO[9] and TCO (Edin and Holmlund, 1995). The shut-down of SAF's bargaining unit in 1990 and the power-shift to industries and local levels resulted in that central unions lost their ability to promote wage equalization. The wage formation process was now based on skills and company profit (Hibbs and Locking, 2000). The history of wage equalization in Sweden could lower the incentives to invest in education for an individual. The individual is facing an income loss while engaging in higher education and an expected low wage would lower the returns to education and therefore lower the incentives to invest. This follow a normal investment strategy, if the returns are lowered you are less eager to invest in the product, in this case your own human capital.

The role of labor unit economists have to a high degree been present in Sweden. It was two labor unit economists representing LO; Gösta Rehn and Rudolf Meidner that constructed the idea of solidarity wage policy. Further, the EFO[10] model which can be seen as a Scandinavian model of inflation was very influential in inter-sectoral wage linkages. The EFO model was designed in a collaboration between the research departments directors of the three largest labor unions, TCO, SAF and LO. The tradeable sector (mining and manufacturing) acted in the framework as the wage leader with respect to the non-tradeable sector. The tradeable sector transmitted the wage level to the rest of the economy through bargaining institutions and market forces (Jacobson and Ohlsson, 1994).

The system of wage equalization that has been present in Sweden differs to a large extent from other countries. This might be one of the explanations why Sweden have shown to have a lower returns to education compared to other countries. In a comparison with seven advanced countries[11] Sweden stands out as the country with the lowest wage inequality (Davis, 1992). In a study by Asplund and Pereira (1999) where Sweden is compared to some of the countries included in the study by Davis, Sweden has the lowest returns to education.

The rest of the paper is organized as follows: In Section 2 we present the theoretical background for this paper, highlighting the role of returns from education and other sources of investment in human capital. This section ends with the modeling framework and hypothesis. Our data and empirical findings are presented in Section 3 and analyzed. Section 4 concludes and gives ideas for future research.

[8] The Swedish Confederation for Professional Employees.
[9] The Swedish Confederation of Professional Associations.
[10] Named after the authors Edgren, G., K.-O. Faxén, and C.-E. Odhner, following their report "Lönebildning och samhällsekonomi" (Wage formation and the Economy) written in 1970.
[11] Australia, Canada, France, Netherlands, West Germany, United Kingdom and United States.

2 Theoretical background

The fundamental neoclassical argument suggest that the wage equals the marginal productivity of labor. Basic human capital theory shows that this relation does not always hold. Hashimoto (1979, 1981) concludes that productivity profiles are steeper than wage profiles in a model with risk neutral agents and perfect capital and labor markets. Both the employer and the employee share the cost and return of investment in specific human capital[12].

2.1 Regional wage variation

Economic geography is the attempt by academics to explain and predict spatial distribution of economic activity. New economic geography (NEG) is the approach inspired by Krugman (1991) which explain agglomeration tendencies by transportation cost and plant-level scale economies. NEG is one framework that explains wage differences across regions, other models uses technological spillovers and human capital externalities to yield wage equations that link regional wages to the density of local economic activity (Head and Mayer, 2006).

Regions within a nation have different initial endowments of capital and labor which lead to income differentials, this in turn leads to resource movements. Studies have found correlation between higher incomes and regional demand linkages (Brakman et al., 2004). Krugman (1980) found that, ceteris paribus, a larger region will have higher incomes. If production costs are the same in two regions it would be more beneficial to produce near a large market and in this way reduce transportation costs. In order for both regions to keep labor employed the advantage must be offset by an income differential. Hence, regions that have a small market need to compensate the employee's with a higher income.

Wage differentials between regions can arise due to several reasons; quality of the labor force, structure of the labor market, structure and mix of the industry, discrimination, strength of trade unions and amenities. Quality of the labor force is often associated with years of formal education but can also be measured as cognitive skills in mathematics and science (Hanushek and Dongwook, 1995) and have a positive impact on the received income for the individual. The wage differs among industries (Gibbons and Katz, 1991) so the composition of industries in a region can affect the wage level.

A wide range of literature covers the discussion on local amenities. That is, characteristics which could attract or repel residents, commuters and/or firms. The spatial distribution of amenities and disamenties can create regional differences in the wage level. Repelling amenities could be pollution or crime whereas leisure and entertainment facilities could be attractive. Traditional household bid-rent models with location heterogeneity assume that the amenities will be reflected in the rent possible to charge at different locations (Diamond, 1980, McCann, 2001). Roback (1982) focus on local attributes such as the housing market and non-traded goods and states that these factors decide the regional wage differences. Further, she constructs a ranking of the cities based on their quality of life where pollution, crime, cold weather and population density are included and finds that the ranking are fairly robust to specification differences. Thus, a locality that experiences a high degree of disseminates such as pollution and crime needs to compensate a worker with a higher wage level in order to get him or her to stay.

[12] Hashimoto uses a model of on-the-job-training to analyze the impact on sharing of investment in specific human capital.

It has long been stressed that urban areas have a higher land value than rural areas. Denser areas tend to have higher accessibility to various necessary or desirable activities (Brigham, 1965). If no transportation costs were incorporated into rural locations the evaluation of land would follow its best alternative use. This is however not the case and amenity rankings would differ between individuals. The present paper focuses on location of labor with education within natural science, engineering and medicine. This particular group may differ in amenity rankings in a comparison with other groups of educational type. Also, there may be differences within the group.

Classic labor economics assume perfect competition on the labor market where employees possess the market power. If there is perfect labor mobility employees will immediately react when there is a wage cut. This assumption is unlikely to hold due to heterogeneous preferences, mobility costs and pure ignorance (Robinson, 1933). With these conditions it is likely to believe that the labor supply curve is upward sloping rather than infinitely elastic. This shifts some of the market power from the employee to the employer. Perfect mobility is a fairly harsh assumption for Sweden since the mobility is limited (Fischer and Malmberg, 2001).

2.2 Returns to education

There has been more than a century of discussions about whether the social returns to education exceeds the private. Reasons for the former to surpass the latter could be knowledge spillovers which are spread within formal and informal networks in a particular region. This intricate issue plays an important role for the empirical analysis of the present paper.

In standard textbooks of labor economics, the individual marginal rate of return to education can be described as the percentage increase in earnings per dollar spent on educational investments. An individual facing an activity that requires much education values the future higher earnings more than the initially lost net earnings (Becker, 1962). The relation is far more complex and the marginal return has been shown to consist of a variety of parts. One of the major benefits of acquiring an education is the reduced risk of unemployment. Educational differences in unemployment rates are largely driven by the reduced incidence of unemployment rather than the reduced length of unemployment (Mincer, 1991)[13]. Therefore, it would be plausible to believe that the individual accounts for a reduced risk of unemployment already when deciding to educate. If this is true, the expected utility of education is equal to expected return as a function of the risk of unemployment.

Other factors such as the possibility of self-employment, future location of residence, and location of work may also affect the expected income level. However, these opportunities can be considered as accounted for when deciding upon the length and type of education. There are additional investments possibilities e.g. housing, which influence the choice of becoming educated. If one complete an education and acquire a well paid job the individual have a greater opportunity to buy a house or another form of housing. It is often the case that an investment in a house or another form of housing increases in value and thus gives a high return on the investment, especially in metropolitan regions.

[13] This is a study only on male labor.

Becker (1964) state that individuals make their decision, before entering education i.e. investment in human capital, based on a comparison between the rate of return that equates the present values of earnings after education with rates that could be obtained elsewhere. Individuals would choose to educate if the present value were greater than those found elsewhere. Thus, individuals would choose to educate if the returns from education i.e. the higher earnings later on, offset the cost of education i.e. the lower initially earnings. Hence, investment in education can be viewed as any investment decision. Becker further recognizes that schooling, training and mobility are different ways to invest in human capital that is incorporated in the initially decision to invest in human capital i.e. education. Education is received from an institution that is specialized in the production of teaching. Education can be specialized in one skill such as barbers or can be of a more general kind. The investment period of an education can be measured as the number of years to finish a degree (Becker, 1962).

Individuals with higher human capital have a higher tendency to move to get a job and commute over longer geographical distances compared to individuals with lower human capital (Becker, 1964, McCann, 2001, Johansson et al., 2003a). The argument is straightforward. A utility maximizing individual seeks to maximize life time utility, in terms of earnings *and* job satisfaction, subject to the cost of acquired education. These individuals also tend to have a higher reservation income which prolongs the process of job search.

The debate around return to education has not been whether individuals capture benefits but rather whether the social rate of return exceeds that of individuals. There are two types of social externalities of education (Moretti, 2003). The first may be called productivity spillovers. These can enhance economic growth to a larger extent than individuals can accrue higher productivity by an extra year of study. Also, if there is imperfect substitution between labor with high education and those with low, it is plausible to believe an increased productivity for low skilled labor as well. The second type of spillovers is the one generated from reduced probability to engage in activities which create negative spillovers e.g. crime.

To argue that education is totally geographically bounded once an individual is located is likely to fail in practice. Networks created by individuals and firms allow some knowledge to travel over long distances. However, it has since long been argued (Marshall, 1920) that face to face interactions have a very important role to play in enhancing productivity[14].

It has to be stressed that the relation between educated and uneducated labor may impact the expected income of one and other. Standard neoclassical models suggest that if the two groups are imperfect substitute i.e. do not compete for the same positions, an increase in the share of educated labor will raise the productivity of the uneducated labor (Moretti, 2004). Empirical studies unanimously maintain increasing inequality within the group of educated labor but this is not as clear within the group of unskilled labor. The most traditional explanation for this is different trends of returns to education. Meckl and Zing (2004) stress an alternative argument where the composition of the two groups of labor that arise during economic development would determine the national wage structure. Even though individuals with a higher education level earn more income in Sweden, there is a welfare equalization amongst educational levels, with the university educated bearing the brunt of taxes and transfers (Maasoumi and Heshmati, 2000).

[14] It is also plausible to believe the existence of negative social returns of education. That is when educational level of individuals function as a *signal* of high productivity than *actual* high productivity. Then, individual returns exceed the social returns.

2.3 Further human capital investments

There are several ways in which one can invest in human capital such as education, on-the-job training and medical care. Most employees that acquire on-the-job training increase their productivity by improving old skills or learning new ones. On-the-job training and formal education differ in that sense that on-the-job training is an investment conducted at the job while the later is done at an institution focusing on teaching. The cost associated with on-the-job training is the effort and time by both the recipient and giver and in addition equipment and materials used (Becker, 1962).

On-the-job training can be both general and specific. General training has the characteristics of being useful in many firms besides the one providing the training. Thus, the future marginal product increases for employees in the present firm, providing the training, and for other firms as well. The future income rates along with marginal products increases in firms providing general training and to the firms not providing the training, operating in a competitive labor market. Specific training embodies employees with knowledge specific to the firm and cannot be used by other firms. Hence, the training increases productivity at the firm providing it compared to all other firms. In a rational firm, an employee with general training would receive a lower income than an employee with a specific training, Training can also be specific to a sector of industry, product or geographical location (Becker, 1962).

An individual can retain income from several sources such as labor income, rent, transfers and from capital. The return from these sources differs and will therefore affect the optimizing behavior of an individual i.e. self-employment provide returns to capital which is paid out later on. The return from labor income is as mentioned previously affected by investment in human capital. A large part of the private sector wealth is made up by owner-occupied homes. During the postwar period in Sweden housing wealth as fraction of household net wealth has differed between 50 to 75 per cent. An increase in asset prices increases the rental cost which could offset the impact on real wealth. Several studies have however empirically found a significant relationship between housing wealth and aggregate consumption (Englund and Ioannides, 1997). Equilibrium house prices should be related to future discounted rents. The discount factor for an individual is determined by their attitude towards risk and fluctuations in their consumption bundle. The expected return on housing should be equal to the return on other investments in a simple pricing asset model. There are however more factors affecting the house price such as the market condition in the housing market, transaction costs and regulations (Ayuso and Restoy, 2006).

2.4 Regional agglomeration

A wide variety of literature on agglomeration of individuals and economic activities have been presented beginning with von Thünen (1826), his early arguments have been extended and the theory of geographic concentration have numerous lines of research. Traditional theory argue that the centripetal forces such as linkages, market density and knowledge spillovers can be opposed to forces of concentration such as immobile factors, land rent and congestion effects. The line of new economic geography mostly focuses on linkages and the factor immobility as factors opposing each other (Fujita and Krugman, 1999).

One regional classification that is frequently used is functional regions based on commuting patterns. The urban regions within the functional region form a common market for labor, housing, household and company service as well as the market for many firms in the region. All urban regions can be divided into central urban regions and those in the surrounding

hinterland. A central urban region is the urban region within the functional region with the largest number of residents and also the highest inward commuting in absolute numbers. Hence, the central urban region is the main provider of job possibilities in a functional region.

In general, the central urban region is a larger city surrounded by smaller urban regions. Economic agents in these regions interact in a variety of ways but face-to-face contacts generally take place by commuting from hinterlands to centrally located places of work. The flow of job related commuters are related to the size of labor market as well as travel time. By the results of Johansson et al (2003a) it is credible to believe that most individuals commute between urban regions but within the functional region in Sweden. Individuals tend to live in the hinterland where there are more housing possibilities and work in the central urban region where there are more working possibilities.

The mobility differs between different regional classifications in a country. Thus, the mobility in urban regions is not the same as the mobility in functional regions. Geographical labor mobility involves transaction costs for the individual and consequently a higher reservation wage must be given in order for the individual to move. It is plausible that the mobility in a urban region is higher than in a functional region since it involves less transaction costs. Even if the distances in a functional region are such that one can commute, there are still costs associated with commuting such as travel expenses and time loss.

2.5 Modeling framework

In order to measure the returns to higher education the Mincer equation will be used which relates the logarithm of earnings to years of schooling, years of work experience and years of work experience squared. The Mincer equation is derived in Appendix A. There has been an extensive debate regarding measurement errors and failure to control for ability in the schooling variable. The general view is that the schooling coefficient (β_1) is upward biased due to omitted variables, i.e. ability. However, if schooling is measured with error the schooling coefficient is downward biased. Thus, the total effect is ambiguous.

The costs and the rate of return can be estimated using information about earnings e.g. income. Which is fortunate since the return on human capital cannot empirically be separated from other earnings (Becker, 1964). In the model used, we assume that individuals maximize their expected utility, $E(u)$, formulated as the expected income, $E(Y)$, incorporating the employment possibilities in the region. This is shown in Equation 1. We assume that individuals are risk neutral, i.e. they only care about expected income and not the risk in itself. Further, we assume perfect mobility.

$$E(u) = E(Y) = (1 - unemshare_{ir}) * Y_i$$

Eq. 1

Where $unemshare_{ir}$ is the regionally specific share of unemployment. The $unemshare_{ir}$ has further been customized according to the individuals age[15] and sex since these are factors that influence the possibility to become unemployed. Hence, $1 - unemshare_{ir}$ illustrates the reduced possibility of becoming unemployment for individual i. The income for individual

[15] The individuals where divided into the age groups (i) 20-30, (ii) 31-40, (iii) 41-50 and, (iv) 51-65

i is represented by Y_i. Thus, if a region experiences a high share of unemployment this will reduce the expected income of the individual i located there. Our dependent variable will therefore incorporate the regional specific unemployment share as well as the individually specific income level. It might be argued that highly educated labor largely integrate the risk of getting a job in the wrong sector rather than the risk of unemployment. This is not explicitly included in the present analysis. Though, a small regional unemployment (large supply of job) does most likely also reflect a smaller risk of employment in the "wrong" sector. Thus for individual i located in region r it follows that;

$$\left(1 - unemshare_{ir}\right) * Y_i = Y_{ir} \qquad \textbf{Eq. 2}$$

Our model described in Equation 3 is estimated by using a log linear least square approach, following the standard Mincer wage equation and adding a dummy for gender and for the country of birth;

$$\ln Y_{ir} = \alpha_i + \beta_{1i} yearedu_i + \beta_2 Exp_i + \beta_3 Exp_i^2 + D_{Gender} + D_{Birth} + \varepsilon_i \qquad \textbf{Eq. 3}$$

, where $yearedu_i$ is the number of years exceeding senior high school education. Consequently, emphasize should be given to the coefficient β_{1i} since it measures the additional return from an additional year of education. An alternative interpretation would be that β_{1i} reflects the risk premium of entering a higher education. A lower return may therefore be a result of a lower risk premium. The second right hand side variable Exp_i signifies the number of years after completing the highest education degree. The square of the variable Exp_i is included to allow for decreasing returns. A dummy for gender D_{Gender} is inserted in order to distinguish whether there are significant differences between men and women, 0 for women and 1 for men. Individual *i*'s country of birth, D_{Birth} is also a binary variable and is represented by 5 groups of countries, (i) Africa, (ii) EU15 and Norway, (iii) Asia and Oceania, (iv) Europe (apart from EU15 and Norway) and Russia, and (v) North and South America. Neither gender nor country of origin can be selected by an individual and is external in the decision process whether to obtain a higher education or not.

The theoretical framework presented above can be summarized in five major hypotheses:

Hypothesis 1
The length of education is positively related to the expected income of individual i. By that we assume that when starting an education the individual has incorporated aspects such as self-employment, future location of residence, and location of work.

Hypothesis 2
Second, further human capital enhancements related to work experience have a positive effect on the expected income of individual i. The experience is however assumed to be marginally decreasing.

Hypothesis 3

Third, the return to education for individual i is affected by location. Locations with a wide variety of amenities can attract individuals on other basis than income and is therefore expected not to have as high return to education. Therefore, the sample has been divided into several classifications based on both geographical locations in space as well as regional characteristics. Possible differences are searched for between metropolitan cities, urban and rural regions as well as those regions that inhabit large universities. This should be reflected in the analysis.

Hypothesis 4
Fourth, the gender of the individual is assumed to affect the expected income. There are earlier results showing that there are systematic differences between the income of women and the income of men. Accordingly, men are anticipated to have a higher expected income.

Hypothesis 5
Fifth, the return to education is expected to be lower for individuals that are not born in Sweden. These discrepancies may be caused by the level of language proficiency, lack of experience on the Swedish labor market or pure discrimination.

3 Analysis

The data in this paper is provided by Statistics Sweden and contains data on approximately all individuals residing in Sweden with a two to nine year long higher education in natural science, engineering or medicine. The data set comprises about 222 000 individuals between 1990 and 2000[16]. This could cause biased results if not interpreted with care. Individuals with a lower degree of education or no education at all are not included which means that the parameters and intercepts are assumingly not applicable to that particular group. A different intercept as well as slope of the relation between income and years of education can be expected.

For the purpose of this paper, only those individuals (20-64 years of old) with some kind of education are selected. For some individuals the year as well as region of latest graduation is not available and they are not included in the final data set. Work experience is defined as the number of years after completed highest education. Consequently, the final number of individuals is slightly more than 136 000. The region of education, region of living and region of work can all be extracted. The income sum of all individuals is based on their region of living.

The highest level of education is registered for the individuals in the dataset. This specification avoids the problem that engineers often have a higher wage level than PhD candidates even if the engineers have a shorter education period. Since the PhD candidates are not registered during their education but after completing their PhD and often receive a high wage level this occurrence does not pose any problem in the data set.

The employment status as well as the income sum has also been extracted from the data set. That is, an individual can either be unemployed or employed. It is further possible to find the type of employment i.e. self-employed or employed, but not whether an individual has another source of income than income from employment e.g. income from capital. Consequently, some individuals have zero income being unemployed. But a minority also has no income even though registered as employed. The number of people living on social welfare cannot be distinguished why an important restriction has been made. Those who are registered as unemployed and have zero or a yearly income less than minimum social welfare i.e. 41 652 SEK[17] have been given this value. A minority of individuals has an income lower than this but is not registered as unemployed. These have another source of income which is non-observable in the data set. It should also be recognized that it is impossible to distinguish between part-time employment and full-time employment in the data set.

3.1 Empirical findings

Table 1 presents the descriptive statistics of the variables used in Equation 3 and the description of the variables. The statistics in Table 1 are based on all individuals in the dataset. Work experience, Exp_i is the only variable with a mean that deviates slightly from the median. The standard deviation is relatively large for all variables. The dummy indicating the sex of the individual has a mean value of 0.7 signifying that a high share of the sample are men. This is not surprising since men have traditionally been overrepresented in natural

[16] The number of individuals varies somewhat over time.
[17] Based on the minimum social welfare in 2007.

science, engineering and medicine. Estimations were initially performed by ordinary least square tests but the tests for robustness indicate that the data set suffers from heteroscedasticity. Consequently, the estimations will be performed by White's robust covariance matrix to adjust the standard OLS estimates.

The minimum value found for the expected income is surprisingly low and is the income for an individual that is registered as employed. The individual can however have other sources of income that is not registered in the dataset. There are approximately 1 000 individual in the dataset that are registered as employed with a lower income than the minimum social welfare.

As abovementioned, D_{Birth} represents the country of birth or individual *i* and is illustrated by 5 groups of countries. Clearly, the majority of individuals where born in Sweden and represent 92 % (125 334) followed by Asia and Oceania 2.7 %(3 712), EU15 and Norway 2.5 % (3 413), Europe (apart from EU15 and Norway) and Russia 1.7 %(2 370), North and South America 0.6 % (819), and Africa 0.4 % (537).

Table 1 Variable description, sum of all individuals

Variable	Description	Mean	Median	St.dev	Min	Max	Skew.	Effect
$Expected\ Income_i$	Total income per year from gross income and from active business times employment probability	$33.84e^4$	$31.10e^4$	$26.54e^4$	3	$22.23e^6$	15.59	
$\ln Income_i$		12.50	12.65	0.80	0.93	16.86	-1.51	
$yearedu_i$ (β_{1i})	Number of years in higher education	4.8	4.0	1.9	1.0	9.0	1.48	+
Exp_i	Age minus the year of finishing the highest degree	12.6	9.0	10.5	0.0	42.0	0.63	+
Exp_i^2	Age minus the year of finishing the highest degree, squared.	270.8	81	350.3	0	1764	1.44	-
D_{Gender}	Dummy where 1=man, 0=woman	0.7	1	0.4	0	1	-1.02	+
D_{Birth}	Dummy where 1= Country of birth, 0= otherwise	*	*	*	*	*	*	-
N=136 185								

The final column in Table 1 illustrates how the regressors are expected to affect the regressand. Supposedly, the length of education has a positive effect on the return for individual i. The same holds for the work experience. The squared work experience is inserted in order to reflect the decreasing return of staying on the labor market over time. Hence, it is expected to generate a negative coefficient. It is well recognized that men have a higher wage level than women. This is why the return to higher education also may be higher. However, an alternative interpretation is possible. Since women have a lower wage level the *marginal return* of education may be higher than for men. Consequently, separate estimations

on women and men may generate a higher return for women[18]. Individuals not born in Sweden is expected to have a lower income.

Supposedly, the return to education may differ according to specific regional characteristics (locations). In order to search whether there are any regional differences in Sweden, the estimations are performed as seven alternative models. This is as an attempt to capture those specific regional characteristics affecting returns to education.

1. *All observations*; estimates all observations in the sample no matter of functional region or urban region. This is performed for a comparative cause.
2. *Three largest cities*; estimates the observations in the urban regions consisting the three largest cities in Sweden, Stockholm, Gothenburg and Malmö.
3. *Ten largest universities*; estimates the observations in the urban regions that inhabit the ten largest universities in Sweden[19]. Size is calculated with respect to the number of students. One of the ten largest universities is located in two urban regions so 11 urban regions is included in the analysis.
4. *Peripheral urban region in a large functional region*; estimates the observations in all urban regions which are not a central urban region in a functional region with a population larger than 100 000.
5. *Peripheral urban region in a small functional region*; estimates the observations in all urban regions which are not a central urban region in a functional region with a population less than 100 000.
6. *Central urban region except the three largest cities*; estimates the observations in all central urban regions except the three largest cities in Sweden.
7. *Central urban region except the three largest cities and the ten largest universities*; estimates the observations in all central urban regions except the three largest cities and those urban regions that inhabits the ten largest universities. Not much emphasis will be give to this classifications since it overlap with some of the other regional classifications.

The geographical position of the different regional classifications can be found in Appendix B. There are some overlaps for some of the regional classifications. This hold for estimation number 6 and 7. However, the ambition is not to avoid overlaps but to find classifications that can capture relevant regional characteristics. Table 2 presents the regression results for all alternative models described above.

[18] This was tested for, using all individuals, and the results showed that women had a higher return to education than men. These results can be delivered from the authors upon request.

[19] The 10 largest universities are located in the following urban regions Stockholm, Göteborg, Lund, Uppsala, Umeå, Linköping, Norrköping, Malmö, Östersund, Härnösand, Sundsvall, Karlstad, Eskilstuna and Västerås.

Table 2 Regression results for all alternative regional characters in year 2000, dependent variable $\ln Income_i$ *(t-values)*

	1	2	3	4	5	6	7
	All observations	*3 Largest cities*	*10 largest universities*	*Periph.urban reg. in large func. region*	*Periph.urban reg. in small func. region*	*Central urban reg. excep 3 largest cities*	*Central urban reg. except 3 largest cities and 10 univers.*
α_i	11.74* *(1669.59)*	11.85* *(900.53)*	11.77* *(1233.68)*	11.71* *(966.13)*	11.58* *(176.78)*	11.68* *(1004.03)*	11.69* *(669.10)*
$yearedu_i$ (β_{1i})	0.0382* *(35.69)*	0.0333* *(15.79)*	0.0387* *(26.96)*	0.0319* *(18.49)*	0.0414 *(3.32)*	0.0489* *(27.45)*	0.0544* *(17.81)*
Exp_i	0.0627* *(85.32)*	0.0554* *(39.06)*	0.0584* *(54.15)*	0.0688* *(57.07)*	0.0647* *(12.45)*	0.0619* *(48.45)*	0.0590* *(33.69)*
Exp_i^2	-0.0018* *(-74.39)*	-0.0016* *(-33.45)*	-0.0016* *(-44.67)*	-0.0020* *(-51.03)*	-0.0020* *(-12.10)*	-0.0018* *(-41.20)*	-0.0018* *(-30.36)*
D_{Gender}	0.410* *(87.95)*	0.3794* *(44.17)*	0.3803* *(58.27)*	0.4591* *(58.56)*	0.3793* *(10.78)*	0.3788* *(47.84)*	0.3760* *(34.03)*
D_{Africa}	-0.7314* *(-16.86)*	-0.8760* *(-11.30)*	-0.8623* *(-14.68)*	-0.6974* *(-10.33)*	-0.3079 *(-1.07)*	-0.6246* *(-7.64)*	-0.3487** *(-2.70)*
$D_{EU15\&Norway}$	-0.1858* *(-12.33)*	-0.2777* *(-9.54)*	-0.2437* *(-11.29)*	-0.1575* *(-6.51)*	-0.0326 *(-0.26)*	-0.1407* *(-5.44)*	-0.0875** *(-2.36)*
$D_{Asia\&Oceania}$	-0.4975* *(-30.36)*	-0.6501* *(-22.70)*	-0.5785* *(-25.83)*	-0.4276* *(-16.27)*	-0.0450 *(-0.22)*	-0.4165* *(-13.81)*	-0.3817* *(-8.38)*
$D_{Europe\&Russia,notEU15\&Norway}$	-0.3177* *(-16.69)*	-0.4069* *(-12.77)*	-0.3761* *(-14.83)*	-0.2779* *(-9.09)*	-0.2027 *(-1.13)*	-0.2556* *(-6.79)*	-0.1730** *(-3.17)*
$D_{North\&South\ America}$	-0.4269* *(-12.46)*	-0.5049* *(-9.01)*	-0.4866* *(-10.53)*	-0.4150* *(-7.35)*	-0.4198 *(-1.14)*	-0.3445* *(-5.07)*	-0.2494** *(-2.81)*
N	*136 145*	*39 613*	*67 597*	*52 237*	*2 903*	*41 392*	*21 900*

* Significant at the 0.01 level, ** Significant at the 0.05 level

The return to education, represented by β_{1i} is positive for all regional classifications indicating that an extra year of schooling has a positive effect on the expected income, consistent with Hypotheses 1. The highest return to education is found for the central urban regions, except the three largest cities and ten largest universities. The second largest value appears for central urban regions except the three largest cities, the value for periphery urban regions in small functional regions are close to the later value. The group of urban regions in the periphery in large functional regions has the lowest value of β_{1i}, return to education. The second smallest coefficient is found for the regions consisting of the three largest cities, Stockholm, Gothenburg and Malmö. The return to education for the urban regions consisting the ten largest universities has a somewhat higher value than found for three largest cities.

The three lowest values for return to education appear for regions that are either large in themselves or have a commuting distance to a large central urban region. As discussed in the theoretical part of the paper this may be explained by the presence of highly valued amenities. In the case of the three largest cities it could be a result of urbanization where peripheral areas need to attract individuals with a higher return in order to compensate for the location. Stockholm, Gothenburg and Malmö have other amenities that the individual values as compensation. This result concurs with Hypotheses 3.

For the case of the urban regions that contain the 10 largest universities other underlying factors can be found. The low return to education may be an indication of the difficulty to find a job in a region where the supply of labor is very high. Hence, many students leave this region after their studies in order to find a job.

The work experience Exp_i has a positive relation to the income in all the alternative models. Thus, when searching for a new job the experience achieved at earlier positions are advantageous for the applicant which is consistent with Hypotheses 2. The largest impact is generated in model 4, urban regions in the periphery in large functional regions. The lowest value is for model 2, the three largest cities. The second highest value appears for peripheral urban regions in small functional regions. Hence, the highest return to experience is achieved in the areas surrounding the core of urban regions. The functional regions are defined by commuting patterns where individuals to a large extent commute from the periphery into the central parts. Individuals in the periphery have access to a large supply of job opportunities and a diverse labor market. It is likely to believe that congestion effects and housing prices increase the attractiveness of living in the peripheral areas. Also, since experience is highly correlated with age individuals tend to leave larger cities in favor of suburban areas.

The squared work experience Exp_i^2 shows a negative sign irrespectively of the regional classification, meaning that the returns from experience are decreasing, consistent with Hypotheses 2. This effect is largest for model 4 and 5 periphery urban regions in large and small functional regions. The effect is smallest for model 2 and 3, the urban regions with the three largest cities and the 10 largest universities. Model 2 and 3 are both regional classifications are characterized by a high knowledge intensity. Working in these regions may give a value added coming from the knowledge spillovers available by the knowledge intensity.

By combining the linear and quadratic experience term and using envelope calculations one can find the experience level where wages start to fall. The critical experience level is found to be between 16 and 19 years. The mean age when finishing the highest education is 28.7 in

this sample which implies that the wage level would peak near 50 years of age. This seems plausible since the highest marginal wage increases assumingly occurs when individuals change occupation or positions. This volatility decreases when the individual becomes older (Andersson and Thulin, 2008).

The dummy for gender, where one representing men and a zero representing women, is positive and ranging from a value from 0.37 to 0.46. Thus, men seem to have a higher income than women. This result is consistent with Hypotheses 4. The result has also been found in other studies (see for example, Albrecht et al (1999)) and could be a result from wage discrimination or by the fact that women tend to choose occupations with a average lower wage level. The lowest value is found in the central urban regions, except the three largest cities and ten largest universities and the highest is found for peripherally urban regions in large functional regions. This could indicate the fact that numerous head offices are located in these regions offering managerial positions that are often occupied by men.

The dummy representing the country of birth is negative for all regional classifications and significant for all but model 5, *Peripheral urban region in a small functional region,* verifying hypotheses 5. No matter of regional classification, individuals born in an African country seem to have the largest difficulties gain a return on their education followed by Asia and Oceania, North and South America, Europe (apart from EU15 and Norway) and Russia, and EU15 and Norway. The regressions for all regional classifications have been estimated with a dummy representing Sweden as the country of birth. This is positive for all models and significant for all but model 5.

The population growth for all regional classifications respectively is presented in Figure 6 in Appendix C. The time series are indexed with the base year 1968 and by an ocular inspection it is evident that the growth has not been developed similarly in all regions. The three largest cities experienced a downward trend during the seventies and the beginning of the eighties. During this period numerous households in Sweden moved from the city centers to the sub-urban areas influenced by the environmental thinking at the time being. This is reflected in the high population growth in the peripheral urban regions in large functional regions.

The peripheral urban regions in small functional regions have experienced a negative trend of the population growth. This is consistent with the empirical results where these are the regions with the highest return to education. It is plausible to believe that the negative net migration affects the return to those highly educated labor in a positive way. The supply of highly educated labor is small why the wage has to be high enough to compensate for this.

4 Conclusions

If one conclusion were to be drawn from the empirical analysis in the present paper it would be that there *are* significant differences between regions in Sweden with respect to their return to higher education. Regions which can attract a large number of highly educated labors should have the highest return to education. This is since individuals are assumed to maximize their expected income. However, the pattern does not seem to be as clear cut. The estimated coefficients for the three largest cities in Stockholm, Gothenburg and Malmö are not the largest in a comparison with the other alternative regional classifications. Though, these cities in general and Stockholm in particular attract many graduated individuals. The central urban regions except the regions with the three largest cities and ten largest universities seem to generate a higher return to each year of additional education. In order for these regions to attract highly educated labor they need to offer a higher return. Assumingly, metropolitan (urban regions) have a wider variety of attractive factors e.g. entertainment, consumption, culture that compensate for the lower returns from higher education.

This study verifies previous empirical studies in the sense that men seem to have a higher return to their education. Also, individuals born abroad have a lower return to their high education compared to the native population in Sweden.

Future studies should widen as well as deepen the perspective. First, much previous literature on regional returns on education assumes individuals with a fixed location. This is a questionable assumption and individuals moving patterns can be further elaborated on such as the difference in income for individuals that are mobile versus immobile. Second, the study can be extended with respect to time. The fact that women and men have different returns to higher education could be further developed with the regional classifications to distinguish if there are any patterns. Third, it is also possible to decouple individuals into the type of industry where they are employed. As indicated in the theoretical part of the paper, some industries or locations may have a higher average income per se. This may be due to strong unions, strongly domination by one gender or a path dependency factor.

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Appendices

Appendix A. Derivation of the Mincer equation (Mincer, 1974)

The standard Mincer equation is expressed in Equation 1*'

$$\ln Y_{ir} = \alpha_i + \beta_{1i} yearedu_i + \beta_2 Exp_i + \beta_3 Exp_i^2 + \varepsilon_i$$

Eq. 1'

The Mincer equation is derived by the following approach, the resent value of earnings for a person with S years of schooling is:

$$V_S = \int_S^L E_t e^{-rtdt}$$

Eq. 2'

where E_t is the earnings, L is the age of retirement and r is the discount rate. By assuming that in the absence of post school investment (i) an individual with S years of schooling would have a flat age-earnings profile and, (ii) the present discounted value of lifetime earnings would be equal for all individuals regardless of how long they stay in school the term E_t can be substituted for a constant E_S. This gives:

$$\left(E_s / r\right)\left(e^{-rS} - e^{-rL}\right) = V$$

Eq. 3'

where V is a constant. By assuming that the number of years at work, N, is independent of the number of years spent in school, each additional year of schooling postpones retirement by exactly one year. The length of time, L, is equal to $N+S$. By using this assumption in Equation 3' and simplification leads to:

$$\left(E_S / r\right)e^{-rS}\left(1 - e^{-rN}\right) = V = E_0 / r\left(1 - e^{-rN}\right)$$

Eq. 4'

Or, $$E_S = E_0 e^{rS}$$

Or, $$\log E_S = \log E_0 + rS$$

Eq. 5'

This means that in the absence of post school investments the logarithm of earnings are a linear function of years of schooling. However there exist post school investments in form of "on-the-job training". In order to incorporate this, Mincer first differentiate between concepts; E_t is the potential earnings at age t, Y_t is the actual earnings at age t, C_t is the human investments defined as E_t -Y_t, and k_t is the investment ratio at age t defined as C_t/E_t. Mincer then assumes that the rate of return to all post school investments in human capital is a

constant, ρ, so that investing ΔC_1 at time $t=t_1$ increases potential earnings by $\Delta E_t = \rho \Delta C_1$ for all $t > t_1$. This assumption gives the following identity:

$$E_t = E_{t-1} + \rho C_{t-1} = E_{t-1}(1 + \rho k_{t-1})$$

Eq. 6'

By solving the recursion formula:

$$LogE_t = LogE_S + \sum_{i=S+1}^{t-1} Log(1 + \rho k_i)$$

If ρk_i is small and using Equation 5' it can be approximated by:

$$LogE_t = LogE_0 + rS + \rho \sum_{i=S+1}^{t-1} k_i$$

And in continuous time:

$$LogE_t = LogE_0 + rS + \rho \int_0^X k(\tau) d\tau$$

Eq. 7'

Where τ is a dummy variable of integration and X measures time spent at work after completing the schooling, i.e. experience. The investment ratio during the post schooling investment period $k(\tau)$ declines linearly with τ starting at $\tau = 0$ and reaches zero at $\tau = T$, this gives:

$$k(\tau) = k_0(1 - \tau / T)$$

Eq. 8'

By substituting Equation 8' into Equation 7' and integrating, yields:

$$LogE_t = LogE_0 + rS + \rho k_0 X - (\rho k_0 / 2T) X^2$$

Eq. 9'

The problem with this form is that the actual and potential earnings are not equal during the on-the-job training period, instead we have:

$$LogY_t = LogE_t + Log(1 - k_t)$$

Eq. 10'

By substituting both the Equations 8' and 9' into Equation 10', the human capital earnings function is given:

$$LogY_t = LogE_0 + rS + \rho k_0 X - (\rho k_0 / 2T)X^2 + Log(1 - k_0 + (k_0 / T)X)$$

Eq. 11'

In order to get the Mincer equation, Mincer assumed that the function

$$f(X) = Log[1 - k_0 + (k_0 / T)X]$$

Eq. 12'

can be approximated by a second-order Taylor series expansion. This yields the Mincer equation found in Equation 1.

Appendix B. The geographical position of the regional classifications

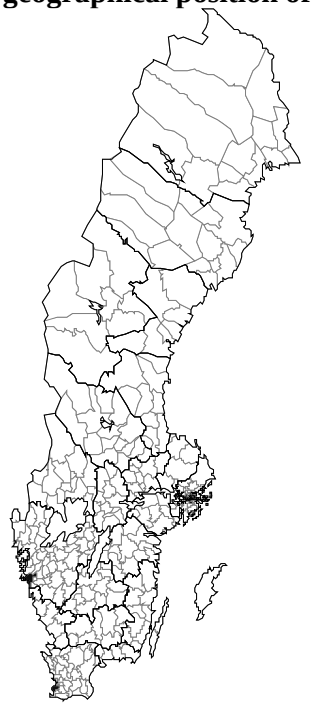

Figure 1 Map of Sweden divided into 289 urban regions where Stockholm, Gothenburg and Malmö are shaded in black.

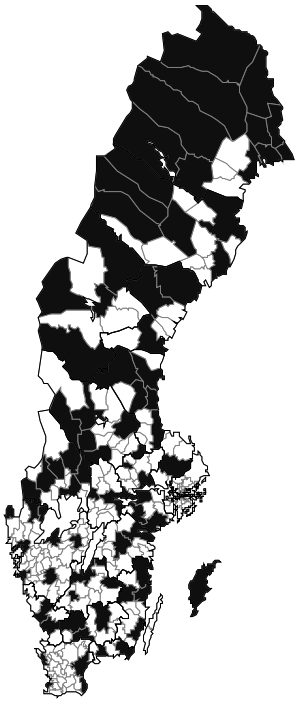

Figure 2 Map of Sweden divided into 289 urban regions where the central urban regions in the 81 functional regions are shaded in black.

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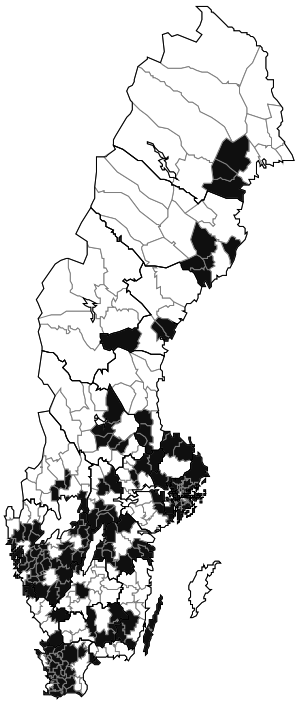

Figure 3 Map of Sweden divided into 289 urban regions where the peripheral urban regions in the functional regions with population < 100 000 are shaded in black

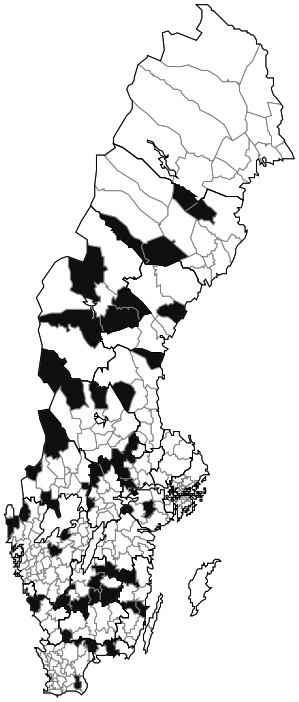

Figure 4 Map of Sweden divided into 289 urban regions where the peripheral urban regions in the functional regions with population > 100 000 are shaded in black.

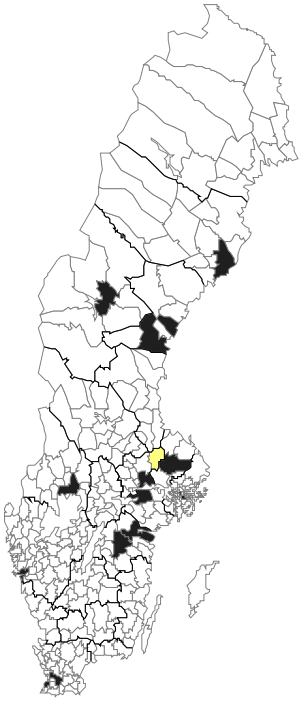

Figure 5 Map of Sweden divided into 289 urban regions where urban regions inhabiting the 10 largest universities are shaded in black.

Appendix C. Population growth 1968-2004 in all regional classifications

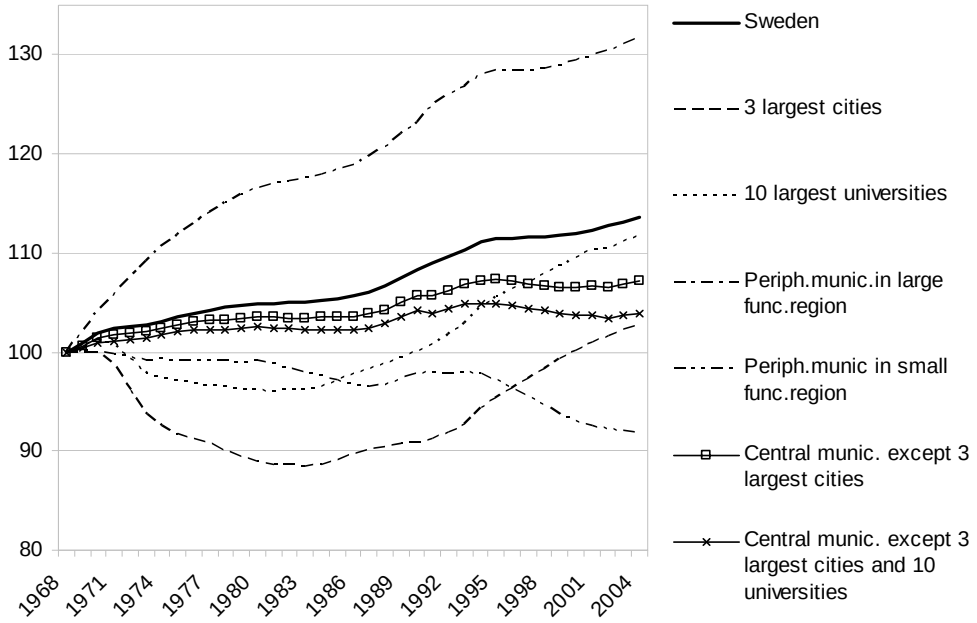

Figure 6 Population growth 1968-2004 in all regional classifications. Index base year is 1968