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## Higher education and migration

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# Higher Education and Migration

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## **Abstract**

Nearly sixty percent of the highly educated individuals within Science, Engineering and Medicine do not stay in their region of education. They have in addition an average income that is higher for those that stay. In this paper we explore the relocation pattern of individuals, assuming that they are heterogeneous in terms of types of mobility and education. To the authors' knowledge there has not been any previous empirical research that distinguishes between different categories of higher education. The influences on the probability to move can be divided into three factors. First, the income has a positive effect on the probability to move but plays only a minor role in the decision process compared to other decision factors. Second, socio-biological factors such as age and gender are more significant in the decision process, which supports the results in earlier empirical studies. A third factor in the decision process is the regional characteristics that create incentives to choose a geographical location corresponding to the individual preferences.

Keywords: labour mobility, highly educated individuals, inter-regional migration

JEL classification codes: R23

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## Introduction

We find that nearly 60 percent of the highly educated individuals in Science<sup>1</sup>, Engineering and Medicine do not stay in their region of education and that they have an average income that is higher than that of those who stay. The fact that individuals move away from their region of education is likely due to two main reasons. First, not all regions are self-sufficient in terms of higher education while some regions have an excess supply of highly educated persons. Second, individuals have preferences related to the region where they would like to work and live that are different to those attached to the region where they would like to have their education. This implies that the educated individuals can be divided into two groups: (i) *Stayers* who stay in the region of education and (ii) *movers* who move to other regions.

In this paper we analyse the relocation pattern of individuals assuming that they are heterogeneous in mobility and educational type. It is generally held that mobility increases with the educational level (Borjas, 2002). It is less clear how the mobility pattern is described when highly educated are not considered as a homogenous group. This paper disentangles the mobility patterns of those highly-educated individuals with an education in Science, Engineering and Medicine, in Sweden. We incorporate different factors that influence the migration decision such as income level, regional characteristics, transaction costs and social and personal factors. To the authors' knowledge there has not been any previous empirical research that distinguishes between different categories of higher education. The empirical analysis is based on data for individuals for the period 1990 to 2000. The data set allows for an extraction of individual information on location of work, education and living, educational level, as well as income for more than 140 000 individuals. A logit model is used to estimate the probability to move from the region where the individuals finished their highest education and the main results are as follows: First, the income has a positive effect on the probability to move but plays only a minor role in the decision process compared to other decision factors. Second, the socio-biological factors such as age and gender are more significant in the decision process, which supports the results in earlier empirical studies. A third part of the decision process is the regional characteristics that create incentives to choose a geographical location corresponding to the individual preferences.

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<sup>1</sup> Including the subject's chemistry, biology, physics and geosciences.

The location choice of highly educated individuals is important to analyze since well educated individuals have a higher propensity to migrate. Those regions that can attract these individuals will gain in several dimensions. Not only will they increase the size of population but also the size of the workforce which yields more tax income to the region. Since highly educated individual tend to earn a higher wage rate this increases the tax income even further. Assuming that amenities are normal goods, a higher income increases the demand and therefore a large amenity supply makes the region attractive. The opposite would therefore be true for regions with a shrinking population.

Regional comparative advantages, in terms of employment- and/or education possibilities are important in this context since these relations are non-stable over time. New universities are established and the regional industrial structure is sensitive to economic fluctuations. The demand and supply of highly educated individuals vary both in time and space which affect the expected income.

To summarize, migration can be subdivided into at least three types: (i) international migration, (ii) inter-regional migration and (iii) intra-regional migration. International migration is beyond the scope of this paper but the second two types need further clarification. Inter-regional migration describes the migration between regions and depends on geographical delimitations. Intra-regional migration has frequently been referred to as *residential mobility* (Rossi, 1980) and the reasons to move are related to distance. The longer distance the individuals move, the larger is the weight of employment, whereas shorter distances are largely explained by life cycle reasons such as income, family changes and housing (Gleave and Cordey-Hayes, 1977). This paper focuses solely on inter-regional migration which means a residential shift from the urban region  $r$  to the urban region  $s$ , where region  $r$  is the region of education. This excludes all observations on intra-regional migration *within* urban regions such as moving from the city centre to a less urban location.

## **Theoretical aspects on returns to migration**

*Differences in net economic advantages, chiefly differences in wages,  
are the main causes of migration.*

Hicks (1932 pp.76)

Much research has been conducted since Hicks' time and the present paper rests on the assumption that an individual's decision to invest in higher education can be thought upon as any other investment decisions (Andersson and Beckmann, 2009).

Assuming that individuals are rational agents with the ambition to maximize the expected life time earnings, then migration can be seen as an investment in human capital, similar to education and on-the-job-training. The obvious consequence of this is that the costs of moving should be incorporated into such an optimization problem. These costs are transportation costs, costs of change in housing, but also the socio-psychological cost of moving e.g. separation from friends and family and other social networks. An individual estimates the value of the available employment opportunities in alternative labour markets and compares it with the cost of moving. Borjas (2002) states that the probability to move is high if the individual can recoup the human capital investments. Widening this statement, it is plausible that individuals seek a return that goes beyond breakeven between the costs and investments of human capital. Migration, as a human capital investment also affects the risk of unemployment, career opportunities and standard of living which all could generate an increasing return on higher education.

The research on the relation between regional income differentials and migration probability in Sweden has not had unanimous conclusions (Nilsson, 1995, Westerlund, 1998). Sweden has a history of strong labour unions which has partly led to wage equalization which makes wages sticky and rarely decreasing<sup>2</sup>. This implies that the regional differences in employment possibilities should play a major role in migration decision. The wage level will not be forced down if the demand for labour decreases in a region. Instead, the unemployment will increase. The same is true in expansive regions where the unemployment rate decreases. There is actually a negative relationship between unemployment rates and inter-regional migration in Sweden (Nilsson, 1995, Westerlund, 1997, 1998). In general, interregional mobility is lower in Europe compared to the US (Eichengreen, 1998). During the 1960's and 1970's Sweden went through a wide expansion of the public sector which led to a peak in migration rates. Since the middle of the 1980's, the migration rates have again increased. This can mostly be explained by the increased migration propensity of people outside the labour force such as students. People within the labour force have actually become less mobile than they were before for reasons such as two-income families, tied stayers, children's schooling situation etc. (Lundholm, 2009). Also, the increased commuting possibilities make people more reluctant to shift residential location.

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<sup>2</sup> Between the middle of the 1950s and until the beginning of the 1980s, the entire blue-collar labour force in the private industry was covered by detailed wage agreements. The solidarity wage politic was formed by economists at The Swedish Trade Union Confederation. Wage equalization was in place between 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.

Most essentially, four questions are related to the migration decision (Lee, 1966). First, what are the characteristics of the region the individual is moving from? These are known to the individual and are based on own experience. Second, what are the characteristics of the receiving region? These characteristics are not as well known to the individual why the decision to move is restrained by asymmetric information. Third, what are the transaction costs of moving between these two regions? These may differ over time but also over geographical locations. Fourth, the personal and social factors related to this potential change of residential region. Following Lee (1966), the rest of this chapter will go through regional factors, transaction costs and personal and social factors.

### **Regional factors**

The utility maximizing decision maker is often assigned a probability to migrate in a discrete choice manner. This is a natural way to model it given the life cycle effects and possible optimization errors. A representative agent with a constant probability to move would generate a temporal equilibrium (Harrigan and McGregor, 1993). However, if there are changes in the factors influencing the indirect utilities to migrate, disequilibrium may arise at a microeconomic level. With two equally sized regions with the same number of possible migrates, the gross migration flows would self-cancel in equilibrium. Harrigan and McGregor (1993) point out that in order to generate a long-run equilibrium we must relax the assumption that all decision makers have identical characteristics (Evans, 1990). In this paper it is therefore assumed that equilibrium will hold i.e., where the *movers* are a homogenous group in terms of educational length but not in type and personal and social factors.

A framework allowing to account for repeated changes in location by the same agent is investigated in the model by Lucas and Prescott (1974) and Alvarez and Veracierto (1999). The economy is composed by isolated regions that are geographically separated so that all individuals can distinguish between distinct markets. For all firms, labour is employed where marginal product equates the wage and the regions function as competitive Marshallian industries such that  $p = D(z, Q)$ , where  $z$  is a shock that enters the region and is driven by a Markov chain process. New employment opportunities are available outside the region which also means that new workers can arrive. The total workforce of the economy is fixed and once this is stationary distributed over regions, the expected present value of searching for a new employment,  $\lambda$  is constant and individual. Region  $(z, y)$  seek the equilibrium values of wages  $w(z, y, \lambda)$  and

employment  $n(z, y, \lambda)$ . In equilibrium supply constraint,  $n(z, y, \lambda) \leq y$  and the market clearing condition,  $n(z, y, \lambda) = R(s, n(z, y, \lambda))$  must hold.

At the initial stage, all regions have a fixed number of employees in their workforce,  $y$ . When the stochastic shock,  $z$  is revealed all individuals decide whether to stay in their current employment in the region (*stayers*) or to enter unemployment and search for a new job in another region (*movers*). All individuals are aware of all attributes in the region where they currently are and the probability distributions of the future governing of this region. Also, all individuals are aware of the present and future state of all other regions. Hence, individuals learn from previous periods in such a way that they have rational expectations. Also, they are risk neutral and seek to maximize their expected present value of life time earnings. That is, the current wage plus the present value of the discounted future wage;

$$u(z, y, \lambda) = w(z, y, \lambda) + \beta E\{v(z'y'\lambda)\} \quad 0 < \beta < 1 \quad \text{Eq. 1}$$

,where the expectations are conditioned upon the current state  $(z, y, \lambda)$ . The current state is assumed to be positive but this does not imply a direct relationship to the regional characteristics. There might be regions where it is possible to earn a high income with the presence of negative amenities. Also, some regions may be attractive even though the income level is relatively low. Hence,  $z$  contains all regional characteristics known to the individual and can therefore vary across all alternative locations.

There are three possible scenarios. First (1), some individuals decide to stay in the region and some decide to leave. All face the same opportunities outside the region why this scenario leads to a present value equal to the present value of search,  $u(z, y, \lambda) = \lambda$ .

Second (2), all individuals,  $y$  with a current wage  $R(z, y)$  decide to be stayers and no additional individuals arrive in the following period. The following period's state  $(z', y)$  with  $z'$  given probabilistically by  $f(z', z)$  is then,

$$u(z, \lambda) = R(s) + \beta \int v(z', y, \lambda) f(z', z) dz' \quad \text{Eq. 2}$$

The third scenario (3) is where all individuals are stayers but additional individuals arrive in the following period. For the individuals searching a new employment and for those staying in  $(z, y)$ , the  $\beta E\{u(z'y'\lambda)\}$  will have the common value of  $\lambda$ . Thus,

$$u(z, y, \lambda) = R(z, y) + \lambda \quad \text{Eq. 3}$$

If all individuals remain and no one arrives in the next period (scenario 2) it must be that the expected rent in current state  $(z, y)$  is non-positive with the future workforce

$y$  or the discounted value of future wage flow are at least as large as the expected present value of search,  $\beta \int v(z', y, \lambda) f(z', z) ds' \leq \lambda$ . A combination of the first and second scenario can therefore be illustrated such as,

$$u(z, \lambda) = R(s) + \min[\lambda, \beta \int u(z', y, \lambda) f(z', z) dz'] \quad \text{Eq. 4}$$

, where the minimum illustrates the choice by the arriving individuals. If  $\lambda$  is the smallest value, there are incentives for externally located individuals to leave their jobs and search for an employment in this particular region.

It is important to stress that for all cases, the individuals that decide to stay in the region have all rejected the possibility to leave their employment and search for a new one so that,  $u(z, y, \lambda)$  combining scenario 1, 2 and 3 yields <sup>3</sup>,

$$u(z, \lambda) = \max\{\lambda, R(z) + \min[\lambda, \beta \int u(z', \lambda) f(z', \lambda) dz']\} \quad \text{Eq. 5}$$

There is an extensive literature treating amenities as a factor besides income levels that influence the location patterns of educated labour<sup>4</sup>. General residential amenities are the regionally specific goods and services that are directly incorporated into the utility functions of individuals (Gottlieb, 1995). A wider definition of positive amenities also incorporates diversity of consumer goods and services, attractive architecture, recreation areas, and well functioning public services. Consequently, negative amenities are those location characteristics that enter the utility function in a negative way, such as high crime rates, poor educational systems and congestion. Tiebout (1956) who regarded amenities as local public goods illustrated that mobile consumers revealed their preferences for amenities by their choice of residence. Amenities can however also be regarded as normal goods leading to a higher demand when income increases (Power, 1980, Pacione, 1984).

Amenities are often characterised by being rationed i.e. consumers cannot choose the quantities freely. Consumers can in some cases choose whether or not to accept a ration. In some cases a consumer might even have an incentive to reduce consumption of certain goods if compensated. The optimal behaviour of consumers that have chosen to accept a ration or consumers who unwillingly face a quantity constraint is however identical (Schwab, 1985). Rationing of amenities has implications in the migration choice for individuals. Standard economic theory states that individuals change location due to wage differentials but that amenities can distort this relationship. A location with a large

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<sup>3</sup> Following Lucas and Prescott (1971, 1974) and Muth (1961)

<sup>4</sup> Though closer to reality, this complicates the concept of equilibrium. To enforce equilibrium on a spatial economy in disequilibrium would have the rather severe implication that the valuations of amenities are biased. That is, too low in regions with a positive net-migration and the reverse for regions with a negative net-migration Research generally fails to present an acceptable answer to whether the U.S economy is in equilibrium (Evans, 1990).



amount of positive amenities can yield a lower requirement for income in order to change location, i.e. bias in income. Thus, positive amenities decrease  $\Delta y_{rs}$  in equation 3.

A growing amount of literature focuses on regional factors and location decisions of individuals (Florida, 2002c, Florida, 2002a, Glaeser et al., 2001, Lloyd, 2001, Lloyd and Clark, 2001). Contrary to other literature, Florida (2002b) finds that talent, as a proxy for human capital is rather attracted to diversity than standard measures of amenities such as recreation and culture. Also, talent is largely associated with the location of industries in the high technology sector which may raise regional incomes.

It is plausible that the size and characteristics of the labour market in a region affects the probability of migration. A larger labour market tends to be more differentiated since it consists of a larger local demand and can therefore offer more employment opportunities but also a larger diversity. This is especially important if the household consists of more than one adult since then the net family gain rather than the net personal gain is important.

The degree of mobility is also influenced by decentralized tax policies. The regional tax levels affect the expected income level i.e., the likelihood of covering the migration costs and this is true for Sweden and other countries (Day, 1992, Gabriel et al., 1992, Nedomysl, 2004). Haque and Kim (1994) claim that the tax differentials will have an actual effect on the domestic human capital distribution. Commuting, working on a distance and double housing are all substitutes for migration (Hedberg, 2005). These migration alternatives are affected by regional tax differentials. For individuals with a high income even small tax differentials have a large impact on their disposable income why double housing is a better alternative than a change of residential location.

Different sectors demonstrate different demand for highly educated labour depending on their product and production process. Developed sectors have naturally a high demand for individuals with a high level of education. Technology change has shifted the demand away from production labour towards more educated individuals (Berman et al., 1994). It is likely that highly educated individuals are more responsive to changes in local labour demand since they are overall more mobile than less-educated individuals (Schwartz, 1973). Thus, shifts in labour demand have a stronger effect on less educated individuals' wage and employment. When industries agglomerate they tend to attract employers from other sectors as well as from other regions (Puga, 1999).

## **Transaction costs**

Distance is frequently mentioned as an important factor of the probability migration and the relation is often shown to be negative (Schwartz, 1973, Schwartz, 1976). Longer distances between region  $r$ , region of education, and region  $s$ , receiving region, increase the physical costs of moving, amplify the risk of asymmetric information i.e. higher search costs and increase the costs of lost private and professional networks. Schwartz claims that individuals with a higher education can decrease this asymmetric information by using their personal networks and formal education why they tend to move longer distances. Furthermore, individuals with a higher education level are probably better at finding employment opportunities. The search-production function is technologically more efficient when education levels rise.

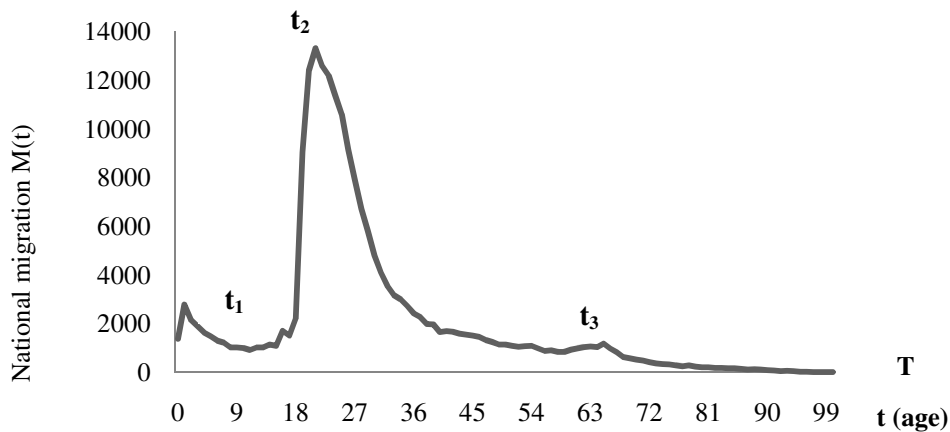
The negative impact of distance is not only true when moving to a region of residence or work but also when moving from region of birth to the region of education. In this aspect, regions that offer possibilities of a higher education have a higher attraction than those regions which do not supply those possibilities<sup>5</sup>. This is why the decision process of labour mobility is slightly more intricate.

## **Personal and social factors**

Eliasson et al. (2003) find two important characteristics of geographical labour mobility. First, inter-regional labour mobility decreases with the access to employment opportunities within the region of origin but also in the neighbouring regions. Second, younger people are more likely to move to their region of work. There is a vast amount of literature on the relation between age and migration and what is of main interest are the different motives along the life cycle. This is expressed diagrammatically in Figure 1. The vertical axis shows the national migration  $M(t)$  and the horizontal axis shows the age  $t$  i.e. finite life time  $T$ . The two peaks in Figure 1 at  $t_2$  and  $t_3$  indicate the median age of the labour force entry and retirement age respectively. The migration rate is very low in the early adolescent years but increases gradually when reaching the age of leaving the family home.  $t_3$  indicates the retirement age.

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<sup>5</sup> Clearly, there are distance courses available which offer the possibility to live in another region than the educational center.



**Figure 1** Relationship between national migration and age (Source: Statistics Sweden)

If the individual seeks to maximize the expected life time earnings age can be considered as a factor of allocation of costs and benefits of migration. Migration would therefore more likely occur when there is enough expected life time until point  $T$  in order to reap benefits to cover the costs of migration (Graves and Linneman, 1979). Fewer remaining periods would therefore imply a lower discounted benefit of migration. A typically young individual at time  $t_2$  has made only minor investments through on-the-job training and relatively large investments in formal education compared to older individuals. Thus, in this aspect aging is a smaller problem for younger individuals. They have a longer life expectancy which increases the present value of the returns to additional investment (Sjaastad, 1962). At time  $t_3$ , migration is not driven by employment possibilities or a higher potential income but rather consumption preferences, reduced travel costs and positive amenities (King et al., 1998). Further explanations to migration patterns rest in the sociological field of research. The social aspects of migration such as younger people seeking denser areas to find city-life and elderly seeking slower pace and beautiful locations such as coastal areas are both examples of this.

Migration as a consequence of a new employment differs between point  $t_1$  and point  $t_3$ . Though, the rate of employment shifts is not constant through time. Individuals change employment more frequently in the initial stage of the career and tend to stabilize over time. Topel and Ward (1988) show in a U.S study that a typical worker changes employer six times during the first ten years at the labour market. Andersson and Thulin (2008) declare similar results for Sweden. The average mobility<sup>6</sup> for individuals aged 16 to 24 is roughly 25 per cent, while for individuals aged 55 to 64 the average mobility is roughly five per cent.

<sup>6</sup> Measured as number of individuals in the labour force that have changed employer standardized with the total number of employees within respective sector.

On a microeconomic level, regional characteristics alone are not sufficient to describe the costs and benefits of migration. It needs to be intertwined with private and professional gains and losses. The private social network is that of family, relatives and friends. It is related to the duration of location in a region but also to a person's age and the purpose of the location. The region may be the native region, a temporary location due to studies, or a new permanent location due to work where a new private network gradually evolves<sup>7</sup>.

The professional network is sometimes described as a community of practice where teams of people are formed and defined by specific knowledge rather than tasks (Wenger, 1997). The growth of electronic and other communication media has facilitated long distance networks but also face to face contacts to exchange experiences and complex knowledge. The friction associated with information transfers in space can actually be negligible but the transfer of knowledge is much more sensitive to such friction (Andersson and Beckmann, 2009). Established knowledge can be spread with only minor friction through books, lecture notes or internet. By contrast, knowledge that is related to a new creative processes is distance sensitive. If knowledge is embedded in people rather than employments or regions the loss of private and professional networks has to be incorporated into the migration decision process.

Numerous sociological studies show that migration patterns differ between men and women. Men tend to move locally while women are more inclined to move longer distances. Frequently, these social factors move the discussion of migration from an individual decision to a family decision (Mincer, 1977)<sup>8</sup>.

## **Hypothesis formulation and modelling framework**

The data in this paper is provided by *Statistics Sweden* and contains data on all individuals residing in Sweden with a two to nine-year higher education in Science, Engineering and Medicine. The data set comprises about 222,000 individuals for the period 1990 to 2000<sup>9</sup>.

The year and region when finishing the highest education can be extracted for each individual. For some individuals the year, region of latest graduation, region of work

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<sup>7</sup> This implies that some individuals prefer to move back to their region of birth but this can unfortunately not be controlled for in the empirical part of this paper.

<sup>8</sup> All family members do not need positive private gain in order for a family to migrate and these differences in private gains may lead to *tied stayers* and *tied movers* (Costa and Kahn, 2000).

<sup>9</sup> The number of individuals varies somewhat over time.

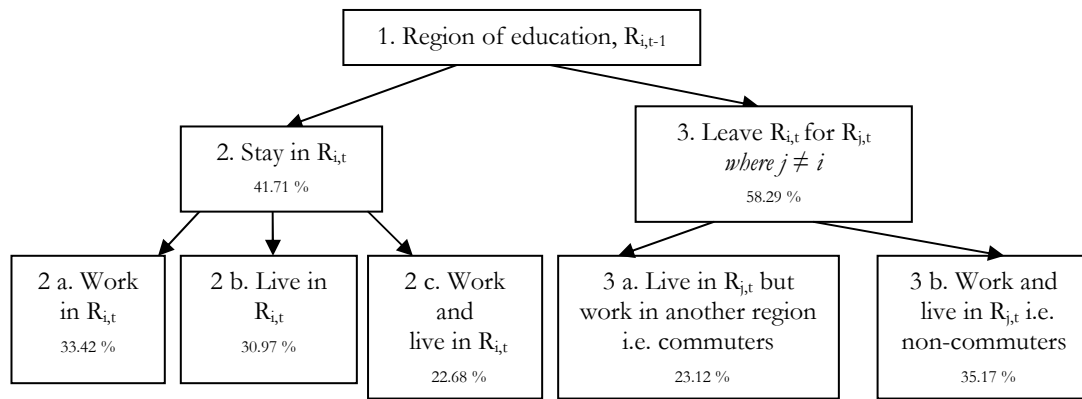
as well as region of living are not available and they are not included in the final data set. Consequently, the final number of individuals in the data set is 142 947.

Out of 289 Swedish regions the region of education, region of living and region of work can all be extracted for all individuals in the data set. This implies that two main groups of individuals are present. First, some have no connection to their region of education. That is, those who live and work in a different region than that of the latest graduation. Commuting can still be done but only between region of work and region of living. Second, some have a connection to their region of education. That is, they could live, work, or live and work in the same region as that of the latest graduation. The income for the individuals is registered in the region of living.

The feasible options for an individual after finishing higher education can be described as a two level choice problem i.e., a nested logit model with two branches (2 and 3) and five choices (2a-c and 3a-b). Hence, an individual has a number of choice sets that can be divided into subgroups conditional upon the previous decision (Greene, 2003, McFadden, 1980). This is illustrated in Figure 2 and visualizes the objectives of the present paper. The first level of decision is whether to stay in the region where the education was conducted or to leave this region and have no relation to it, branch numbered as 2 and branch 3 in Figure 2. Henceforth, the individuals in group 3 are called movers. Movers have a higher average income<sup>10</sup> than those individuals who stay in the region of education, i.e. stayers. The second level is the available choices and these demonstrate the individual inter-regional activity. An individual can either work (2a), live (2b), or work and live (2c) in the region. Due to overlapping options 2a, 2b and 2c do not add up to group 2 i.e., individuals can appear in more than one of the three options. As shown in Figure 2, group 3 can easily be separated into two groups i.e. 3a and 3b. Our focus will be on those individuals who have no relation to their region of education in the time period  $t$ , i.e. movers. In this paper, no further attention is given to whether the individuals commute or not.

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<sup>10</sup> The mean yearly income is 392 143 for movers and 386 806 for stayers.



**Figure 2** Feasible options after finishing higher education

The total income of the individuals has been extracted from the data set<sup>11</sup>. It is further possible to find the status of employment, i.e., unemployed or employed and type of employment. However, it is not possible to discern whether an individual has another source of income than income from employment e.g. income from capital. These individuals have another source of income which is non-observable in the data set. It should also be noted, that it is impossible to distinguish between part-time employment and full-time employment in the data set<sup>12</sup>.

The main hypothesis is constructed below and is followed by three sub-hypotheses related to regional factors, transaction cost and personal and social factors:

*Hypothesis: A higher net present value of future income increases the individual likelihood to move from the region of education.*

In order to shift geographical location the benefits must exceed the costs. Regions that can offer specific employment opportunities for those individuals with higher education are likely to be receiving regions. In order for the employers in these regions to attract individuals with a specific type of education, they must offer an income that covers the costs for inter-regional movers. Also, a newly graduated individual is more prone to shift their employment both geographically and occupationally.

- i) *The characteristics of the receiving region are incorporated into the individual's decision to move.*

<sup>11</sup> Since only the highest education is registered the problem that engineers often have a higher wage level than PhD candidates even if the engineers have a shorter education period is avoided. Since the PhD candidates are not registered during their education but after completing their PhD and are then compensated with a higher wage level this occurrence does not pose any problem in the data set.

<sup>12</sup> One individual is unemployed and has an income lower than the minimum social welfare which is 41,652 SEK. This individual has been assigned this income.

A low income tax is assumed to be an attractive feature for individuals with a high income. The individuals in the data base are highly educated and thus more likely to have a high average income.

The industrial composition in a region influences the probability to move. A region with a large service sector is expected to have a positive influence on the probability to move. A variety of consumer goods and services, as well as functioning public services is regarded as positive amenities that will encourage individuals to move to a region with these characteristics. A large manufacturing sector in a region is also expected to have a positive impact on the probability to move. Individuals with an education in Science and Engineering are most likely to have an occupation in this sector. Individuals with an education in Medicine are less likely to end up in the manufacturing sector.

In addition, living in a metropolitan region gives the individual a higher access to amenities such as culture, restaurants and a variety of shopping. Also, metropolitan areas have large and diverse labour markets which would be attractive for an individual searching for employment.

*ii) Higher transaction costs have negative influence on the likelihood to move.*

The transfer costs of moving consist of two main parts. The first part is the costs of the physical distance. This could be time and money spent on organizing the move from one region to another. The second part is the costs of the social distance. The network built up during their higher education is harder to maintain with a longer distance. Assumingly, an individual is more likely to stay in a region when the social network is established e.g. family and friends.

*iii) Besides regional factors the individual characteristics such as age and gender influence the likelihood to move.*

The relation between age and the probability to move is positive at a diminishing rate. The life cycle hypothesis suggests that individuals in a younger age group are keener to shift their residential location. It is therefore reasonable to assume that age is positively related to the probability to move but only to a certain age where the net present value is lower than the costs of moving i.e. there is a break point illustrating the diminishing returns. There are two main rationales for this phenomenon. First, older individuals tend to build strong social networks such as spouses, children and colleagues which

strengthen the willingness to stay. Second, there are fewer years to obtain a positive net present value with higher age.

Numerous empirical studies show that women are more likely to move longer distances (Pleiborn and Strömquist, 1997, Detang-Dessendre and Molho, 2000). This is clearly a matter of geographical classification. This paper uses functional regions, which can be considered as Local Labour Markets (LLM)<sup>13</sup> for the individuals. Women are therefore assumed to be more likely to move outside of these local markets while men are more likely to stay. Men are also assumed to be more dependent on their local networks which post a higher cost if they decide to leave the region.

### ***Mobility patterns***

The population density varies substantially across Sweden but is clearly the highest in the southern parts. The six functional regions with the largest populations occupy slightly more than eight per cent of the land area but host nearly 50 per cent of the total population. The Stockholm LLM and the Northern parts of Sweden have experienced the largest fluctuations. Between the years 2000 and 2006 the share of immigration decreased in the Stockholm region and increased in northern Sweden.

Table 1 presents the mobility pattern of the individuals referred to as movers subdivided according to educational category<sup>14</sup>, and gender. In general, there are only small variations among the categories. The second column in Table 1 presents the share (in per cent) of individuals that have moved within one LLM. That is, region of education lies within the same LLM as the receiving region. Similarly, the third column presents the share of individuals that live in another LLM than the one they finished their highest education. Column four and five give the average distance moved for the individuals in the two previous columns. The maximum possible distance is constant over time and for all individuals. Hence, it is like an isolated space which makes the variations relatively small<sup>15</sup>.

The last column shows the average number of times the individuals have moved between 1990 and 2000.

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<sup>13</sup> LLM is a geographical classification where smaller geographical units are merged together with respect to the size and direction of commuting patterns.

<sup>14</sup> **Science** (natural science, mathematics and computer science), **Engineering, Medicine, Other** (the individuals not comprised by the other categories i.e. general education, pedagogic and teaching, art subjects, social studies and law, agriculture, services and unknown).

<sup>15</sup> A system following the *principle of conservation*.



**Table 1** Mobility patterns i.e. only *movers*

|                        | $\Sigma$      | Moved<br>within<br>LLM (%) | Moved<br>outside<br>LLM (%) | Average<br>distance<br>inside<br>LLM<br>(km) | Average<br>distance<br>outside<br>LLM<br>(km) | Average no.<br>of times<br>moved<br>1990-2000 |
|------------------------|---------------|----------------------------|-----------------------------|--|---|---|
| <b>All individuals</b> | <b>83,467</b> | <b>19</b>                  | <b>81</b>                   | <b>25.71</b>                                 | <b>344.25</b>                                 | <b>1.13</b>                                   |
| Women                  | 23,438 (28 %) | 20                         | 80                          | 25.14*                                       | 351.28  | 1.23  |
| Men                    | 60,029 (72 %) | 19                         | 81                          | 25.94*                                       | 341.54  | 1.09  |
| <b>Science</b>         | <b>12,352</b> | <b>18</b>                  | <b>82</b>                   | <b>26.67</b>                                 | <b>330.25</b>                                 | <b>1.04</b>                                   |
| Women                  | 4,582 (37 %)  | 20                         | 80                          | 26.28  | 336.80  | 1.27  |
| Men                    | 7,770 (63 %)  | 17                         | 83                          | 26.91  | 326.94  | 0.92  |
| <b>Engineering</b>     | <b>43,191</b> | <b>20</b>                  | <b>80</b>                   | <b>25.32</b>                                 | <b>357.62</b>                                 | <b>1.29</b>                                   |
| Women                  | 6,899 (16 %)  | 19                         | 81                          | 24.18  | 389.03  | 1.64  |
| Men                    | 36,292 (84 %) | 20                         | 80                          | 25.52  | 351.60  | 1.23  |
| <b>Medicine</b>        | <b>24,306</b> | <b>19</b>                  | <b>81</b>                   | <b>25.65</b>                                 | <b>316.56</b>                                 | <b>0.88</b>                                   |
| Women                  | 10,245 (42 %) | 22                         | 78                          | 24.70  | 320.82  | 0.97  |
| Men                    | 14,061 (58 %) | 18                         | 82                          | 26.49  | 313.60  | 0.82  |
| <b>Other</b>           | <b>4,118</b>  | <b>11</b>                  | <b>89</b>                   | <b>29.37</b>                                 | <b>402.86</b>                                 | <b>1.05</b>                                   |
| Women                  | 2,212 (54 %)  | 12                         | 88*                         | 30.31  | 392.52*                                       | 1.10  |
| Men                    | 1,906 (46 %)  | 11                         | 89*                         | 28.17  | 414.71*                                       | 0.99  |

\*The difference between women and men is not statistically significant

The vast majority of the movers move outside the labour market region where they finished their highest education and this is true for all educational categories. The data contains 28 per cent women and 78 per cent men and this skewed distribution is reflected in Science and Engineering. Medicine has a more even distribution between the genders<sup>16</sup>. On average, men and women seem to move equally far when they move within the LLM. However, when an individual decides to move outside the LLM, women tend to move larger distances than men and this is true for all the three main educational categories. The final column presents the average number of times an individual has moved between 1990 and 2000 in each category respectively. The overall mobility over a ten year period is rather low but it is important to stress that intra-urban area mobility is not captured here. Individuals that decide to move from the city centre to the county side in the same urban area are therefore not registered in these results. The average number

<sup>16</sup> A finding that follows employment statistics which shows that a relatively large share employed in the health sector is women.

of times moved is highest for women in Engineering, and women have overall a higher mobility than men.

The three specific educational categories differ in their general characteristics. There are 27 regions that graduated more than 20 students in Engineering, whereas only 17 regions graduated this number of students in Science. The number of regions is even lower for Medicine where only 11 regions graduated more than 20 students and there are only six regions that graduate more than 1 000 students. Clearly, regions with graduation possibilities are unevenly distributed, why freedom of choice is restricted. That is, the decision where to study is restrained due to the limitation in space of that the variety of educational regions. If the educational region is external to the decision where to study, it may affect the decision where to move after graduation. The number of individuals moving back to their region of birth is unknown in the present data set but needs to be reflected upon.

The limitation in the freedom of choice may also be apparent in the first part of the individuals' two-stage decision process since possible regions of work are also limited in space. The structure of the regional labour market may hamper the freedom of choice of where to work after graduation. This is exemplified in the final column in Table 1. The vast majority of employment opportunities in the educational category Medicine are within the public sector and these result in the relatively low figures in the average number of times moved. Two implications are worth mentioning. First, numerous local hospitals act as regional monopolies. This, in addition to that women are to a larger extent hired in the public sector may lead to a distortion of the local labour markets (Rosen, 1996, StatisticsSweden, 2000). This may affect the probability to move but also the wage setting behaviour. Second, there are only eight regions in Sweden that have university hospitals. These locations have all rights reserved to pursue medical education and the majority of research is therefore performed in these specific regions. This may also be an influential factor in the probability to move but also on the income structure within this specific educational category.

Figures 3 to 5 in the Appendix illustrate the geographical distribution of the movers. Figure 3 shows the outflow of individuals from their region of education. There are only 49 regions represented in this figure since not all regions host an institution of higher education. Figure 4 illustrates the inflow of individuals after finishing their higher education. Figure 5 offers an ocular representation of the difference between figures 3 and 4, i.e. the difference between region outflow and region inflow. Those regions with

high negative values have had a larger inflow than outflow. Typically, these seem to be peripheral regions around the largest cities Stockholm, Gothenburg and Malmö. The regions with the highest positive values (large outflow) are regions containing the large universities such as Lund, Gothenburg, Linköping, and Uppsala.

## **Modelling framework and descriptive statistics**

The theoretical framework invites to a Linear Probability Model since the dependent variable is dichotomous. Either the individuals stay in their region of education or they move. All individuals in the data have finished their higher education and have thereafter decided to stay in their region of education or to leave for another region. Here, the decision to move is a binary response variable explained by the individual's chances to earn a high income with a specific education in the receiving region. The linear probability model is describes such as (Cramer, 1991, Greene, 2003, Gujarati, 2003),

$$P_i = E(Y = 1|X_i) = \beta_0 + \beta_1 X_i + \varepsilon_i \quad \text{Eq. 6}$$

,where  $X_i$  is the income for individual  $i$  and is measured as the average income for all individuals living in the receiving region  $s$  with a degree in educational type  $e$ , and  $Y = 1$  means that individual  $i$  has decided to move away from the region of education. If the number of observations is large the properties of the stochastic disturbance term  $\varepsilon_i$  is distributed independently such as  $\varepsilon_i \sim N\left[0, \frac{1}{N_i P_i (1 - P_i)}\right]$ . Hence,  $\varepsilon_i$  follows the normal distribution with zero mean and the variance  $1/[N_i P_i (1 - P_i)]$ .<sup>17</sup> Here, the disturbance term is assumed to correspond to the  $i$ th mover as well as to the observer why the logit model is suitable (McFadden, 1973). The cumulative distribution function of the  $i$ th mover is;

$$P_i = (Y = 1 | X_i) = \frac{1}{1 + [\exp(-(\beta_1 + \beta_2 X_i))]} = \frac{1}{1 + \exp(-Z_i)} + \varepsilon_i \quad \text{Eq. 7}$$

Where the last term illustrates the probability of moving.  $Z_i = \beta_1 + \beta_2 X_i$ ,  $-\infty < Z_i < \infty$ ,  $0 < P_i < 1$  and  $P_i$  is not linearly related to  $Z_i$  i.e  $X_i$  and  $\beta$ . If the last term in Equation 6 indicates the probability of being a mover, the probability of being a

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<sup>17</sup> This implies that the disturbance term is heteroscedastic.

stayer is  $(1 - P_i) \frac{1}{1 + \exp(Z_i)}$  why we can illustrate the odds ratio of an individual being a mover. That is, the ratio between the probability of a mover to the probability of a stayer is;

$$\frac{P_i}{(1 - P_i)} = \frac{1 + \exp(Z_i)}{1 + \exp(-Z_i)} \quad \text{Eq. 8}$$

Given these conditions, OLS is not optimal to estimate the parameters in the model. The standard procedure is to present the odds ratio between the probability to move and the probability to stay. By taking the natural log, Equation 8 presents the Logit model. That is, the log of odds ratio is linear not only in the explanatory variables but linear in the parameters.

$$L_i = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 X_i + \varepsilon_i \quad \text{Eq. 9}$$

Equation 9 represents the logit model that is empirically tested:

$$L_i = \beta_0 + \beta_1 \text{Income}_{ise} + \beta_2 \text{Distance}_{isr} + \beta_3 (\text{Distance}_{isr})^2 + \beta_4 \text{Age}_i + \beta_5 \text{Age}_i^2 + \beta_6 \text{DGen}_i + \beta_7 \text{Tax}_{is} + \beta_8 \text{AccessServcie}_{is} + \beta_9 \text{AccessManuf}_{is} + \beta_{10} \text{AccessAirport}_{is} + \beta_{11} \text{DRank}_{ir} + \varepsilon_i$$

Eq. 10

,where  $L_i$  is the conditional odds of being a mover given the independent variables,  $\text{Income}_{ise}$  is the average yearly income in thousands per region and educational type;  $\text{Distance}_{isr}$  is the distance in 10 kilometres between the region of education  $r$  and the receiving region  $s$  for individual  $i$ . Here, no distinction is made between those individuals working in their residential region and those that commute;  $(\text{Distance}_{isr})^2$  is inserted in order to control for diminishing returns.

$\text{Age}_i$  represents the age of individual  $i$  year 2000;  $\text{Age}_i^2$  is included to control for diminishing effects from aging;  $\text{DGen}_i$  is a dummy variable where 1 represents man and 0 women;  $\text{Tax}_{is}$  is the income tax (in per cent) in the receiving region;  $\text{AccessServcie}_{is}$  is the accessibility to the number of employees in the service sector<sup>18</sup> in the LLM. The conceptual framework for geographic spillovers is based on the knowledge production function of Griliches (1979). Also, a discussion of accessibility

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<sup>18</sup> Standard Identification Code (SIC) 50-55 and 92-93.

and the association to exponential distance decay is available in Weibull (1976) and the accessibility concept is shown in detail in Gråsjö (2005b) <sup>19</sup>.

$AccessManuf_{is}$  is the accessibility to the number of employees in the manufacturing sector<sup>20</sup> in the LLM;  $AccessAirport_{is}$  is the accessibility to the number of total passengers utilizing an airport in the LLM, if the LLM contain an airport;  $DRank_{ir}$ <sup>21</sup> is a dummy variable where 1 represents if the region of education has a university that is included in the ranking list by QS World university ranking<sup>22</sup>, 0 otherwise. Table 2 shows the descriptive statistics for all variables.

**Table 2** Descriptive statistics \*, all variables (movers and stayers) N=142 947

| Variable             | Description  | Mean      | Med.      | St.dev    | Skew. | Min   | Max       | Effect |
|----------------------|--|-----------|-----------|-----------|-------|-------|-----------|--------|
| $Income_{ise}$       | Average yearly income per region and educational type (in thousands) | 389.92    | 394.35    | 62.39     | -0.29 | 41.65 | 636.14    | +      |
| $Distance_{isr}$     | Distance in kilometres between region $r$ and $s$ (in 10 kilometres) | 16.99     | 4.29      | 24.66     | 1.95  | 0     | 173.21    | -      |
| $Age_i$              | Age of individual $i$  | 42.26     | 42.0      | 11.12     | 0.27  | 21.0  | 83.0      | +      |
| $DGend_i$            | Man: 1<br>Woman: 0   | 0.72      | 1         | 0.45      | -0.98 | 0     | 1         | -      |
| $Tax_{is}$           | Income tax in the residential location (in %).                       | 30.0      | 30.25     | 1.44      | -0.25 | 26.5  | 33.12     | -      |
| $AccessService_{is}$ | Accessibility to service living in region $s$                        | 18 809.68 | 15 166.79 | 20 340.43 | 1.21  | 0     | 83 616.77 | +      |
| $AccessManuf_{is}$   | Accessibility to manufacturing living in region $s$                  | 12 177.55 | 12 722.40 | 11 029.04 | 1.30  | 0     | 56 800.83 | +      |
| $AccessAirport_{is}$ | Accessibility to airports living in region $s$                       | 383 935   | 280 695.3 | 445 006.2 | 1.43  | 0     | 2 643 759 | +      |
| $DRank_{ir}$         | Rank of university   | 0.61      | 1         | 0.49      | -0.43 | 0     | 1         | +      |

<sup>19</sup> For further readings see (Andersson and Johansson, 1995, Gråsjö, 2005b, Gråsjö, 2005a, Johansson et al., 2003, Weibull, 1976)

<sup>20</sup> Standard Identification Code (SIC) 15-37.

<sup>21</sup> There are no abnormally high bivariate correlations between the variables.

<sup>22</sup> <http://www.topuniversities.com/university-rankings>

|             |  |  |  |  |  |  |  |
|-------------|--|--|--|--|--|--|--|
| Rank: 1     |  |  |  |  |  |  |  |
| 0 otherwise |  |  |  |  |  |  |  |

\*The tax level it set on a municipal level while all other regional factors are observed for the local labour market region.

The data solely contain individuals with a higher education in Science, Engineering and Medicine and we can therefore assume that we have no problem with unobserved heterogeneity. Individuals with a lower degree of education or no education at all are not included and we cannot apply inferences in the present analysis on this group (Heckman, 1979).

Table 3 presents the results of the logit estimations for all individuals and all educational categories respectively. The fifth column is the results for the group named *Other*. The number of observations in this last group is slightly more than four per cent of all observations and it is a heterogeneous group in terms of education why little emphasize will be put on this group.

Table 3 reports  $\beta$ -coefficients, z-values and the odds change. According to preceding expectation, the average income per region and educational type  $Income_{ise}$  is positive for *All individuals*, *Science*, and *Engineering*. Individuals with a degree in any of these categories are more likely to move away from their region of education if the average income (in thousand SEK) in this region for the specific education is high. *Medicine* diverges from this with a negative relationship. As earlier mentioned the number of regions offering education in Medicine is lower than for any of the other educational categories. In addition to this, the largest seats of learning also host the university hospitals in Sweden<sup>23</sup>. The health sector in Sweden is a public sector and it is likely that the majority of individuals with a very long education also end up in these regions where they accordingly would have a higher income. These results highlight that even though income has a positive effect on the probability to move; in comparison to other factors it plays only a minor role in the decision process. The limited amount of possible working regions for individuals in *Medicine* is also reflected by the physical distance variable  $Distance_{isr}$ . This is positive with a diminishing effect for all categories but is slightly higher in *Medicine*. The decision to move away from the region of education has been preceded by the decision stay or move away from their region of birth. Here we can only observe the region of education why we cannot observe whether the individuals actually decide to move back to their region of birth after graduation. Since education takes place

<sup>23</sup> Following locations have university hospitals: Uppsala, Stockholm (Huddinge and Solna), Umeå, Gothenburg, Skåne (Lund and Malmö), Linköping and Örebro.

during only a limited period of time in an individual's life cycle, he/she may not be reluctant to move a long distance to find an education that corresponds to his/her preferences.

The variable  $Age_i$  is positive for all groups. Individuals in *Medicine* have a much higher break point (age 67) compared to *Science* (age 37) and *Engineering* (age 20). This break point signifies where the effect of ageing becomes negative on the probability to move. A late break point may reflect a decision to shift residential location after retirement age illustrated as  $t_3$  in Figure 1.

Gender,  $DGend_i$  indicates if the individual is a male mover or not and is negative for all but *Engineering*. This is consistent with earlier empirical research suggesting that men tend to move locally while women move longer distances (Pleiborn and Strömquist, 1997, Detang-Dessendre and Molho, 2000). The positive coefficient is therefore most likely due to the male dominance. The gender variable varies across educational categories. *Science* has the lowest factor change in odds,  $e\beta$  with a value of 0.82. Hence, the odds for males to move are 0.82 times lower than the odds for females in this educational category. The opposite holds for the educational category *Engineering* with a value 1.06. The odds for males to move are 1.06 times higher than for females with this type of education.

Four regional location factors have been implemented into the analysis. The income tax is applied as a proxy for a residence location factor affecting the income level in a direct way which can be easily observed by the individual. A higher regional percentage rate of income tax is disadvantageous to that specific region in terms of attracting graduates. We assume that the highly educated labour in the data set search for regions where they maximize their disposable income. Then, tax is an essential decision variable. The factor change in odds is lowest for those individuals with a degree in *Medicine* with a value 0.76. This implies that one-unit increase in income tax lowers the probability to move to this specific region by 24 per cent. For individuals with a degree in *Science*, this has a smaller impact on the decision to move since the factor change in odds is 0.86. That indicates a 14 per cent lower probability to move when the income tax is increased by one unit.

The residence decision is not only influenced by the local factors such as the tax level but also by the characteristics of region  $s$ . The accessibility to services  $AccessService_{is}$ , is positive for all groups and has the largest effect in *Medicine* and the smallest effect in *Engineering*. A large service sector reflects a large share of retail and

whole sale trade, hotel and restaurants, recreation, culture and sport activities. All these factors are for most individuals considered as positive amenities and increases therefore the probability to move. The accessibility to the manufacturing sector  $AccessManuf_{iS}$  is also positive for all groups but has a slightly larger value for *Engineering*. A large share of manufacturing in a region represents employment opportunities for individuals with an education, in especially *Science* and *Engineering*. Individuals with an education in *Medicine* should have a lower interest of employment in this sector.

The accessibility to airports  $AccessAirport_{iS}$  is actually negative for all groups which could be cumbersome to explain. However, two reasonable explanations can be presented. First, those individuals with a job that requires numerous business journeys, or those that divide their lives between two locations prefer other means of transportation. Second, the decision to move may have the purpose of having an employment where less commuting and travelling are involved.

Whether or not the university is ranked among the top 500 universities  $DRank_{iU}$  is positive for all groups. The impact is largest for *Medicine* which may be a result of the fact that all university hospitals besides Örebro are among the top world 500 universities. That means that only a minority of individuals in *Medicine* has an education from a non-ranked university.



**Table 3** Logit estimations for each educational category respectively, Dependent variable:  $L_i$ , conditional odds of being a mover

|                       | All<br>Individuals   |                           | Science              |                           | Engineering          |                           | Medicine              |                           | Other                |                           |
|-----------------------|----------------------|---------------------------|----------------------|---------------------------|----------------------|---------------------------|-----------------------|---------------------------|----------------------|---------------------------|
|                       | $\beta$ -Coef.       | Odds <sup>†</sup>         | $\beta$ -Coef.       | Odds <sup>†</sup>         | $\beta$ -Coef.       | Odds <sup>†</sup>         | $\beta$ -Coef.        | Odds <sup>†</sup>         | $\beta$ -Coef.       | Odds <sup>†</sup>         |
|                       | <i>(z-value)</i>     |                           | <i>(z-value)</i>     |                           | <i>(z-value)</i>     |                           | <i>(z-value)</i>      |                           | <i>(z-value)</i>     |                           |
| $Income_{ise}$        | 9.02e <sup>-4</sup>  | <b>9.0e<sup>-4</sup></b>  | 0.005                | <b>5.4e<sup>-3</sup></b>  | 0.003                | <b>2.6e<sup>-3</sup></b>  | -0.009                | <b>-9.0e<sup>-3</sup></b> | 4.37e <sup>-5</sup>  | <b>**</b>                 |
|                       | <i>(5.53)</i>        |                           | <i>(6.99)</i>        |                           | <i>(8.32)</i>        |                           | <i>(-12.13)</i>       |                           | <i>(0.03)</i>        |                           |
| $Distance_{isr}$      | 0.52                 | <b>0.68</b>               | 0.46                 | <b>0.58</b>               | 0.48                 | <b>0.62</b>               | 0.70                  | <b>1.01</b>               | 0.45                 | <b>0.56</b>               |
|                       | <i>(140.44)</i>      |                           | <i>(60.77)</i>       |                           | <i>(96.99)</i>       |                           | <i>(73.51)</i>        |                           | <i>(28.75)</i>       |                           |
| $(Distance_{isr})^2$  | -3.42e <sup>-3</sup> | <b>-3.4e<sup>-3</sup></b> | -3.18e <sup>-3</sup> | <b>-3.2e<sup>-3</sup></b> | -3.19e <sup>-3</sup> | <b>-3.2e<sup>-3</sup></b> | -4.18e <sup>-3</sup>  | <b>-4.2e<sup>-3</sup></b> | -3.36e <sup>-3</sup> | <b>-3.3e<sup>-3</sup></b> |
|                       | <i>(-118.21)</i>     |                           | <i>(-47.69)</i>      |                           | <i>(-87.19)</i>      |                           | <i>(-67.85)</i>       |                           | <i>(-23.61)</i>      |                           |
| $Age_i$               | 0.02                 | <b>0.02</b>               | 0.007                | <b>7.3e<sup>-3</sup></b>  | 0.002                | <b>2.1e<sup>-3</sup></b>  | 0.04                  | <b>0.04</b>               | -0.02                | <b>-0.02</b>              |
|                       | <i>(2.69)</i>        |                           | <i>(0.46)</i>        |                           | <i>(0.23)</i>        |                           | <i>(2.34)</i>         |                           | <i>(-0.86)</i>       |                           |
| $Age^2_i$             | -5.43e <sup>-5</sup> | <b>-1.0e<sup>-4</sup></b> | 9.31 e <sup>-5</sup> | <b>1.0e<sup>-4</sup></b>  | 5.00 e <sup>-5</sup> | <b>**</b>                 | -2.97 e <sup>-4</sup> | <b>-3.0e<sup>-4</sup></b> | 2.88e <sup>-4</sup>  | <b>3.0e<sup>-4</sup></b>  |
|                       | <i>(-0.76)</i>       |                           | <i>(0.53)</i>        |                           | <i>(0.47)</i>        |                           | <i>(-1.80)</i>        |                           | <i>(1.09)</i>        |                           |
| $DGend_i$             | -0.17                | <b>-0.15</b>              | -0.22                | <b>-0.20</b>              | 0.06                 | <b>0.06</b>               | -0.08                 | <b>-0.08</b>              | -0.25                | <b>-0.22</b>              |
|                       | <i>(-8.42)</i>       |                           | <i>(-4.69)</i>       |                           | <i>(1.80)</i>        |                           | <i>(-2.04)</i>        |                           | <i>(-2.52)</i>       |                           |
| $Tax_{is}$            | -0.16                | <b>-0.14</b>              | -0.15                | <b>-0.14</b>              | -0.05                | <b>-0.05</b>              | -0.27                 | <b>-0.24</b>              | -0.09                | <b>-0.09</b>              |
|                       | <i>(-15.97)</i>      |                           | <i>(-5.84)</i>       |                           | <i>(-3.50)</i>       |                           | <i>(-12.47)</i>       |                           | <i>(-1.90)</i>       |                           |
| $AccessServic_{is}$   | 3.25e <sup>-5</sup>  | <b>**</b>                 | 3.14e <sup>-5</sup>  | <b>**</b>                 | 2.44e <sup>-5</sup>  | <b>**</b>                 | 5.80e <sup>-5</sup>   | <b>1.0e<sup>-4</sup></b>  | 2.41e <sup>-5</sup>  | <b>**</b>                 |
|                       | <i>(24.12)</i>       |                           | <i>(9.33)</i>        |                           | <i>(13.41)</i>       |                           | <i>(17.54)</i>        |                           | <i>(3.00)</i>        |                           |
| $AccessManuf_{is}$    | 1.32e <sup>-5</sup>  | <b>**</b>                 | 1.43e <sup>-5</sup>  | <b>**</b>                 | 1.45e <sup>-5</sup>  | <b>**</b>                 | 1.13e <sup>-6</sup>   | <b>**</b>                 | 2.35e <sup>-5</sup>  | <b>**</b>                 |
|                       | <i>(6.63)</i>        |                           | <i>(3.05)</i>        |                           | <i>(5.31)</i>        |                           | <i>(0.24)</i>         |                           | <i>(2.00)</i>        |                           |
| $AccessAirport_{is}$  | -1.07e <sup>-6</sup> | <b>**</b>                 | -9.28e <sup>-7</sup> | <b>**</b>                 | -9.59e <sup>-7</sup> | <b>**</b>                 | -1.34e <sup>-6</sup>  | <b>**</b>                 | -5.78e <sup>-7</sup> | <b>**</b>                 |
|                       | <i>(-35.30)</i>      |                           | <i>(-12.41)</i>      |                           | <i>(-24.439)</i>     |                           | <i>(-19.73)</i>       |                           | <i>(-3.46)</i>       |                           |
| $DRank_{ir}$          | 0.53                 | <b>0.70</b>               | 0.69                 | <b>1.00</b>               | 0.50                 | <b>0.65</b>               | 0.77                  | <b>1.17</b>               | 0.03                 | <b>0.03</b>               |
|                       | <i>(19.56)</i>       |                           | <i>(10.86)</i>       |                           | <i>(13.57)</i>       |                           | <i>(11.24)</i>        |                           | <i>(0.25)</i>        |                           |
| $\beta_0$             | 1.06                 |                           | -0.67                |                           | -2.36                |                           | 7.67                  |                           | 1.09                 |                           |
|                       | <i>(3.12)</i>        |                           | <i>(-0.71)</i>       |                           | <i>(-4.42)</i>       |                           | <i>(9.54)</i>         |                           | <i>(0.64)</i>        |                           |
| N                     | 142 947              |                           | 23 261               |                           | 76 717               |                           | 37 126                |                           | 5 843                |                           |
| Pseudo R <sup>2</sup> | 0.59                 |                           | 0.59                 |                           | 0.57                 |                           | 0.66                  |                           | 0.62                 |                           |

†Odds change i.e., change in the odds for a unit increase in the regressor (percentage change is obtained by multiplying by 100)

\*\* Odds change is smaller than 1.0e<sup>-5</sup>

## Summary and Conclusion

This paper analyses the highly educated individuals and their decision on whether to stay or leave their region of education. The probability to move is estimated as logit functions using a rich micro-data base. All individuals with at least two years of higher education within *Science*, *Engineering*, and *Medicine* are comprised in the data set. Estimations on individuals in each group respectively indicate differences with respect to how the explanatory variables influence the probability to move from the region of education.

The results highlight that even though income has a positive effect on the probability to move; in comparison to other factors it plays only a minor role in the decision process. A plausible explanation may be the wage setting system in Sweden where there are relatively small differences in wages. Instead, there seems to be two main groups of underlying reasons behind the decision to move. First, the socio-biological factors Gender and Age have a relatively larger impact on the decision to move. Men are more inclined to stay in the local market with the built up network. Also, age is an explanatory factor even though it differs only slightly between the educational categories. Second, the income tax reflects regional factors that attract these educational categories. The tax rate influences negatively the probability to move. The relatively large service and manufacturing sector have both positive influences on the probability to move since these reflect positive amenities and employment opportunities.

The rich data set allows for taking the analysis even further by including marital status of the individual and the type and status of the family. This would enhance the understanding of socio-biological decision factors of migration.

Mobility has an intrinsic spatial complexity which, for the purpose of this paper requires a brief discussion. The migration decision of an individual also incorporates the possibility to move to a specific location while working at another location. A region with a well functioning transportation network would allow an individual to widen the search area of housing as well as employment opportunities. This could possibly be true for dense metropolitan areas with a diverse labour market but where the rents are high. This is a matter of future studies.

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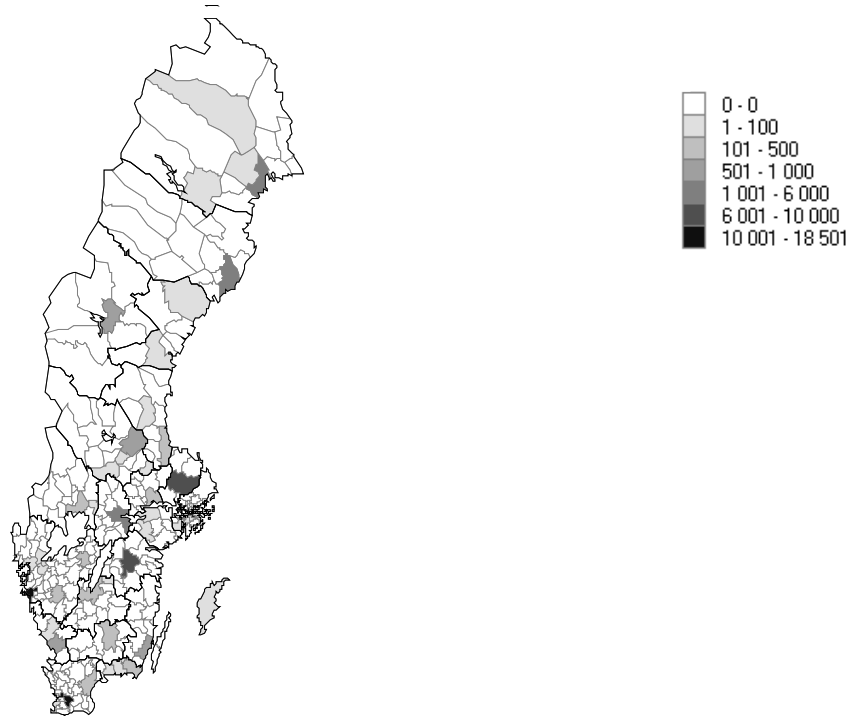
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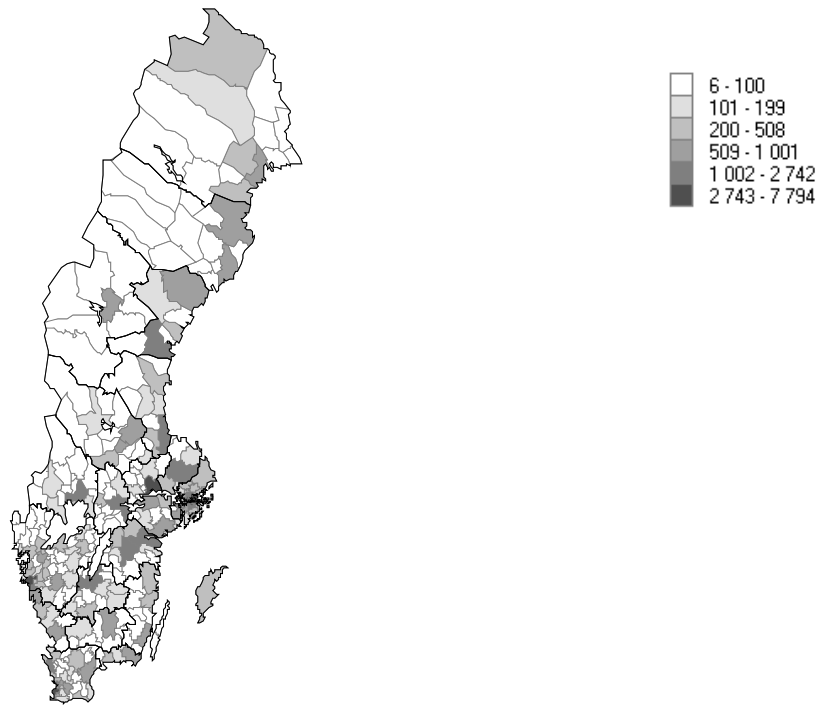
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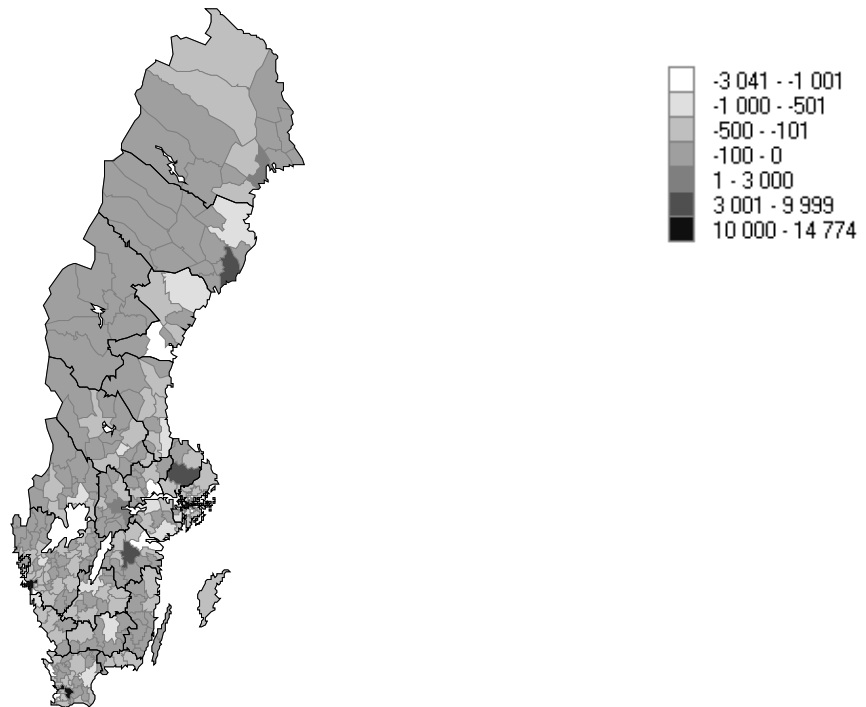
# Appendix



**Figure 3** Outflow from region with an educational institution.



**Figure 4** Inflow into receiving regions<sup>24</sup>



**Figure 5** Difference between outflow and inflow

<sup>24</sup> All regions are represented. The number of individuals is not the same in Figure 5 as in Figure 6. There are 713 individuals fewer in Figure 6 than in Figure 5 which can be a result of individuals emigrating.