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Disability and labor market outcomes in Sweden

Controlling for skill

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Author: Elvira Andersson

Supervisors: Inga Persson, Dan-Olof Rooth

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Abstract

In this thesis, employment and earnings differentials between visually or hearing-impaired and non-disabled Swedish workers are analyzed. The thesis investigates whether there are any differences and if so, how large, in the earnings and the employment probabilities of the visually or hearing-impaired and the non-impaired on the Swedish labor market. Due to the detailed measures of visual acuity and hearing capacity provided by the data, a great degree of differentiation between different degrees of impairment is made.

Acknowledging the possibility of investments in schooling being affected by actual or perceived labor market discrimination, a cognitive test score is used as an alternative measure of skill that is likely to be exogenous. A pooled sample is used to estimate differences in employment probability and earnings between individuals with various degrees of impairment, using the test score as the main explanatory variable.

The results indicate that the degree of impairment is negatively related to both employment probability and earnings for both groups, although the differentials are small in most cases. Productivity differentials are likely to account for the main part of the employment and earnings gaps, while discrimination does not seem to have a substantial impact.

Keywords: Ability, discrimination, disability, earnings, employment

1. Introduction

The labor market opportunities of disabled people have been a matter of debate for a long time and most industrialized countries have recognized the need for effective policies to facilitate their labor market participation and prevent discrimination against them. There is extensive evidence that the earnings as well as the employment rates of disabled people are lower than those of the able-bodied (e.g. Statistics Sweden 2007, SOU 2001:56, Currie and Madrian 1999) but little proof on the reasons for this. Although there is a widespread belief that disabled people, in addition to the difficulties caused by their impairments, face discrimination in the labor market, few studies have been done to detect or measure the extent of such discrimination.

1.1 Aim of the study

The reasons behind disabled people's lower earnings and lower employment rates determine the efficiency of different kinds of policies intended to strengthen the labor market position of the disabled. If discrimination is believed to be the main cause of the weak labor market position of the disabled there may be a need to strengthen anti-discrimination policies, while public disability insurance policies would be a better solution to these issues if the lower earnings and employment rates of the disabled are mainly due to lower productivity caused by their impairments. Baldwin and Johnson (1994) also note that economic incentives may be more efficient in creating job opportunities for the disabled than anti-discrimination legislation if the main reason for not hiring them is the requirement of costly job-modifications.

The aim of this thesis is to shed light on the employment and earnings gaps between the disabled and the able-bodied. The focus is specifically on young men suffering from visual or hearing impairments. The thesis thus investigates whether there are any differences and if so, how large, in the earnings and the employment probabilities of the visually or hearing-impaired and the non-impaired on the Swedish labor market. Further, it studies if there are any indications of labor market discrimination against disabled workers. Absolute knowledge about the causes of the weak labor market situation of the disabled is generally not feasible, since identifying causal effects is often very difficult in social sciences. Correlations between impairments and variables that measure labor market success can, however, indicate connections between them and provide a basis for potential policy improvement.

1.2 Method and data

Earlier studies, using a set of standard control variables such as age, years of schooling, marital status etc. (e.g. Johnson and Lambrinos 1985, Baldwin and Johnson 1994, Skogman-Thoursie1999a, 1999b, DeLeire 2001), have not been able to account for the entire wage differential between disabled and non-disabled workers. Kidd et al (2000) also find that a substantial share of the labor market participation gap remains unexplained when controlling for a standard set of control variables. This suggests that either discrimination or unobserved differences in productivity or a combination between these two factors causes the earnings gap between disabled and able-bodied workers.

This thesis adds to the earlier studies both by studying differences in labor market outcomes between individuals suffering from different degrees of the same type of impairment and by explicitly controlling for cognitive ability, as measured by the result on the Swedish Military Enlistment Battery (henceforth SME) Test. This improves the possibility of separating the effects of differences in productivity from discrimination. I follow an approach used by Neal and Johnson (1996), who use a similar cognitive test score, the Armed Forces Qualification Test, as the main predictor of the income gap between black and white workers in the United States. Neal and Johnson (1996) argue that many of the observed productivity characteristics that are traditionally treated as exogenous in studies of wage gaps between different groups of workers should instead be treated as endogenous. Since variables such as post-secondary schooling, labor market experience, occupation, marital status and geographical location are subject to worker choice and therefore are partly based on expectations of future pecuniary returns, they could be affected by actual or perceived labor market discrimination. Therefore, controlling for these variables could lead to a biased estimate of labor market discrimination. To avoid this bias, the authors suggest estimating reduced-form wage equations that only include variables that are exogenous or determined before labor market entry. In this way, the resulting estimate of the wage differential also includes the effects of the previously mentioned endogenous variables. Unlike Neal and Johnson, I also use the cognitive test score variable to analyze the difference in employment probability between disabled and non-disabled workers. For this purpose, I use a probit model where the marginal effects of different degrees of impairments on the probability of having a job are estimated, conditional on the

SME test results. Studying both labor market outcomes is important as their combined effects may have a substantial impact on the overall welfare of disabled people.

The data set is constructed by integrating register data from Statistics Sweden (SCB) and the Swedish National Service Administration (Pliktverket). The sample consists of 730,599 Swedish-born male workers who were 25-38 years old in 2003. The number of females and immigrant men taking the SME test is limited and, at least for women, selective. The specific age group is chosen because of the large amount of data available from the Swedish National Service Administration from the years 1984-1997. The data is financed through a research grant from the Swedish Council for Working life and Social Research (FAS), which is gratefully acknowledged. The thesis is part of the project “Ethnic discrimination and Swedish-specific human capital”.

1.3 Outline

After this introduction, chapter 2 presents the background of the problem. Definitions of disability-related concepts are presented and an overview of the legal framework surrounding disabled people’s labor market situations is given. In chapter 3, the theoretical framework is presented. Human capital theory and discrimination theory are discussed as complementary theories. An overview of previous research in the labor market outcomes of disabled workers is given in chapter 4. Chapter 5 introduces the data. In chapter 6, descriptive statistics for the sample is presented and the labor market characteristics of the sample groups are discussed. The empirical models are presented in chapter 7. In chapter 8 the results of the empirical study are presented. These are further discussed in chapter 9, which concludes the thesis.

2. Background

Many factors interact to determine the labor market behavior of employers and disabled workers. Anti-discrimination laws and labor market policies that are designed to improve the labor market situation of disabled workers provide incentives that affect both labor supply and demand. The concept of disability is also rather complex, as different types and degrees of impairments could have different effects on labor market outcomes.

2.1 Defining disability

In order to differentiate between various types of physical effects and labor market outcomes, it is necessary to distinguish between some terms that are sometimes used synonymously. In 1980 the World Health Organization developed an international classification that clearly separates the concepts of impairment, disability and handicap and that has become widely accepted. *Impairment* is, according to this classification, a psychological, anatomical, or mental loss, or some other abnormality. *Disability* is any restriction on, or lack of, ability to perform an activity in the manner, or within the range, considered normal. *Handicap* is a disadvantage resulting from impairment or disability (WHO 1980). A person who suffers from hearing loss but whose profession does not require good hearing is according to these definitions impaired but not work disabled. If employers are prejudiced against people with hearing loss, however, this will handicap this person, even though he/she is not disabled. Hence, according to this classification, discrimination is in itself a handicapping factor.

Although Sweden has adopted the WHO definitions, several Swedish authorities use definitions of disability that emphasize the relation between the disabled individual and the environment, stating that ”[a] handicap exists because the environment is not so adjusted that the individual can perform the particular activity as well as a non-disabled person” (Skogman-Thoursie 1999a:3). This definition seems to put a larger responsibility on society to adjust to the needs of the disabled than does the WHO definition.

2.1.1. Visual impairments

The WHO definition of *visual impairment* includes *low vision* and *blindness*. Low vision is defined as visual acuity between 30% (6/18) and 3/60 of full vision or a corresponding visual field loss to less than 20 degrees, in the better eye with best possible correction. Blindness is defined as visual acuity of less than 3/60 or a corresponding visual field loss of 20 degrees or more in the better eye with best possible correction (WHO 1998). Visual impairments that are less severe than the WHO definition could still cause restrictions on the daily life and labor market opportunities of the impaired individual, as many common activities require good vision.

2.1.2 Hearing impairments

The type of *hearing impairment* concerned in this thesis is *hearing loss*, as this is the only type that is measured by the SME test. According to the WHO definition an individual is hearing-impaired if he/she can, as an average of the frequencies 500, 1000, 2000 and 4000 Hz, hear sounds at 26 dB or more with the better ear without hearing aids. The hearing impairment is classified as disabling if the person can only hear sounds at 41 dB or more (WHO 2008). Deafness is defined as complete inability to hear on one or both ears (WHO 2006). Hearing loss is in general possible to ameliorate by hearing aids. Even deafness can in most cases be improved through the use of cochlear implants.

2.2 Disability and work in Sweden

A considerable share of the Swedish work force consists of disabled workers. In a yearly general living conditions survey (ULF) 2006, 15.7% of the working-age population (those aged 16-64) reported being disabled. This group generally has a relatively weak labor market position compared to the non-disabled. Disabled individuals are on average less likely to be labor market participants, more likely to be unemployed and tend to have a lower education level than the able-bodied population. Additionally, a significantly larger share of the disabled workers work part time compared to the non-disabled.

Among the disabled population, 16,000 individuals, corresponding to 0.3% of the working-age population, were deaf, 79,000 persons, which equals 1.4% of the working-age population, suffered from hearing impairments and 57,000 individuals, which corresponds to 1.0% of the working-age population, suffered from a visual impairment or blindness. The prevalence of these impairments increases with age, resulting in these groups having a higher average age than the able-bodied population. The visually or hearing-impaired groups appear to fare relatively well in the labor market compared to individuals suffering from other types of impairments, e.g. psychological or muscular or skeletal impairments. 82.9% of the deaf or hearing-impaired and 69,5% of the blind or visually impaired were labor market participants, compared to 80% of the able-bodied working-age population and 67% of the total disabled population. Except for the hearing-impaired, the employment rates of these groups were lower than those for the non-disabled population. In 2006, 71.3% of the deaf, 80.8% of the hearing-impaired and 63.0% of the visually impaired or blind were employed, compared to 77% of the non-disabled population. Additionally, these groups have lower average education levels than the non-disabled, which could have adverse effects on their labor market situation. Thus, the labor market situations of the visually and hearing-impaired appear to be reduced compared to the non-disabled, although considerably better than that for individuals suffering from many other types of impairments (Statistics Sweden 2007, SOU 2001:56).

2.3 Legal protection of disabled workers

Most industrialized countries have policies to facilitate labor market participation and prevent discrimination of disabled people. In Sweden, the Prohibition of Discrimination Act and the Prohibition of Discrimination in Working Life of People with Disability Act protect disabled workers' rights. These acts prohibit direct and indirect discrimination and harassment of disabled people and their family members by employers. The working life situations covered include hiring, firing, promotion, wage setting, assignments, further education and working environmental issues. Employers are also required to provide reasonable support and adaptation measures to create equivalent situations for disabled and non-disabled workers. The acts cover a broad range of impairments that can be expected to lead to disability in the present or future, such as visual and hearing impairments, allergies, dyslexia, HIV etc. The degree of impairment is not regarded, i.e. even mildly impaired individuals are covered (Prohibition of Discrimination Act, Prohibition of Discrimination in Working Life of People with Disability Act, The Swedish Disability Ombudsman).

3. Theoretical framework

Individual and group differences in labor market outcomes are determined by the interaction between supply and demand side factors. Supply side theory, represented by the human capital approach, explains differences in wages and employment possibilities as a result of individual characteristics and choices, while demand side theory focuses on opportunity differences due to discrimination. Therefore, one has to control for differences in individual characteristics related to the supply side of the labor market to detect discrimination. These supply side factors could, however, in turn be affected by discrimination.

3.1 Human capital theory

Human capital theory, which was originally developed by Becker (1964) and Mincer (1974), is the standard neoclassical supply side framework for analyzing individual wages and labor supply. Individual productivity is assumed to determine wages. In the traditional human capital framework, the standard productivity measure used is the person's human capital stock, roughly measured by the amount of schooling and labor market experience. Individuals invest in productivity-enhancing activities, such as education, by direct outlays as well as by foregoing potential earnings for a period of time in return for higher future earnings.

Other variables, such as health or disability status, may also affect productivity and may thus be included in the model. Unobserved characteristics, such as ability and motivation, are also important determinants of productivity. Since reliable measures of these variables are usually not available, their effects are generally unknown. This causes some uncertainty about to what extent the remaining differences in labor market outcomes after controlling for observed characteristics are actually caused by differences in unobserved characteristics and to what extent they have to be attributed to demand side factors.

The decision to work is assumed to be determined by the person's *reservation wage*, e.g. the lowest wage for which he/she is willing to work. Since individuals can underbid each other with respect to reservation wages and since the market is assumed to supply job opportunities to anyone with a sufficiently low reservation wage, unemployment is non-existent in the model. All non-employment is viewed as non-labor market participation due to high reservation wages (Polachek and Siebert 1993).

This theory is, however, based on the assumption of a non-regulated, perfectly competitive labor market. In reality, labor market regulations and unionization prevent employers from extensively differentiating individual wages. Actual wages may thus be higher than the value of some workers' marginal products. Employers do not want to hire these individuals although they are willing to work at the going wage, which results in unemployment. Pay-roll taxes may have similar effects as they simultaneously raise the gross wages paid by employers and lower the net wages received by employees.

3.2 Discrimination theory

On the demand side, the main explanation of differences in earnings and job attainment is labor market discrimination, defined as the unequal treatment of individuals with the same productivity. This is reflected by differences in wages or unequal job opportunities. There are two different types of approaches, *taste discrimination* and *statistical discrimination*, in economic theory. Although these are two distinctly different concepts they have similar consequences and it is very difficult to distinguish empirically between their respective effects. Even in experimental studies, where employer behavior can be directly observed, determining which type of discrimination is prevalent could be extremely difficult (see i.e. Carlsson and Rooth 2007).

3.2.1 Taste discrimination

The theory of taste discrimination, which was first developed by Becker (1957), states that discrimination occurs as a result of prejudice against certain groups of people. In the case of *employer discrimination* against disabled workers, prejudiced employers require a compensatory economic differential for the disutility of hiring disabled individuals. Therefore, they are not willing to hire disabled workers at the same wage rate as equally productive non-disabled workers (Borjas 2005:359, Skoglund-Thoursie 1999a:20). The compensation required is equal to the *discrimination coefficient*, d, which is a monetary measure of the disutility caused by hiring the disabled person. If the actual wage rate for a disabled worker is w_d, the employer acts like it is $w_d(1 + d)$, thus incorporating his/her prejudice into the wage function. Because of this, the employer is only willing to hire disabled individuals if $w_d(1 + d) \leq w_n$, where w_n is the wage rate for non-disabled workers.

The end result of employer discrimination depends on the total demand and supply of disabled workers in the economy. If there are enough non-discriminatory employers to hire all the disabled workers, discrimination leads to labor market segregation. If the demand by non-discriminatory employers is not large enough to absorb the supply of disabled workers, discrimination also results in lower wages for the disabled group. The wages offered to disabled workers may be reduced below the reservation wage rate of some individuals, thus reducing the employment rate of the disabled (Borjas 2005:356-366).

Taste discrimination can also be the result of co-worker or customer preferences against the disabled. Prejudiced co-workers perceive their wages, w_c, to be less than they actually are, corresponding to $w_c(1 - d)$. Therefore, they require higher wage rates to compensate for the disutility of working with disabled people. Similarly, prejudiced customers perceive the price of a good that is produced or sold by disabled workers as $p(1 + d)$, i.e. as more expensive than its actual price, p. They are therefore only willing to pay less for this good than for a similar good produced or sold by non-disabled individuals. Co-worker and customer discrimination may affect the behavior of employers, who demand compensation for the loss caused by discrimination by lowering the wages for the disabled group. This could, just like employer discrimination, result in both segregation and wage differentials. (Bosworth et al 1996).

Employer taste discrimination is, however, a costly business. Neoclassical theory implies that, provided that the economy is perfectly competitive, discriminatory employers will eventually go out of business, as non-discriminatory employers, who hire whichever group is cheaper, will be able to produce the same amount of output at a lower cost. In less than perfect competition, however, taste discrimination by employers may be sustainable (Björklund et al 2006:149-150). Thus, the existence of employer taste discrimination is an empirical issue.

3.2.2 Statistical discrimination

Statistical discrimination, as modeled by Phelps (1972) and Aigner and Cain (1977), originates in rational behavior and not in prejudice against the discriminated group. This type of discrimination may occur when information about individual productivity or costs of hiring and training are difficult or expensive to obtain. The employer may then try to estimate individual productivity as the average productivity of the group the person belongs to. If disabled people are (correctly or incorrectly) perceived as being on average less productive or more expensive to hire and train than able-bodied people, disabled people as a group are likely to be offered lower wages and fewer job opportunities than the non-disabled. If the employer estimates average group productivity correctly, the members of each group are *on average* offered wages corresponding to their productivity and their hiring and training costs although the wages of the *individual* workers may be both positively and negatively affected by the statistical discrimination (Borjas 2005:370-373, Skoglund-Thoursie 1999b:4).

Statistical discrimination may also occur when information on the productivity of a certain group is more difficult or expensive to obtain than that of others. A risk-averse employer may respond to this by not hiring individuals from the group where the uncertainty about productivity is larger (Björklund et al:151).

Since statistical discrimination originates in rational behavior and not in prejudice towards certain groups, it can be reduced by improved information (Johnson and Lambrinos 1985:265, Skoglund-Thoursie 1999a:20). However, if employers estimate group productivity correctly, statistical discrimination is profitable for the firm. Thus, statistical discrimination does not have a tendency to erode itself, like employer taste discrimination.

3.3 The interaction between the supply and demand sides

The supply and demand sides are, as remarked by Neal and Johnson (1996), not separate spheres but interacting factors. Since the decision to invest in post-secondary education, as well as decisions concerning occupational field, labor market region etc are partly based on the expectation of future pecuniary returns, they could be affected by actual or perceived labor market discrimination. If the return to schooling is lower for disabled individuals than for the non-disabled, the disabled group may systematically under-invest in education compared to the non-disabled group. It could also be the case that individuals belonging to disadvantaged groups ceteris paribus invest more in education than non-disabled individuals, as indicated by Neal and Johnson's and Nordin's (2007) estimates of ethnic differences in schooling. Other standard productivity measures, such as labor market experience and tenure, could also be directly affected by discrimination. Discrimination prior to labor market entry could also affect productivity directly as well as indirectly, e.g. by limiting the possibilities of human capital formation. Thus, supply side factors, which are usually treated as exogenous, could be influenced by the demand side.

3.4 Measuring discrimination against the disabled

Labor market discrimination against disabled people is generally more difficult to detect and measure than discrimination against other groups, such as women, ethnic minorities or the elderly. The reason for this is that low earnings and poor job opportunities may be caused by employer discrimination, but at the same time it is also the case that impairments could have a negative effect on individual productivity, thus reducing wages and job opportunities (Johnson and Lambrinos 1985:274, DeLeire 2001:145, Hotchkiss 2004:888). Disabled individuals could also experience a greater cost of entering the labor market, due to the additional effort and costs they have to make compared to the non-disabled, and thus have a higher reservation wage (Hotchkiss 2004:888). Since poor health may limit an individual's work experience the productivity of disabled workers could be adversely affected by the lesser degree of human capital accumulation and the depreciation of human capital that the absence and/or career breaks imply (Johnson and Lambrinos 1985:268, Sciulli et al 2007). There could also be additional hiring and training costs that arise from the employment of disabled individuals, i.e. costs for provision of suitable accommodation. The workplace modification needed may be expensive, which causes employers to lower the wages below the productivity of the disabled workers to make up for the loss (ibid). This may not only lead to lower wages for the individuals who are in fact less productive or more expensive to hire and/or train, but also result in statistical discrimination (Johnson and Lambrinos 1985:265, Skoglund-Thoursie 1999a:20).

Taste discrimination due to negative attitudes towards disabled workers may also be prevalent. Hahn (1983) finds that disabled people are subject to "greater animosity and rejection than many other groups in society". Bowe (1978) concludes that employers' attitudes towards disabled people are less favorable than their attitudes towards many other marginalized groups in society, such as the elderly or ethnic minorities. Discrimination could result in permanently lower wages and fewer job opportunities for equally productive disabled workers than for workers from the able-bodied group (Johnson and Lambrinos 1985:26, Baldwin and Johnson 1994:2-4). Wage discrimination could also contribute to the lower employment rates among the disabled by lowering the offer wages below some of these individuals' reservation wages (Baldwin and Johnson 1994:14).

4. Previous studies

Numerous studies find a connection between disability and substantially lower earnings or employment probability. Few studies, however, explicitly investigate discrimination as a possible cause of these outcomes. All of these studies are based on general categorizations of disability, and thus do not provide detailed measures of the types and degrees of severity of the impairments included, and most of them focus on wage discrimination only. The wage gaps are analyzed by estimating separate OLS earnings functions for the groups studied using a set of potentially endogenous standard explanatory variables, such as years of schooling, occupational category and labor market experience and decomposing the differentials found into an explained and an unexplained part using the Oaxaca-Blinder approach. By doing this, between-group differences in the observed characteristics that are included in the original functions can be controlled for. As discussed below, however, the unexplained part contains elements of both over- and underestimation the true extent of discrimination and should therefore not be seen as an actual discrimination measure. A few studies also use a similar approach to decompose the employment gaps and to investigate whether discrimination plays a significant role in explaining the differences in employment rates between disabled and non-disabled workers.

Johnson and Lambrinos (1985) compare a group of disabled people who according to attitudinal studies are likely to face discrimination to a group consisting both of non-impaired individuals and of persons who suffer from impairments which may reduce their productivity but that are less likely to be a cause of prejudice. The authors find substantial wage differentials between these groups; the total differential is estimated to 17.1% for men and 15.2% for women. About one third of these wage differentials for men and about 40% for women, are estimated to be a result of discrimination. Since Johnson and Lambrinos do not distinguish between disabled workers who are not likely to face discrimination and non-disabled workers, however, the wage effects of reduced productivity remain uninvestigated in this study. This could cause an upward bias in the discrimination estimate.

Later studies attempt to overcome this problem by using a similar approach based on three different groups. In order to separate the effects of discrimination from the effects of reduced productivity, Baldwin and Johnson (1994) compare a group of disabled people who are likely to face discrimination, (handicapped), to a group of disabled individuals who are likely to face little or no discrimination but whose productivity is likely to be reduced due to their impairments (disabled), and to the non-disabled. Unexplained wage differentials between the first group and the able-bodied are viewed as a result of both productivity differences and discrimination, while unexplained differentials between the second group and the able-bodied are attributed to productivity differences only. Baldwin and Johnson find that the handicapped group tends to have lower wages than the other two groups. 40% of the wage gap between handicapped and non-handicapped men is unexplained and could be a result of prejudice-based discrimination and/or unobserved ability differentials. The wages of the disabled and the non-disabled are approximately equal, but reflects a lower return to experience for the disabled group, which leads the authors to conclude that wage discrimination of this group also seems to exist. Comparing wage and employment differentials from the years 1972 and 1984, between which the American civil rights legislation was extended to cover the disabled, Baldwin and Johnson’s results also suggest that the anti-discrimination act did not succeed in decreasing wage discrimination, but may have contributed to a large increase in the employment rates of disabled workers.

Another possible strategy, used by DeLeire (2001), is to compare a group of disabled individuals whose impairments do not affect their productivity but who are still likely to face discrimination, a group of disabled people who experience both productivity loss and discrimination due to their disability and a non-disabled group. While unexplained wage differentials between the first group and the non-disabled are more likely to be a result of discrimination, differences between the second group and the non-disabled are more likely to originate in productivity differences as well as in discrimination. DeLeire finds substantial wage and earnings gaps between the disabled and the able-bodied, but estimates only 5-8% of these gaps to be due to discrimination. The results show that, in absolute terms, the negative effect of impairments on earnings declined by 11.3 percentage points between 1984 and 1993. This is suggested to be a result of an increase in the productivity of disabled workers, caused by changes in technology and by the passing of the Americans with Disabilities Act, which requires firms to supply reasonable accommodation to disabled workers. The unexplained fraction of the wage differentials, however, seems to have increased by 1.7 percentage points between 1984 and 1993.

In a study based on Swedish data, Skogman-Thoursie (1999a, 1999b) argues that differences in occupational distributions could be due to unequal opportunities for attaining certain professions or for improving occupational status, and thus should be treated as endogenous. By estimating within- and between-occupation wage differentials between the disabled and the non-disabled groups, he shows that the major part of the total unexplained differential, estimated without controlling for occupational differences, is due to differences in occupational distributions. The between-occupation wage differential seems to be due to better qualifications for high-wage occupations among the non-disabled while the major part of the within-occupation wage differential is unexplained. The unexplained part is insignificant for 1981 but highly significant for 1991, where it accounts for 50-60% of the total wage differential. Skogman-Thoursie suggests that this could be an effect of the greater decentralization in wage setting in the 1990´s compared to the 1980´s, which led to increased wage dispersion and may have increased employers´ possibilities of discriminating against disabled workers. The increase in unexplained within-occupation wage differentials could, however, also reflect an increasing return to ability following the decentralization of wage setting.

In addition to detecting wage discrimination, two studies using British data also investigate whether the large employment gaps between disabled and able-bodied workers are likely to be caused by discrimination. When analyzing the wage differentials, using the method suggested by Baldwin and Johnson (1994), Kidd et al (2000) explain approximately half of the 13% estimated wage gap between disabled and non-disabled British workers. Occupational differences seem to be the main contributors to the explained part of the wage gap. Similarly to the analyze of the wage differentials, the authors also decompose the difference in employment rate between the groups into a part explained by productivity-related observable characteristics and an unexplained part using a variant of the Oaxaca-Blinder technique suggested by Even and Macpherson (1990). They find that approximately half of the 50% total employment gap can be attributed to a standard set of productivity-related observed characteristics, the other half remaining unexplained.

By estimating the average probability of employment with and without the presence of wage discrimination for disabled and non-disabled individuals respectively, Kidd et al also investigate whether this type of discrimination is likely to contribute to the unexplained employment differential by lowering the wage offered to disabled workers below their reservation wage. The results indicate that the discriminatory and non-discriminatory probabilities are very close for the disabled group, suggesting that wage discrimination does not seem to cause extensive employment effects. Their estimates also suggest that disabled workers have a very inelastic response to an increase in the wage rate. The employment elasticities are estimated to 0.099 and 0.032 for the non-disabled and disabled groups respectively, whereas the responsiveness of hours worked to the wage rate is estimated to 0.27 for the able-bodied and 0.025 for the disabled group.

In a similar study, Jones et al (2006) follow DeLeire's (2001) approach, which allows for a more explicit control for productivity differentials as a cause of the earnings and employment gaps than does the method used by Baldwin and Johnson (1994) and Kidd et al (2000). This approach results in very small unexplained wage differentials between a group of disabled but non-work limited men and a group of non-disabled men being found, which suggests that there is no substantial wage discrimination, at least against male individuals whose impairment is not work limiting. Using the same methodology as Kidd et al (2000), the authors find no sign of wage discrimination being an important cause of the substantial differences in employment rates by lowering wage offers for disabled workers below their reservation wage, as employment elasticities are estimated to be very small for disabled men.

The estimates of discrimination from all the above studies are based on the Oaxaca-Blinder approach, which decomposes the wage or employment differentials into an explained and an unexplained part. The latter does not necessarily equal the effect of discrimination but could also be the result of unobserved differences in productivity, if these are negative for disabled workers. The unexplained component thus provides an upper limit to the extent to which the wage differentials are due to direct wage discrimination. On the other hand, as Neal and Johnson (1996) remark, differences in observable characteristics such as schooling and experience could be a result of discrimination both in the labor market and prior to labor market entry. Thus, the discrimination estimates in the earlier studies may contain elements of both over- and underestimation of the total consequences of discrimination. Since this uncertainty is partly due to unobserved differences in ability, introducing an ability measure in the earnings function could lead to an improved understanding of the labor market situation of the disabled.

There could also be differences in observable characteristics due to the physical limitations of disabled people. Occupational choice could, as suggested by Skogman-Thoursie, be related to disability due to physical limitations as well as to discrimination. The same could, however, be true for other explanatory variables. A visual or hearing impairment could e.g. reduce the individual's ability to attain and profit from post-secondary education. The differences owing to productivity loss could be difficult to separate from those that are due to discrimination.

When analyzing the employment gap, one also has to bear in mind that both labor supply and demand of disabled workers could be affected by the presence of disability benefits and anti-discrimination legislation. In the American case, a number of studies have shown that the employment rates among disabled workers have decreased since the 1990 passage of the Americans with Disabilities Act (ADA), which prohibits discrimination of disabled people by employers and requires firms to provide reasonable accommodation to disabled workers. Several studies have suggested that the ADA itself is one of the causes of this development by raising the costs of hiring disabled individuals due to the risk of lawsuits and the potential need for costly job accommodations (e.g. DeLeire 2000, Angrist and Acemoglu 2001). Many studies also argue that generous disability programs could create work disincentives and lead to more individuals making an effort to be classified as disabled (e.g. Autor and Duggan 2003, Bound and Waidmann 2002, Kruse and Schur 2003, Burkhauser et al 2003).

5. Data

The empirical study is based on a data set constructed by integrating registers from Statistics Sweden (SCB) and the Swedish National Service Administration (Pliktverket). The original data set contains information on 730,599 individuals, which corresponds to all Swedish born males who were 25-38 years old in 2003. Out of these, 680,573 enlisted between 1984 and 1997. The Swedish National Service Administration data set contains information on both individual cognitive abilities, based on the SME test score, and different types of physical abilities, based on the results on other tests performed during the enlistment procedure. Since these physical and cognitive ability measures are based on registered test scores, they provide objective measures of individual ability. The bias commonly found in self-reported measures is thus avoided. The data also covers a large population. Due to the Draft Service System in Sweden, all male Swedish citizens are obliged to enlist for military service on demand from the National Service Administration at age 18. During the 1980's and 1990's in principle every male Swedish citizen went through the enlistment process. The only men who were excluded from enlistment during this time period were those who were currently in institutional care or in prison. The data therefore avoids the selectivity bias that is commonly found in similar data.

5.1 The Enlistment tests

The enlistment process includes various tests, which estimate an individual's physical and cognitive ability. Scores from the vision test, the hearing test and the Enlistment Battery Test, which is the test measuring cognitive ability, are used in this thesis.

The *vision test* is performed by having the enrollee read letters of different sizes from a board, for each eye independently. For those whose vision is reduced, the test is performed both with and without corrective lenses. If the enrollee cannot read the top line on the vision test board, a supplementary test is performed, where he/she is asked to count how many fingers the test leader is holding up from a distance of approximately 2 meters. The results from the corrected, non-corrected and supplementary vision tests are combined and normalized into a nine-point scale, which ranges from complete blindness to perfect vision.

The *hearing test* is conducted by having the enrollee listen to tones at specific frequencies and specific levels through headphones for each ear independently. By pressing a button the enrollee conveys that he/she can hear the tone. The test results for both ears are combined and normalized into a six-point scale, ranging from deafness to perfect hearing.

The *Swedish Enlistment Battery Test* is the enlistment test for cognitive ability and is primarily used to evaluate the enrollee's suitability for military service or for specific military positions. The individuals in the sample have taken the Enlistment Battery 80, which consists of four parts; instructions, synonyms, metal folding and technical comprehension. The instructions test measures the individual's ability to make inductions. It also measures verbal skills together with the synonyms test. The metal folding test is a spatial test, which measures mathematical/logical ability. The technical comprehension test is more related to general knowledge. The scores on each of the different parts of the test are normalized into a nine-point scale and in accordance with the factor analysis method, summed up and transformed into a new nine-point scale. The variable constructed is seen as a measure of general intelligence. The method of calculating the test score changed during the time period covered by the study, but since the test consists of separate parts, Nordin and Rooth (2008) have been able to construct a time-consistent measure which is the variable used in this thesis. The time consistent measure is a continuous variable, ranging from 1.01 to 9.11, unlike the original discrete variable (see Nordin – Rooth, 2008, appendix A).

5.2 Using the Swedish Military Enlistment Battery Test result as a skill measure

Several studies, opposing the results of Herrnstein and Murray (1994) which suggest that the AFQT mostly measures inherent ability, have shown that achievement test scores such as the AFQT increase with age and schooling, and thus should not only be seen as measures of innate ability (e.g. Hansen et al 2004, Neal and Johnson 1996). Following this reasoning, concern has been raised about scores concerning cognitive abilities from tests such as the SME test possibly being affected by previous schooling and labor market experience. Nordin (2007) remarks, however, that since the SME test is generally taken at age 18, i.e. during upper-secondary school, which is attended by the vast majority of Swedish citizens, the test results should not be affected by post-secondary education and labor market experience[1]. The SME test score can therefore serve as a skill measure that is unlikely to be contaminated by labor market discrimination after the age of 18. The estimate is, however, still affected by differences in human capital formation before the time of the test.

[1] Around 17% take the test at age 19, mostly due to random delays and illness, and around 3% take it between the ages 20 and 27. Thus, most individuals who take the test later than at age 18 still do it during upper-secondary school (Guttormsson 2000).

Systematic differences in e.g. school quality or parental investment in the human capital of their children may thus affect the test score.

Using the SME variable as a measure of ability reduces uncertainty about differences in general ability amongst individuals or between the disabled and non-disabled groups. On the other hand, skills specifically relevant to certain professions, as well as other unobserved variables, such as motivation and social skills, are not measured by the SME test. Systematic differences in unobservable characteristics between the two groups may therefore still exist.

5.3 Defining sample groups

The objective disability measures provided by vision and hearing test results, and the objective skill measure provided by the SME variable leads to improved productivity measures and thus a greater possibility of comparison between equally productive individuals from the disabled and the non-disabled groups. The detailed measures of vision acuity and hearing capacity in the Swedish National Service Administration data set also allows for a great degree of differentiation between various degrees of impairment. The nine-point scale of the enlistment vision test result is used to divide the sample into nine groups representing different degrees of visual acuity, while the six-point scale representing the enlistment hearing test results is used to define six groups with respect to non-corrected hearing.

Table 1. The vision test score groups

		Non-corrected vision, minimum values		Corrected Vision minimum values	
		Better eye	Worse eye	Better eye	Worse eye
Blind	**Vision 0**	0.0	0.0	0.0	0.0
Non-correctable visual impairment	**Vision 1**	F2	0.0	0.1	0.0
	Vision 2	F2	F2	0.4	0.1
	Vision 3	F2	F2	0.5	0.2
	Vision 4	F2	F2	0.7	0.2
Correctable visual impairment	**Vision 5**	F2	F2	0.7	0.3
	Vision 6	F2	F2	0.7	0.7
	Vision 7	0.7	0.3	0.7	0.7
	Vision 8	1.0	0.7	1.0	0.7
Full vision	**Vision 9**	1.0	1.0	1.0	1.0

Note: A value of 1.0 represents perfect vision and corresponds to being able to read the bottom line on the vision test board. A value of 0.1 corresponds to being able to read the top line on the vision test board. 0.0 represents absolute blindness. F2 represents a capability to determine how many fingers the test leader holds up from a 2-meter distance.

The vision test provides a detailed measure of visual acuity as it combines the results of corrected and non-corrected vision. Group 9 represents individuals with *full vision*. Most individuals belonging to group 8, 7 and 6 can achieve full vision through correction. Their productivity can therefore be assumed to be unaffected by their impairment. Most individuals belonging to group 5 can fully correct their vision on the best eye, but suffer from a (potentially very small) non-correctable visual impairment on the worst eye. Additionally, the high education levels and test results of these groups (see table 3) indicate that their productivity is not adversely affected by low vision. Thus, group 8, 7, 6 and 5 are categorized as having a *correctable visual impairment*. Individuals belonging to the groups 4, 3, 2 and 1 suffer from various degrees of uncorrectable visual impairments, which lead to a potential productivity loss due to low vision. Thus, they are categorized as having a *non-correctable visual impairment*. Group 0 represents the *blind*. According to the WHO definition, which defines a visual acuity of 0.3 or less as disabling (WHO 1998), all individuals belonging to groups 1 and 0 and some individuals belonging to group 2 can be categorized as disabled. Individuals belonging to these groups are likely to experience a significant productivity loss due to their impairment. Slighter impairments could however also reduce productivity and cause restrictions in work or daily life situations, e.g. a corrected visual acuity of

0.5 on both eyes is the minimum requirement for getting a Swedish drivers license. Hence, the less strict categories used in this thesis

Table 2. The hearing test score groups

		Average perceived sound level		Frequencies
		Better ear	Worse ear	
Hearing-impaired	Hearing 0	>60 dB	.	Any
	Hearing 1	10-60 dB	.	500-2000 Hz
	Hearing 3	10-40 dB	.	500-2000 Hz
Reduced hearing	Hearing 5	10-20 dB	25-40 dB	500-2000 Hz
	Hearing 7	10-20 dB	25 dB	500-3000 Hz
Perfect hearing	Hearing 9	10-20 dB	10-20 dB	500-6000 Hz

The hearing test results are less detailed and provide no information on corrected hearing. Group 9 represents individuals with perfect hearing. Group 7, 5, 3, 1 and 0 have various degrees of reduced hearing, which could have adverse productivity effects. The lower limit in the enlistment hearing test, 60 dB, corresponds to the sound level of a normal conversation at close range. Thus, deaf individuals are included in group 0, but cannot be distinguished from severely hearing disabled persons by this classification.

WHO defines a hearing impairment due to hearing loss as the capability of hearing sounds at 26 dB or more without hearing aids, which corresponds to the incapability to hear a whisper. The hearing impairment is classified as disabling if the person can only hear sounds at 41 dB, i.e. the sound level of birds singing, or more (WHO 2008). Thus, according to the WHO definition only group 3, 1 and 0 can be categorized as hearing-impaired and only group 1 and 0 are disabled.

The WHO definitions are used to construct three different groups. Also in this case, the categories of interest are not mainly the strictly disabled, but rather the hearing-impaired, who are likely to experience limitations in labor market and every-day situations. Consequently, group 3, 1 and 0 are categorized as *hearing-impaired*, groups 7 and 5 are categorized as having *reduced hearing*. Individuals belonging to group 9 have *perfect hearing*.

6. Descriptive statistics

A statistical description of the different groups included in the sample shows that hearing and vision groups differ substantially with respect to labor market outcomes and characteristics. The groups that suffer from a correctable visual impairment have a higher average education level than individuals with perfect vision, but for individuals with non-correctable visual impairments the education level tends to be lower. The same pattern appears when describing the SME test score distribution, indicating a connection between the test results and later investments in schooling. For the blind, the test score is considerably lower than for the seeing individuals. A possible reason for this is that carrying out parts of the SME test, i.e. the metal folding test, requires some vision. Individuals suffering from hearing loss tend to invest in less education and have a lower score on the SME test the more severe their impairment.

The employment rates are generally lower the more severe the individual's impairment for both the visually impaired and the hearing-impaired, with a difference of 10.5 percentage points between the groups with perfect vision and the blind and 6.6 percentage points between those with perfect hearing and the most severely hearing-impaired. For those who are employed, the log annual labor income is lower for the groups with reduced or impaired hearing or visual impairments. In general, more severely impaired individuals earn less than those with a lower degree of impairment. The only impaired group that has higher average earnings than the non-impaired is group 6 in the visual acuity distribution, i.e. individuals who have a correctable visual impairment but very low uncorrected vision. This is the group with the highest earnings, the largest amount of education and the highest test score in the sample. Another circumstance worth noting is the situation of individuals belonging to vision group 5, who have a high level of average education and a high average test score but still tend to have relatively low earnings and a somewhat lower employment rate.

Table 3. Descriptive statistics

	Employed 2003	Log Annual Labor Income	Years of Schooling	SME Test Score	N
Vision 0	.847	12.078 (1.176)	11.000 (1.852)	2.797 (2.899)	59
Vision 1	.903	12.090 (1.010)	12.046 (2.209)	4.083 (2.275)	216
Vision 2	.882	11.735 (1.211)	11.924 (2.015)	4.439 (2.100)	355
Vision 3	.902	12.137 (.916)	11.689 (1.967)	4.198 (2.136)	682
Vision 4	.938	12.222 (.880)	11.712 (1.937)	4.530 (2.017)	5,172
Vision 5	.924	11.907 (1.082)	12.711 (2.010)	5.395 (2.011)	22,786
Vision 6	.949	12.278 (.892)	12.945 (2.141)	5.745 (1.887)	130,288
Vision 7	.944	12.208 (.904)	12.436 (2.060)	5.124 (1.970)	47,222
Vision 8	.947	12.215 (.866)	12.236 (2.021)	4.955 (1.952)	29,287
Vision 9	.952	12.244 (.852)	12.111 (1.951)	4.936 (1.860)	430,315
Correctable Visual Impairment	.945	12.220 (.917)	12.726 (2.114)	5.482 (1.951)	229,583
Non-correctable Visual Impairment	.929	12.183 (.915)	11.732 (1.956)	4.475 (2.047)	6,425
Hearing 0	.885	12.038 (1.210)	11.284 (1.920)	3.287 (2.389)	157
Hearing 1	.905	12.042 (.978)	11.353 (1.827)	3.494 (2.084)	243
Hearing 3	.923	12.100 (.945)	11.739 (1.931)	4.248 (2.039)	8,177
Hearing 5	.933	12.162 (.903)	11.819 (1.939)	4.475 (1.988)	10,877
Hearing 7	.941	12.146 (.906)	12.051 (1.926)	4.692 (1.935)	56,821
Hearing 9	.951	12.246 (.870)	12.363 (2.039)	5.186 (1.896)	590,269
Reduced hearing	.940	12.148 (.905)	12.013 (1.931)	4.657 (1.945)	67,698
Hearing Disabled	.922	12.098 (.951)	11.720 (1.930)	4.209 (2.054)	8,577

Note: Only individuals who have taken the SME test are included in the descriptive statistics. Log annual income is calculated for those who had a positive annual income from labor in 2003. The test score corresponds to the time consistent measure constructed by Nordin and Rooth (2008). Standard deviations are in parentheses.

7. Model specifications

The empirical analysis consists of two parts. First, the employment probability is estimated using a binary model. Second, earnings equations are estimated for those who are employed. Five different specifications, including the same explanatory variables for both models, are estimated. The sample includes the disability groups as well as reference groups consisting of those with perfect vision or hearing. As the separate rather than the combined effects of visual and hearing impairments are the focus of the analysis, the different types of impairments are analyzed in separate models.

7.1 Estimating employment probability

A probit model is used to analyze the employment gap between disabled and non-disabled workers. Since the dependent variable is qualitative and binary, the estimate of interest is the probability of being employed, given a set of characteristics. The probit model estimates the probability that $y_i = 1$, i.e. that individual i has a job, given a set of explanatory variables such as the impairment and skill measures. The probability is frequently viewed as a function of a latent, unobservable variable y_i*, i.e. the utility difference between having and not having a job, that is assumed to be a linear function of the explanatory variables X_i so that

$$y_i* = \beta' X_i + \varepsilon_i$$

where β is a vector of coefficients and ε_i is a normally distributed error term. If $y_i* > 0$, it is assumed to generate an outcome equal to one, e.g. the individual has a job.

$y_i* = \beta' X_i + \varepsilon_i \leq 0 \rightarrow y_i = 0$, i.e. the individual is not employed

$y_i* = \beta' X_i + \varepsilon_i > 0 \rightarrow y_i = 1$, i.e. the individual is employed

The probability that individual i is employed is given by

$$P(y_i = 1) = P(y_i* > 0) = P (\beta' X_i + \varepsilon_i > 0) = P(-\varepsilon \leq \beta' X_i) = F(\beta' X_i) .$$

By maximum likelihood, β and $y_i{*}$ can be estimated. The signs of the coefficients received from the probit model indicate whether the effects of the explanatory variables are positive or negative. To represent the actual sizes of the marginal effects, however, the coefficients have to have to be manipulated further. This is done by taking the partial derivative of the expectation of y_i with respect to a certain explanatory variable

$$\frac{\partial P(y_i = 1)}{\partial x_{ij}} = f(x_i'\beta)\beta_j$$

Thus, the return to each of the specific variables can be estimated (Verbeek 2004:190-194).

7.2 Estimating earnings functions

The income gap is analyzed by estimating standard and reduced form earnings functions in a pooled model. Earnings are assumed to be a log-linear function of the productivity measures and the other observed characteristics. To estimate between-group income differentials, dummy variables representing the respective groups are included in the earnings function, while holding the observed characteristics constant. The basic specification is

$$Ln(EARN_i) = \alpha + \beta_1 AGE_i + \beta_2 \mathrm{IMPAIR}_i + \beta_3 'X_i + \varepsilon_i$$

where X_i is a vector of explanatory variables, such as the test score, years of schooling etc., which vary between the different model specifications, and ε_i is a normally distributed error term. This strategy makes it possible to estimate the income gap directly associated with belonging to certain groups given that all relevant characteristics are controlled for.

7.3 The model specifications

To control for the separate and combined effects of the explanatory variables, five different model specifications are used. First, a *basic model* is estimated, where employment status or log annual labor income is regressed on age, age² and the hearing or vision dummies to estimate the unadjusted employment and earnings differentials.

In *model 2*, Neal and Johnson's (1996) suggested approach is used. Employment probability or log annual labor income is estimated as a function of the variables included in the basic model and the SME test score. Since the test score variable is a measure of productivity at age 18, the estimated differentials include all effects of between-group differences that have occurred after the test was taken, including differences in schooling and experience. Since the variables included are assumed to be determined before labor market entry and thus unaffected by labor market discrimination, the estimated differentials can be seen as upper bounds for labor market discrimination after age 18.

Model 3 instead adds years of schooling and its square to the basic model (model 1). This could cause endogeneity problems. If the anticipation of future discrimination causes disabled individuals to invest in less education than the non-disabled, including schooling in the employment probability or earnings function could lead to an understatement of discrimination. Conversely, if years of schooling systematically overstates the relative skill of the disabled, e.g. if disabled individuals exhibit lower levels of achievement than non-disabled individuals at the same schooling level, discrimination is likely to be overstated if schooling is included in the model. This could occur if e.g. visually or hearing disabled individuals have problems profiting from education due to their impairment. Neal and Johnson (1996) also argue that schooling is a noisy measure of ability since it measures an input rather than an outcome.

In *model 4*, both schooling and test score are added to the basic model. Schooling can in this case serve as a proxy for skills that are not captured by the SME test or that are attained after the test date (Neal and Johnson 1996). As Nordin (2007) remarks, these variables are both affected by the same underlying individual ability. The joint causality could cause endogeneity problems when schooling and test score are included in the same model. This has been illustrated by e.g. Angrist and Krueger (1991), who find that including an endogenous test score causes a negative bias in the return to schooling estimate. However, if Lang and Manove's (2006) argument applies to disabled workers, i.e. that education is more important as a signal of productivity for disabled than for non-disabled individuals, jointly including the SME test score and schooling is relevant.

As suggested by Skogman-Thoursie (1999a, 1999b), differences in occupational distributions could have a substantial impact on the differences in earnings. This is controlled for in *model 5*, which is used to estimate earnings differentials only. In this model, occupational dummies are added to the previous model, which includes both schooling and test score in addition to the basic model. Thus, the model does not take the endogeneity of occupational choice into account, but simply estimates earnings differentials holding occupational category, as well as test score and schooling, constant.

8. Results

As indicated by the statistical description of the sample, individuals with different degrees of visual acuity and hearing capacity appear to differ with respect to both observed characteristics and labor market outcomes (see table 3). The empirical results, which are presented in this chapter, indicate a deeper interrelatedness between the impairments and these different characteristics and outcomes.

Since the SME test score appears to be a biased measure of the ability of blind individuals, the models controlling for this variable are likely to result in biased estimates. For this reason, the blind group is only briefly included in the analysis.

8.1 Employment and vision

The unadjusted estimates reported in model 1, table 4 show that having a visual impairment is associated with a lower probability of having a job. The employment probability appears to be negatively related to the degree of vision impairment. The blind have 11.4% lower employment probability, while individuals with minor correctable impairments only have between 0.5 and 0.8% less probability of being employed than individuals with full vision.

When also controlling for the SME test score (as showed by model 2, table 4) the employment gap is reduced by 22% for the groups suffering from non-correctable visual impairments, compared to those with full vision, while the minor gap between those with a correctable impairment and individuals with full vision increases. Thus, when having equal test scores, individuals with correctable visual impairments seem to be about 1% less likely to find a job than individuals with full vision. For persons with non-correctable visual impairments, the difference is around 2%.

In model 3, where schooling is included as the main explanatory variable, a similar pattern prevails but a slightly smaller share of the employment gap between blind persons or individuals with non-correctable visual impairments and the non-visually impaired is explained compared to model 2. For the groups with correctable impairments, the unexplained fraction of the employment differential increases compared to both of the previous models.

Table 4. Results of estimating the employment gap between individuals with various degrees of visual impairments and the non-disabled, 2003.

	Model 1		Model 2		Model 3		Model 4	
Age	.026 (.001)***	.027 (001)***	.026 (.001)***	.027 (.001)***	.025 (.001)***	.026 (.001)***	.025 (.001)***	026 (.001)***
Age^2	-.000 (.000)***	-.000 (.000)***	|-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***
Vision 0	-.114 (.049)***		-.055 (.037)		-.083 (.044)**		-.051 (.037)	
Vision 1	-.058 (.022)***		-.043 (.020)**		-.054 (.021)***		-.045 (.020)**	
Vision 2	-.047 (.015)***		-.039 (.014)***		-.038 (.014)***		-.034 (.013)**	
Vision 3	-.051 (.012)***		-.038 (.010)***		-.042 (.011)***		-.036 (.010)***	
Vision 4	-.021 (.004)***		-.016 (.003)***		-.017 (.004)***		-.015 (.003)***	
Vision 5	-.016 (.002)***		-.017 (.002)***		-.019 (.002)***		-.018 (.002)***	
Vision 6	-.005 (.001)***		-.009 (.001)***		-.010 (.001)***		-.011 (.001)***	
Vision 7	-.008 (.001)***		-.008 (.001)***		-.009 (.001)***		-.009 (.001)***	
Vision 8	-.005 (.001)***		-.004 (.001)***		-.005 (.001)***		-.005 (.001)***	
Non-correctable		-.027 (.003)***		-.021 (.003)***		-.023 (.003)***		-.020 (.003)***
Correctable		-.007 (.001)***		-.009 (.001)***		-.010 (.001)***		-.010 (.001)***
Test Score			020 (.001)***	.020 (.001)***			015 (.001)***	.016 (.001)***
Test Score^2			-.002 (.000)***	-.002 (.000)***			-.001 (.000)***	-.001 (.000)***
Years of Schooling					.044 (.001)***	.044 (.001)***	.036 (.001)***	.036 (.001)***
Years of Schooling^2					-.001 (.000)***	-.001 (.000)***	-.001 (.000)***	-.001 (.000)***
Pseudo R^2	.006	.006	.015	.015	.019	.019	.022	.022
Log Pseudolikelihood	-132309.25	-131227.84	-131200.6	-131227.84	-130481.46	-130510.92	-130089.72	-130117.95
N	666,382	666,382	666,382	666,382	666,170	666,170	666,170	666,170

Notes: Employment is defined as having a positive labor income. In the basic model (1) I control for age, age² and disability. In model 2 the test score and test score² are added to the basic model. Model 3 omits the test score while instead including years of schooling and years of schooling². In model 4, both the test score, test score², years of schooling and years of schooling² are added to the basic model. Robust standard errors are used. Standard errors are in parentheses. ***, ** and * denote significance at the 5%, 1% and 0.1% level, respectively. The marginal effects are estimated at $\bar{x}$.

When both the test score and schooling are held constant (model 4, table 4), the unexplained employment gap for individuals with non-correctable visual impairments is slightly reduced, compared to the estimates given by model 2 and 3. For people with correctable impairments, the unexplained differential remains at the same level as when controlling schooling only.

8.2 Earnings and vision

The unadjusted differences in earnings between the sample groups with different degrees of visual acuity are shown by model 1, table 5. The earnings of nearly all of the groups with correctable visual impairments are between 1.3% higher (group 6) and 1.5% lower (groups 8) than the earnings of individuals with full vision. Group 5, i.e. individuals with a correctable impairment on the best eye and a (potentially very small) non-correctable visual impairment on the worst eye, however, fare worse than the other groups belonging to the "correctable impairment" category. The raw earnings differential between this group and those with full vision is 11.8%. The corresponding differentials for the groups suffering from a non-correctable visual impairment range between 10 and 21%. The earnings of the blind are on average about 31% lower that those of individuals with full vision.

When controlling for the test score (model 2), the unexplained earnings differentials are considerably reduced for all groups with non-correctable visual impairments. Earnings gaps of between 7% and 18% for the groups with non-correctable impairments compared to individuals with full vision, remain. For the groups with correctable impairments, however, the earnings gap nearly quadruples when the test score is controlled for, and all degrees of visual impairment become

Table 5. Results of estimating the earnings gap between individuals with various degrees of visual impairments and the non-disabled, including individuals with a positive annual labor income, 2003.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Age	.401 (.005)***	.416 (.005)***	.405 (.005)***	.419 (.005)***	.398 (.005)***	.411 (.005)***	.401 (.005)***	.414 (.005)***	.266 (.004)***	.274 (.004)***
Age²	-.002 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.004 (.000)***	-.004 (.000)***
Vision 0	-.308 (.120)*		-.191 (.120)		-.226 (.121)		-.142 (.121)		-.142 (.110)	
Vision 1	-.214 (.061)***		-.172 (.061)**		-.216 (.061)***		-.183 (.061)**		-.136 (.055)*	
Vision 2	-.200 (.048)***		-.179 (.048)***		-.184 (.048)***		-.040 (.023)		-.163 (.044)***	
Vision 3	-.103 (.034)**		-.070 (.034)*		-.091 (.034)**		-.071 (.034)*		-.036 (.031)	
Vision 4	-.118 (.012)***		-.098 (.012)***		-.107 (.012)***		-.097 (.012)***		-.075 (.011)***	
Vision 5	-.118 (.006)***		-.138 (.006)***		-.135 (.006)***		-.141 (.006)***		-.097 (.006)***	
Vision 6	.013 (.003)***		-.021 (.003)***		-.021 (.003)***		-.030 (.003)***		-.028 (.003)***	
Vision 7	-.011 (.004)**		-.019 (.004)***		-.023 (.004)***		-.024 (.004)***		-.021 (.004)***	
Vision 8	-.015 (.005)**		-.016 (.005)**		-.019 (.005)***		-.018 (.005)***		-.015 (.005)**	
Non-correctable		-.125 (.011)***		-.103 (.011)***		-.114 (.011)***		-.102 (.011)***		-.078 (.010)***
Correctable		-.008 (.002)***		-.031 (.002)***		-.032 (.002)***		-.038 (.002)***		-.032 (.002)***
Test Score			.066 (.002)***	.067 (.002)***			.063 (.003)***	.064 (.003)***	.046 (.002)***	.046 (.002)***
Test Score²			-.002 (.000)***	-.002 (.000)***			-.003 (.000)***	-.003 (.000)***	-.004 (.000)***	-.004 (.000)***
Years of Schooling					.044 (.005)***	.044 (.005)***	.002 (.005)	.003 (.005)	-.061 (.005)***	-.061 (.005)***
Years of Schooling²					-.000 (.000)	-.000 (.000)	.001 (.000)***	.001 (.000)***	.002 (.000)***	.002 (.000)***
Occupation	no	no	no	no	no	no	no	no	yes	yes
R²	.055	.054	.063	.062	.063	.062	.066	.065	.222	.221
N	632,765	632,765	632,765	632,765	632,606	632,606	632,606	632,606	632,606	632,606

Notes: The dependent variable is logarithmic annual labor income. Only individuals with a positive labor income are included in the sample. In the basic model (1) I control for age, age² and disability. In model 2 the test score and test score² are added to the basic model. Model 3 omits the test score while instead including years of schooling and years of schooling². In model 4, the test score, test score², years of schooling and years of schooling² are added to the basic model. Model 5 includes all the previous variables and also controls for differences in occupational distribution by adding 23 dummies representing occupational categories. Standard errors are in parentheses. ***, ** and * denote significance at the 5%, 1% and 0.1% level, respectively.

negatively related to earnings. The test score also seems to explain a larger share of the income differential than does the schooling measure, which is controlled for in model 3, table 5.

Controlling for the combination of schooling and the SME test score (accounted for in model 4) reduce the earnings gaps slightly for the groups suffering from non-correctable visual impairments, compared to when these measures are controlled for separately. For those with a correctable visual impairment, however, the unexplained earnings differential increase by 26% when schooling and test score are jointly included compared to when only the test score is controlled for. Occupational differences, which are added in model 5, table 5, seem to be an important determinant of earnings. When occupational dummies are included, the explained share of the income gap decreases substantially for the groups with non-correctable visual impairments and group 5. For groups 6 and 7 with correctable impairments the earnings gap increases substantially.

8.3 Controlling for differences in part time work and employment spells among the vision test score groups

It is possible that the negative association between visual impairment and earnings are due to a disproportionably large share of visually impaired individuals employed in short part time positions. If a disproportionably large share of disabled individuals has short employment spells, this could also affect the estimated earnings gaps. To account for this possibility, the earnings functions are re-estimated for those who had a labor income of more than SEK 50,000 in 2003. Hence, individuals with very short part time positions and very short employment spells are removed from the sample.
When using SEK 50,000 as an income restriction, the raw earnings differentials between the vision test score groups decrease substantially and turn positive for group 6 and 7 (see model 1, table 6), This results in a positive average earnings differential of 1.6% for individuals with correctable visual impairments, compared to the non-visually impaired. The earnings of group 5, however, remain considerably lower than those of the other groups with correctable visual impairments and are estimated to be 4.1% lower than the earning of individuals with full vision. For the groups with non-correctable visual impairments, earnings remain negatively and significantly associated with the degree of impairment, although to a lesser degree than when positive earnings were used as the income restriction. The average earnings differential for individuals belonging to these groups is

Table 6. Results of estimating the earnings gap between individuals with various degrees of visual impairments and the non-disabled when SEK 50,000 is used as the income restriction, 2003.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Age	.157 (.002)***	.201 (.003)***	.192 (.003)***	.199 (.003)***	.184 (.003)***	.190 (.003)***	.186 (.003)***	.192 (.003)***	.131 (.002)***	.135 (.002)***
Age^2	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.002 (.000)***	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.002 (.000)***	-.002 (.000)***
Vision 0	-.087 (.062)		-.009 (.066)		-.070 (.066)		-.017 (.065)		-.027 (.060)	
Vision 1	-.115 (.034)***		-.076 (.033)*		-.118 (.033)***		-.091 (.033)**		-.066 (.030)*	
Vision 2	-.080 (.028)**		-.057 (.027)*		-.060 (.027)*		-.052 (.027)		-.064 (.025)*	
Vision 3	-.073 (.019)***		-.045 (.019)*		-.060 (.019)***		-.045 (.018)*		-.028 (.017)	
Vision 4	-.071 (.007)***		-.053 (.007)***		-.058 (.007)***		-.050 (.007)***		-.038 (.006)***	
Vision 5	-.041 (.003)***		-.064 (.003)***		-.060 (.003)***		-.067 (.003)***		-.050 (.003)***	
Vision 6	.035 (.002)***		-.005 (.002)***		-.006 (.002)***		-.017 (.002)***		-.015 (.001)***	
Vision 7	.004 (.002)		-.007 (.002)**		-.010 (.002)***		-.012 (.002)***		-.011 (.002)***	
Vision 8	-.009 (.003)**		-.012 (.003)***		-.015 (.003)***		-.014 (.003)***		-.011 (.003)***	
Non-correctable		-.074 (.006)***		-.053 (.006)***		-.061 (.006)***		-.052 (.006)***		-.039 (.005)***
Correctable		.016 (.001)***		-.012 (.001)***		-.013 (.001)***		-.020 (.001)***		-.017 (.001)***
Test Score			.036 (.001)***	.036 (.001)***			.032 (.001)***	.032 (.001)***	.024 (.001)***	.024 (.001)***
Test Score^2			.001 (.000)***	.001 (.000)***			-.000 (.000)*	-.000 (.000)*	-.001 (.000)***	-.001 (.000)***
Years of Schooling					.042 (.003)***	.043 (.003)***	.012 (.003)***	.012 (.003)***	-.037 (.003)***	-.037 (.003)***
Years of Schooling^2					.000 (.000)*	.000 (.000)	.001 (.000)***	.001 (.000)***	.002 (.000)***	.002 (.000)***
Occupation	no	no	no	no	no	no	no	no	yes	yes
R^2	.060	.059	.098	.097	.101	.102	.112	.111	.264	.264
N	591,320	591,320	591,320	591,320	591,179	591,179	591,179	591,179	591,179	591,179

Notes: The dependent variable is logarithmic annual labor income. Only individuals with a labor income > SEK 50,000 are included in the sample. In the basic model (1) I control for age, age^2 and disability. In model 2 the test score and test score^2 are added to the basic model. Model 3 omits the test score while instead including years of schooling and years of schooling^2. In model 4, the test score, test score^2, years of schooling and years of schooling^2 are added to the basic model. Model 5 includes all the previous variables and also controls for differences in occupational distribution by adding 23 dummies representing occupational categories. Standard errors are in parentheses. ***, ** and * denote significance at the 5%, 1% and 0.1% level, respectively.

reduced to 7.4%. The raw earnings gap between the blind and those with full vision is reduced to 8.7% in this sample and the blindness dummy is rendered insignificant. Additionally, the significance of the dummies representing group 1, 2 and 3 are reduced in several of the model specifications when the higher income restriction is used.

When controlling for the SME test score (model 2, table 6), the pattern found when using positive earnings as the income restriction prevails. The unexplained earnings differentials are considerably reduced for individuals suffering from non-correctable visual impairments. For those with correctable visual impairments, the previously positive earnings differentials turn negative, with a decrease of 175% compared to the raw earning differential. The same pattern prevails when controlling for schooling separately although this measure explains smaller fractions of the earnings gaps (see model 3). When the test score and schooling are jointly included (see model 4), the unexplained earnings gap remains at the same level as when controlling for test score separately for the groups with non-correctable impairments, while it increases substantially compared to the previous models for the groups with correctable impairments.

When also including the occupational dummies, the unexplained earnings gaps decrease substantially for the groups with non-correctable visual impairments, while it practically returns to the same level as the raw differential for the groups with correctable impairments.

8.4 Employment and hearing

Model 1, table 7, shows that hearing impairments are associated with a slightly lower probability of being employed. There are no systematic differences between the groups defined as impaired and those with slightly reduced hearing and the negative relationship between hearing loss and employment probability appears to be close to linearity. Individuals belonging to the hearing-impaired groups are on average 2.8% less likely to be employed than individuals with perfect hearing. Those belonging to the most severely hearing disabled group in the sample are 7.1% less likely to be employed than those with perfect hearing. For non-impaired individuals with reduced hearing, the corresponding employment differential is only 0.9% to their disadvantage.

When controlling for the SME test score (model 2), the unexplained parts of the employment differentials decrease by approximately 37% for the hearing-impaired and 44% for individuals with reduced hearing and remain negative for all groups. The resulting unexplained employment differentials range between 0.4% for the group with the mildest degree of hearing loss and 3.9% for

Table 7. Results of estimating the employment gap between individuals with various degrees of hearing impairments and the non-disabled, 2003.

	Model 1		Model 2		Model 3		Model 4	
Age	.027 (.001)***	.027 (.001)***	.027 (.001)***	.027 (.001)***	.026 (.001)***	.026 (.001)***	.026 (.001)***	.026 (.001)***
Age^2	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***	-.000 (.000)***
Hearing 0	-.071 (.026)***		-.039 (.021)*		-.049 (.023)**		-.034 (.021)*	
Hearing 1	-.045 (.019)**		-.025 (.016		-.030 (.017)*		-.021 (.015)	
Hearing 3	-.026 (.003)***		-.017 (.003)***		-.019 (.003)***		-.015 (.003)***	
Hearing 5	-.019 (.002)***		-.013 (.002)***		-.013 (.002)***		-.011 (.002)***	
Hearing 7	-.007 (.001)***		-.004 (.001)***		-.004 (.001)***		-.003 (.001)***	
Hearing-impaired		-.028 (.003)***		-.018 (.003)***		-.019 (.003)***		-.015 (.003)***
Reduced hearing		-.009 (.001)***		-.005 (.001)***		-.006 (.001)***		-.005 (.001)***
Test Score			.020 (.001)***	.020 (.001)***			016 (.001)***	.016 (.001)***
Test Score^2			-.002 (.000)***	-.002 (.000)***			-.001 (.000)***	-.001 (.000)***
Years of Schooling					.044 (.001)***	.044 (.001)***	.036 (.001)***	.036 (.001)***
Years of Schooling^2					-.001 (.000)***	-.001 (.000)***	-.001 (.000)***	-.001 (.000)***
Pseudo R^2	.006	.006	014	.014	.018	.018	.021	.021
Log Pseudolikelihood	-132419.25	-132431.74	-131396.47	-131403.78	-130718.37	-130727.09	-130330.93	-130337.47
N	666,544	666,544	666,544	666,544	666,334	666,334	666,334	666,334

Notes: Employment is defined as having a positive labor income. In the basic model (1) I control for age, age² and disability. In model 2 the test score and test score² are added to the basic model. Model 3 omits the test score while instead including years of schooling and years of schooling². In model 4, the test score, test score², years of schooling and years of schooling² are added to the basic model. Robust standard errors are used. Standard errors are in parentheses. ***, ** and * denote significance at the 5%, 1% and 0.1% level, respectively. The marginal effects are estimated at $\bar{x}$.

the most severely hearing-impaired, compared to the group with perfect hearing. Schooling seems to account for a smaller fraction of the employment gap than the test score for the hearing-impaired, while the gap remains virtually unchanged for those with reduced hearing, as shown in model 3. The joint inclusion of the test score and the schooling variable leads to the employment gap being reduced compared to all the previous models, with about half of the raw wage gap remaining for all groups.

8.5 Earnings and hearing

Earnings appear to be negatively and almost linearly related to the degree of hearing loss. On average, hearing-impaired people earn 11.8% less than individuals with perfect hearing. For individuals with reduced hearing, the corresponding earnings gap is estimated to 4.6%. Within these categories, the raw earnings differentials vary, ranging between 3.8% and 27.3% for the groups with the lowest and highest degree of hearing loss respectively (model 1, table 8).

When controlling for the SME test score (model 2, table 8) the earnings gaps decrease substantially, but remain negative for all groups. The inclusion of the test score also renders the dummy representing the lowest test score group insignificant. For the hearing-impaired groups, the unexplained earnings differential is reduced by approximately 36% and for the groups with reduced hearing, the corresponding decrease is 49%. This results in the remaining differentials compared to the group with perfect hearing being reduced to 7.6% for the hearing-impaired and 2.4% for those with reduced hearing.

Adding schooling to the basic model (model 3) reduces the unexplained fraction of the raw earnings differentials, but by smaller amounts than when controlling for the test score, i.e. by approximately 23% for the hearing-impaired and 35% for those with reduced hearing. Additionally, the vision test score 1 dummy is rendered insignificant. When jointly including the test score and

Table 8. Results of estimating the earnings gap between individuals with various degrees of hearing impairments and the non-disabled including individuals with a positive annual labor income, 2003.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Age	.416 (.005)***	.416 (.004)***	.418 (.005)***	.418 (.005)***	.410 (.005)***	.410 (.005)***	.413 (.005)***	.413 (.005)***	.273 (.004)***	.273 (.004)***
Age^2	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.006 (.000)***	-.004 (.000)***	-.004 (.000)***
Hearing 0	-.273 (.072)***		-.183 (.057)		-.222 (.072)**		-.165 (.072)*		-.129 (.066)*	
Hearing 1	-.185 (.057)***		-.107 (.058)*		-.123 (.057)*		-.082 (.057)		-.059 (.052)	
Hearing 3	-.113 (.010)***		-.073 (.010)***		-.088 (.010)***		-.069 (.010)***		-.051 (.009)***	
Hearing 5	-.087 (.009)***		-.057 (.009)***		-.067 (.009)***		-.054 (.008)***		-.037 (.008)***	
Hearing 7	-.038 (.004)***		-.018 (.004)***		-.023 (.004)***		-.015 (.004)***		-.011 (.004)**	
Hearing-impaired		-.118 (.010)***		-.076 (.010)***		-.091 (.010)***		-.071 (.010)***		-.052 (.009)***
Reduced hearing		-.046 (.004)***		-.024 (.004)***		-.030 (.004)***		-.021 (.004)***		-.015 (.003)***
Test Score			.066 (.002)***	.066 (.002)***			.063 (.003)***	.063 (.003)***	.045 (.002)***	.045 (.002)***
Test Score^2			-.002 (.000)***	-.002 (.000)***			-.004 (.000)***	-.004 (.000)***	-.004 (.000)***	-.004 (.000)***
Years of Schooling					.041 (.005)***	.041 (.005)***	.001 (.005)	.001 (.005)	-.062 (.005)***	-.062 (.005)***
Years of Schooling^2					-.000 (.000)	-.000 (.000)	.001 (.000)***	.001 (.000)***	.002 (.000)***	.002 (.000)***
Occupation	no	no	no	no	no	no	no	no	yes	yes
R^2	.054	.054	.062	.062	.062	.062	.065	.065	.221	.221
N	632,896	632,896	632,896	632,896	632,738	632,738	632,738	632,738	632,738	632,738

Notes: The dependent variable is logarithmic annual labor income. Only individuals with a positive labor income are included in the sample. In the basic model (1) I control for age, age² and disability. In model 2 the test score and test score² are added to the basic model. Model 3 omits the test score while instead including years of schooling and years of schooling². In model 4, the test score, test score², years of schooling and years of schooling² are added to the basic model. Model 5 includes all the previous variables and also controls for differences in occupational distribution by adding 23 dummies representing occupational categories. Standard errors are in parentheses. Standard errors are in parentheses. ***, ** and * denote significance at the 5%, 1% and 0.1% level, respectively.

schooling, as shown in model 4, the explained fraction of the earnings gaps increase compared to the models where these measures are controlled for separately.

Adding controls for occupational differences to the previous model, model 5 accounts for 56% of the unadjusted earnings gap for the hearing-impaired and 72% of the corresponding gap for the groups with reduced hearing. Thus, occupational differences seem to account for substantial shares of the differentials. However, small, negative earnings gaps remain between those with perfect hearing and all the groups with hearing loss, amounting to 5.2% for the hearing-impaired individuals and 1.5% for those with reduced hearing. The test score group dummies remain significant for all groups except group 1.

8.6 Controlling for differences in part time work and employment spells among the hearing test score groups

When the earnings gaps are re-estimated including individuals with a labor income above SEK 50,000, negative earnings differentials are found for all the groups with hearing loss (model 1, table 9). These estimated differentials are significantly smaller than the estimates from the corresponding model using positive earnings as the restriction for all groups except group 7, i.e. individuals whose hearing is only slightly reduced. Additionally, the dummy representing group 0, i.e. the most severely hearing-impaired individuals, turns insignificant when the higher income restriction is introduced. The linearity in the relation between earnings and hearing loss that prevailed in the earlier models is also lost. When controlling for the SME test score (model 2, table 9), the unexplained earnings gap is reduced by 55% for the hearing-impaired and by 54% for the groups with reduced hearing. The inclusion of the cognitive test score especially affects the most severely hearing-impaired group, reducing the earnings gap between them and the group with perfect hearing to only 0.6% and rendering the test score 0 and 1 dummies insignificant. Similarly to the results of the models using positive earnings as the income restriction, separately controlling for schooling results in a larger unexplained fraction of the unadjusted earnings gap (model 3), while the joint inclusion of cognitive test score and schooling reduces the unexplained fraction compared to the previous model specifications. When additionally including the occupational dummies, the unexplained earnings gaps are further reduced to 2.4% for the hearing-impaired groups and 1.2% for the groups with reduced hearing, compared to those with perfect hearing.

Table 9. Results of estimating the earnings gap between individuals with various degrees of hearing impairments and the non-disabled when SEK 50,000 is used as the income restriction, 2003.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Age	.201 (.003)***	.202 (.002)***	.198 (.003)***	.198 (.003)***	.190 (.003)***	.190 (.003)***	.191 (.003)***	.191 (.003)***	.134 (.002)***	.134 (.002)***
Age²	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.003 (.000)***	-.002 (.000)***	-.002 (.000)***
Hearing 0	-.074 (.041)		.006 (.040)		-.037 (.040)		-.004 (.039)		-.001 (.036)	
Hearing 1	-.140 (.031)***		-.060 (.031)		-.089 (.031)**		-.054 (.031)		-.048 (.028)	
Hearing 3	-.074 (.005)***		-.034 (.005)***		-.045 (.005)***		-.030 (.005)***		-.024 (.005)***	
Hearing 5	-.072 (.005)***		-.041 (.005)***		-.048 (.005)***		-.037 (.005)***		-.025 (.004)***	
Hearing 7	-.038 (.002)***		-.016 (.002)***		-.020 (.002)***		-.013 (.002)***		-.010 (.002)***	
Hearing-impaired		-.076 (.005)***		-.034 (.005)***		-.046 (.005)***		-.029 (.005)***		-.024 (.005)***
Reduced hearing		-.043 (.002)***		-.020 (.002)***		-.025 (.002)***		-.016 (.002)***		-.012 (.002)***
Test Score			.035 (.001)***	.035 (.001)***			.032 (.001)***	.032 (.001)***	.024 (.001)***	.024 (.001)***
Test Score²			.001 (.000)***	.001 (.000)***			-.000 (.000)**	-.000 (.000)**	-.001 (.000)***	-.001 (.000)***
Years of Schooling					.041 (.003)***	.041 (.003)***	.011 (.002)***	.012 (.003)***	-.037 (.003)***	-.037 (.003)***
Years of Schooling²					.000 (.000)*	.000 (.000)*	.001 (.000)***	.001 (.000)***	.002 (.000)***	.002 (.000)***
Occupation	no	no	no	no	no	no	no	no	yes	yes
R²	.060	.060	.097	.097	.102	.102	.111	.111	.264	.264
N	591,419	591,419	591,419	591,419	591,279	591,279	591,279	591,279	591,279	591,279

Notes: The dependent variable is logarithmic annual labor income. Only individuals with a labor income > SEK 50,000 are included in the sample. In the basic model (1) I control for age, age² and disability. In model 2 the test score and test score² are added to the basic model. Model 3 omits the test score while instead including years of schooling and years of schooling². In model 4, the test score, test score², years of schooling and years of schooling² are added to the basic model. Model 5 includes all the previous variables and also controls for differences in occupational distribution by adding 23 dummies representing occupational categories. Standard errors are in parentheses. Standard errors are in parentheses. ***, ** and * denote significance at the 5%, 1% and 0.1% level, respectively.

8. Discussion and conclusions

The empirical results indicate that the degree of impairment is negatively related to both employment probability and earnings. The unadjusted earnings gaps amount to 10-20% for individuals with non-correctable visual impairments, while they are practically negligible for people with correctable visual impairments. For individuals with hearing loss, the earnings gaps are larger, amounting to 11-27% for hearing-impaired individuals, and 4-5% for individuals suffering from mild hearing loss. The earnings gaps for individuals suffering from non-correctable visual impairments or hearing impairments are comparable to the ethnic earnings gap of 16% found by Nordin and Rooth (2008), the 16% gender earnings gap (Kumlin 2007) and the 15% earnings gap between non-European immigrants and natives (Le Grand and Szulkin 2002) in Sweden. Compared to the results of previous American and British studies, the (unadjusted and adjusted) earnings differentials found are relatively small. To some extent, this could be a result of the relatively compressed Swedish earnings structure. However, when employers' possibilities of differentiating between individual wages are limited, discrimination or differences in productivity can be expected to affect hiring decisions to a larger extent, resulting in a lower employment rate for disadvantaged groups. The results of this thesis indicate that this is not the case. Although there are significant differences in employment rates, the employment gaps do not seem to be very extensive compared to the earnings differentials. This is the case even for severely disabled individuals, who are likely to experience a substantial productivity loss and whose labor supply may be reduced by a high reservation wage due to the increased effort of working and to the presence of disability benefit programs. A severe visual disability is associated with a decrease in employment probability by less than 5%, while mildly visually impaired individuals are only around 1% less likely to have a job than individuals with full vision. The estimates for individuals suffering from hearing loss are similar. Severely hearing-impaired individuals are about 7% less likely to have a job than those with perfect hearing. Slightly reduced hearing is associated with a decrease in employment probability of less than 1%.

Differences in productivity seem to account for a significant part of the differentials in both employment probability and earnings. For most of the groups representing individuals with visual impairments or hearing loss, the unexplained fractions of the earning and employment gaps are substantially reduced when the cognitive test score and/or schooling are included. Differences in pre-market skill seem to play a substantial role in the determination of labor market outcomes. For both the visually impaired and the individuals suffering from hearing loss, the SME test score accounts for larger shares of the employment and earnings differentials than schooling. Thus, the inclusion of the test score variable could be an additional explanation of the smaller adjusted earnings and employment gaps found compared to previous studies, which use schooling as the main productivity measure.

Whether or not schooling should be included in the model remains controversial. As Nordin and Rooth (2008) remark, the inclusion of schooling could lead to overestimated employment and earnings gaps if schooling is an endogenous measure or a bad indicator of productive skill, but failing to control for schooling could also lead to an underestimation of the employment and earnings gaps if schooling is a better signal of productivity for the disabled than for the able-bodied. Thus, the estimates of the employment and earnings differentials received from the models including schooling can serve as bounds for the size of the potential gaps. The differences between these estimates and the ones from the model that only includes the test score are generally small. With this reasoning, the estimated employment gaps are around 2% for individuals with non-correctable visual impairments, while people with correctable visual impairments seem to be approximately 1% less likely to have a job than the non-visually impaired. For the hearing-impaired, the corresponding differential is estimated to around 1.5%, while the groups with reduced hearing appear to be 0.5% less likely to have a job. Similarly, the estimated earnings differential between individuals with non-correctable visual impairments and those with full vision is about 10% when the test score and schooling are jointly controlled for, which corresponds to the return to about 2.5 extra years of schooling. For those with a correctable visual impairment, the corresponding differential is approximately 4%. The hearing-impaired persons seem to earn about 7% less and those with reduced hearing 2% less than those with full hearing. These estimates are further reduced when controlling for occupational categories, which appear to have a large impact on the earnings differentials.

A large share of the earnings differentials also appears to be a result of impaired individuals working significantly shorter hours than the non-impaired. When individuals with very low earnings are excluded from the sample, the estimated earnings differentials are reduced to approximately 5%, which corresponds to the return to slightly more than one extra year of schooling, for those with non-correctable visual impairments and about 2% for those with correctable visual impairments compared to individuals with full vision. The corresponding differentials are around 3% for the hearing-impaired and 2% for individuals with reduced hearing.

There are different possible interpretations of this result. The possibility of part time work could increase the labor supply of individuals suffering from relatively severe hearing or visual impairments, who would not have worked in the absence of such opportunities. However, there is also a possibility that impaired individuals are involuntarily over-represented in short part time positions as a result of discrimination.

The importance of productivity differentials is expected, as more severe impairments are likely to reduce productivity. The possibility to correct and compensate for one's impairment also seems to have a substantial impact on labor market outcomes. The negative relationships between hearing loss and employment probability and between hearing loss and earnings appear to be linear, which indicates that the possibilities of correction of or compensation for hearing impairments are not restricted to certain groups in the sample, which is the case for the visually impaired. The groups with correctable visual impairments generally have higher education levels as well as higher SME test scores than the non-impaired group. This indicates that their productivity is unaffected by their impairment and could be the explanation for their relatively high employment and earnings levels. However, the increase of the negative unexplained employment and earnings differentials between these groups and those with full vision when controlling for test score and schooling (jointly or separately) indicates that marginally visually impaired individuals do not seem to fully benefit from their high education levels and test scores. The labor market outcomes are especially adverse for group 5, who despite high average education levels and test scores have significantly lower earnings than individuals with full vision. It could be the case that minor visual impairments are associated with a type of productivity loss that does not affect the cognitive ability measured by the SME test or the ability to attain high levels of education, but that does have an impact on working life situations. Alternatively, employer discrimination against these groups could deteriorate their labor market outcomes, given that employers can distinguish the impaired from the non-impaired.

To conclude, the results indicate that the employment and earnings gaps between visually or hearing-impaired and able-bodied workers are largely due to a skill gap. When controlling for skill and other relevant characteristics, small but significant differentials in employment probability and earnings remain in most cases. In some cases the differentials even increase when measures of cognitive ability and/or schooling are added to the basic earnings functions. This indicates that discrimination, or some other unobserved factor, could affect the labor market outcomes of impaired individuals, but that its potential effects are likely to be relatively small.

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