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Estimating Compensating Wage Differentials from Worker Mobility*

Per Johansson† and Mårten Palme‡

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Abstract

We estimate the effects of the implementation of a compulsory work injury insurance in Sweden in 1978 on compensating wage differentials. This involves two steps. First, we investigate if there are compensating wage differentials on the Swedish labor market and second, we assess if these were altered by the reform. We use panel data for the period 1970 to 1990 with annual information for a sample of blue collar workers. The econometric model departs from the worker's job mobility decision. Endogeneity, selection and measurement errors of risk exposure are considered in the estimation. The estimates show significant compensating wage differentials for work-related diseases in the female sub-sample. No significant effect of the reform was found.

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†IFAU - Office of Labour Market Policy Evaluation, SE-751 20 Uppsala, Sweden. E-mail: Per.Johansson@ifau.uu.se.

‡Stockholm School of Economics, Box 6501, SE-113 83 Stockholm, Sweden. E-mail: Marten.Palme@hhs.se.

1 Introduction and Motivation

The theory of compensating wage differentials does not only have impressive intellectual roots dating back to Adam Smith, as is often pointed out in the introduction to many papers on the issue, but is also of great importance for the functioning of a modern labor market and for public policy analysis. The existence of compensating wage differentials tells us something about the completeness of the labor market and also about the impact of different labor market institutions. The public policy interest ranges from the willingness to pay for investments in safer work environments (see e.g. Smith, 1979) to the implications of a work injury insurance, which can crowd out compensating differentials (see e.g. Viscusi, 1993).

In 1977 Sweden implemented a reform of the compulsory state work injury insurance. There were two main elements of the reform. The first one was to, in addition to work accidents, also include work-related diseases in the work injury insurance. The second one was to obtain a better knowledge of hazards at workplaces by introducing a system for reporting work accidents and work related diseases.

In this study we use two opportunities to empirically study the economics of compensating wage differentials provided by the 1977 reform. First, we will estimate compensating wage differentials for work accidents and work related diseases. We use panel data containing information on labor earnings for a sample of blue-collar workers for each year over a 20 year period where data on risk exposure for work accidents and work related diseases, obtained from the information system introduced by the reform, has been matched on using detailed occupational codes.

We will, thus, in addition to measure compensating wage differentials for risk exposure to work accidents - which so far has dominated the empirical research on compensating wage differential - also be able to measure wage compensations for exposure to work-related diseases. Research in social medicine (see e.g. Vågerö and Gullberg, 1996) has drawn the attention to differences in life expectancy between different occupational groups. The extent to which these differences are caused by differences in work environment or by general life habits still remains an open question. It is, however, clear that work accidents are of very little importance in this context. A much more likely explanation is differences in exposure to risks of work-related diseases that have more long-term effects on the health of workers. This suggests that exposure of risk to work related diseases is more important for the worker's general health status.

The second aim of this study is to assess if the compensating wage differentials for work-related diseases changed after the 1977 reform. Economic theory suggests that generous compensations ex post a worker acquired a work-related disease may crowd out wage compensations to risk exposure, i.e., compensations ex ante. If this is the case, a compulsory insurance such a the one introduced in 1977, where the insurance premium is unrelated to level of risk exposure, may decrease the cost for the employer to provide a work environment with high risk exposure, i.e., decrease the economic incentives for improved work environment. The introduction of the compulsory insurance for work related diseases in 1977 enables to assess if this effect is of empirical importance.

Previous empirical studies of compensating wage differentials have dealt with three methodological problems: endogeneity of risk exposure; selection into jobs with high risk exposure; and the effects of measurement, or perception, errors. Most recent studies deal with at least one, or a permutation, of these three problems. The effect of the endogeneity of being employed in jobs with a high risk exposure has been given much attention. In a Monte Carlo study, Hwang et al. (1992) show that the value of a human life is likely to be underestimated by at least 50 percent if endogeneity is not considered in the estimation. Coefficient estimates with the wrong sign are also likely to occur.

The effects of selections into hazardous jobs have received substantially less recognition (see, however, Garen, 1988). Selection seems to be more important in the analysis of compensations for risk exposure to work-related diseases rather than compensation for accidents. In social medicine, for example, it has long been recognized that physically strong workers select jobs with a high exposure to work-related diseases (see e.g. Östlin, 1989). Furthermore, the effect of measurement errors has received comparatively little attention in previous empirical studies (see, however, Duncan and Holmlund, 1983), although all measures of risk exposure are likely to be imprecise.

In this study, we will address all these three methodological problems and we aim at obtaining estimates of the effect of risk exposure. Rather than using a static equilibrium on the labor market, which is most common in the previous literature, the econometric model focuses on the worker's job mobility decision. The data used is obtained from the 1991 Swedish Level of Living Survey (SLLS). In particular, retrospective information, covering the period 1970-1991, from this survey is used. The retrospective information contains codes for detailed workplace characteristics as well as dates for changes in employment for each individual in the sample. Measurement errors are controlled for by an instrument variable approach.

The results show a significant effect of risk for work-related diseases for women. We find no significant effect of the 1977 reform of the sickness insurance, i.e., the returns to risk exposure for work-related diseases did not change significantly after the reform.

The paper is organized as follows. Section 2 gives a detailed description of the Swedish Work Injury Insurance. Data and measurement issues are given in Section 3, Section 4 presents the econometric model and Section 5 the estimation techniques. The results are presented in Section 6. Section 7 concludes.

2 The Development of the Work Injury Insurance

The work injury insurance is Sweden's oldest compulsory social insurance. The first work injury insurance was implemented already in 1901. Today, it consists of two main insurances: one administrated by the state (formally the National Social Insurance Board) and one occupational insurance negotiated on a central level between the main trade unions and the employers confederation. The latter insurance is compulsory for all employees covered by the central agreement, i.e. more than 95 percent of the Swedish labor market.

Although the basic aim of the insurance has largely remained unchanged since it was first introduced, it has changed along at least three dimensions. First, the groups of workers covered by the insurance have gradually increased; when first introduced, the insurance only covered industrial workers. The coverage has then gradually increased to cover all groups on the labor market, even those who are self-employed. Second, the compensation level of the insurance has varied over time. The most generous level was implemented after the 1977 reform, with a 100 percent compensation level for forgone earnings. Third, the concept of work injury has changed over time. Also in this respect, the most radical change took place in the 1977 reform, where the work injury concept was enlarged from basically only including work accidents to also covering various forms of work-related illnesses.

The concept of work injury is far from unambiguous and has changed in the Swedish work injury insurance over the past decades. This can mainly be described as a gradual change in the practice of the law, although there are also some fundamental historical changes. The original insurance, from 1901, only covered work accidents, i.e. the insured individual was only entitled to compensation from the insurance if a particular health deficiency could be referred to a particular event having occurred at the workplace. Health problems acquired over a period of time were not covered by the insurance.

Since 1930, when workers with silicosis were made eligible for compensation from the insurance, an increasing number of illnesses have been included in the list of illnesses covered by the insurance. Only those illnesses caused by a substance or radiating energy in the workplace were eligible for compensation, however. In the 1977 reform, there was a fundamental change in the concept of work-related illnesses: The list of illnesses covered by the reform was then replaced by a general legal examination of whether the illness was caused by the insured individual's work or work environment.[1] This legal examination took place in two steps. In the first step, it was decided if the insured individual was suffering from the particular disease for which he or she claimed compensation. In the second step, it was decided whether or not this particular disease could have been caused by the insured worker's work or work environment. If both these steps were passed, the insured worker was eligible for compensation from the insurance.

In Figure 1, the total number of injuries is broken down into work accidents, accidents on the way to work and work-related illnesses. Figure 1 shows a very clear pattern: The number of work accidents has continually decreased over the observed period of time, probably due to a steadily improved security in the work environment. The number of accidents on the way to work has remained constant, while work-related illnesses increased substantially after the 1977 reform and further between 1985 and 1988.

The main explanation of the increase in the number of reported work-related illnesses between 1985 and 1988 is the change in the strictness in the application of the two-step procedure for legal inquiry described in the Appendix.[2] One way of measuring this strictness is to measure the share of insured workers receiving support from the work injury insurance after the period of 90 days of admitted support from the sickness insurance. Figure 2 shows this share for work accidents and work-related illnesses respectively

[1] Excluded are plant closings, work negotiations, lack of encouragement, lack of promotion and general dislike of tasks and co-workers.

[2] A description of changes in the compensation of the work injury insurance is given in the Appendix.

for the period 1980 to 1991. It can be seen that this share increases markedly up until 1988, primarily for work-related illnesses.

Table 1 shows the number of reported work-related illnesses broken down by diagnosis. It is evident from the statistics shown in this Table that the largest increase is in musculo-skeletal illnesses. This change is consistent with what we would expect from the change imposed by the reform: The causes of these illnesses are sometimes diffuse, compared to e.g. illnesses caused by certain chemical substances, although they can certainly be caused by the insured worker's work conditions or work environment.

To sum up, it is evident from the descriptive statistics below that the concept of work injury did change considerably over the period of time covered by the panel data used in the empirical part of this study. In particular, the coverage of the insurance for primarily Musculo-skeletal illnesses caused by working conditions were improved and therefore, the expected compensation for jobs where the workers are exposed to risks for acquiring such illnesses was increased.

3 Data and Measurement

The data-set is built around the SLLS. This survey is a panel of interviews made in 1968, 1974, 1981 and 1991, respectively. The sample consists of about 6,000 individuals in each wave and is a representative sample of the Swedish population aged 19 to 74.[3] A detailed description of the SLLS can

[3]The sample size is about 0.1 percent of the Swedish population in this age group.

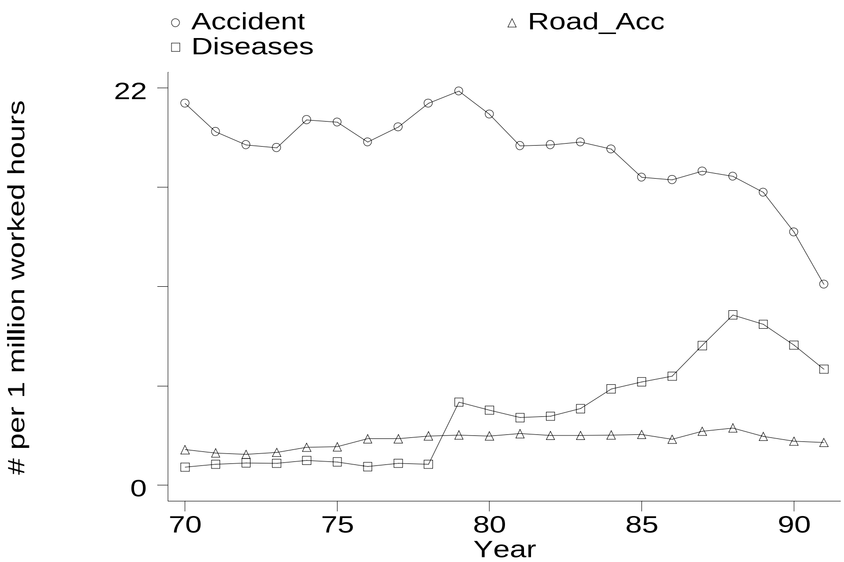

Figure 1: Number of reported work accidents, accidents on the road to work and work related diseases per 1 million worked hours. 1970-1991.

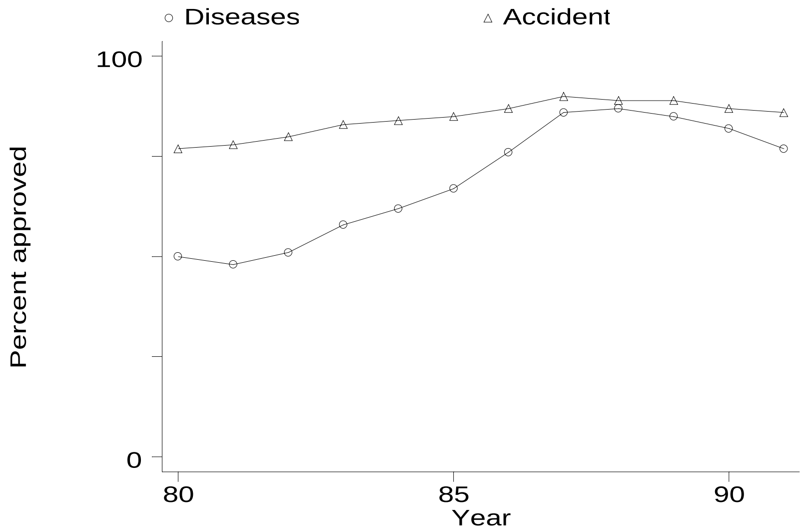

Figure 2: Percentage share of reported work accidents and work related diseases approved after legal inquiry.

Table 1: Number of reported work related diseases per 1,000 workers by suspected cause in 1980, 1885 and 1990.

Cause	1980	1985	1990
Musculo-skeletal disorder	3.5	4.5	9.0
Chemical substances	1.5	2.1	1.3
Noise	0.8	1.0	0.9
Vibrations	0.1	0.3	0.2
Other physical factors	0.1	0.1	0.1
Infections	0.2	0.1	0.1
Phycological factors	-	0.1	0.4
Non-classified	0.3	0.1	0.2
All	6.6	8.3	12.2

Note: Source *Arbetarskyddsstyrelsen 1985 and 1990.*

be found in Erikson and Åberg (1987).

The 1991 wave of SLLS included retrospective questions regarding e.g. work history. Each individual in the sample was asked about the characteristics of his entire history of previous employments. The other main source of information used to obtain the panel data-set used in this study is data from the Swedish tax registers matched against the SLLS survey. Since the tax registers cover all persons living in Sweden, we have been able to get individual earnings data for several years for the individuals included in the sample.

The retrospective questions were used to construct an unbalanced panel of individuals and their work activities from 1970 to 1991. The work history variables were created on basis of the activity of each individual on January 1 each year. The sample was reduced to only include observations when individuals were employed.

Table 2: Sample selection. Number of individuals, n, and number of observations, $\sum n_t$. The effective number of observations for the differenced data is 14,017.

	n	$\sum n_t$
Initial sample	3,276	72,072
Deletions: self employed, white collar workers and individuals outside the labor force		
Blue-collar workers in 1991	1,464	
Missing dates in job sequence (382)	1,082	
More than 3 sequences of being outside the labor force (47)	1,035	
More than 3 missing observations on labor earnings in a sequence (35)	1,000	
Final sample	1,000	15,528

3.1 Sample Selection and Measurement of the Dependent Variable

The initial sample, obtained from the 1991 SLLS survey, consists of 3,276 individuals. However, in order to obtain the final sample used in the estimation, several selections were made. These selections are summarized in Table 2. Self-employed, farmers, white collar workers, students, military personnel as well as pensioners and other individuals outside the labor force or in farming were all excluded from the sample. After these selections had been made, 1,464 blue-collar workers remained in the sample. For 382 of these, the work history is missing or some of the dates are wrong (e.g. start dates are after end dates in a work sequence) and these were also excluded from the sample.

The dependent variable, labor earnings, is measured by taxable annual labor earnings and is obtained from the national tax register matched against the SLLS. Between 1970 and 1973, social insurance incomes, primarily income from the sickness insurance, are not included in taxable income from labor. Between 1974 and 1991, social insurance income components are included. To account for changes in average earnings over time, we deflate the earnings records with the change in average earnings for the aggregate Swedish economy each year.

For some of the years, the earnings variable for some of the individuals in the sample is recorded with a zero or missing value. There may be several reasons for this, e.g. the worker may have been studying or for some other reason been outside the labor force for a period of time. Before 1974, it may also have been the case that the worker received income from social insurances. For most of these observations, when the earnings are missing or zero, we have information on whether an individual is; (i) unemployed; (ii) studying; (iii) doing his military service; (iv) on maternity leave; (v) working at home; (vi) on an early retirement scheme. At each stage, we also have information on type of employment. Sequences where an individual is not employed as a blue-collar worker are excluded from the sample. If, for instance, a worker has changed from being employed to unemployed, and then becomes employed again, the sequence where he is unemployed is not included in the sample. 47 workers who had more than three sequences of unemployment were excluded from the sample.

For a few individuals, we have "true missing values" in the sense that we have recorded an employment, but a zero or missing value on labor earnings.

For these individuals, we use the following procedure:[4] if the missing values occur at the beginning or the end of the time period covered by the panel, the observations are simply deleted. If the missing values appear within a sequence of observations, the missing observations are imputed as weighted averages of the preceding and following observations (one preceding and one following value in the case of one missing value, two preceding and two following values in the case of two missing values etc.). The imputation is based on the assumption that observations are missing randomly.[5] If there are more than two missing observations in a sequence, we have deleted the individual from the sample. This is done for 35 individuals.

The final data-set is an unbalanced panel of 1,000 individuals, 15,256 observations and 1,511 work sequences. The average length of a work sequence is 10.27 years with a standard deviation of 7.55 years.

3.2 Measuring Risk

One of the aims of the 1977 work injury insurance reform was to increase the knowledge of health hazards at workplaces in Sweden. To achieve this, a new system for collecting information on occupational injuries known under the abbreviation ISA was introduced. All suspected work injuries, i.e., those claiming compensation from the work injury insurance were reported to ISA, starting from January 1, 1979.

The main risk measure calculated from the ISA data-base is the Standard

[4] Twenty individuals have one missing observation and three individuals have two missing observations within a sequence.

[5] A weight of 1/2 is given to each observation surrounding the missing observation. With two observations missing; the weights 2/8, 3/8, 2/8 and 1/8 are given to the first missing observation and 1/8, 2/8, 3/8 and 2/8 are given to the second missing observation.

Incidence Ratio (SIR) measure, which measures the number of reported work injuries per 1,000 working hours in each occupation. Data on the number of hours worked within each occupation is obtain from the Swedish National Accounts. The classification used for occupations is the NYK classification.

The NYK classification is a Nordic standard for classifying different occupations. The three-digit level of accuracy used in this study contains about 300 different occupations. The retrospective study of the SLLS also contains the three-digit level NYK code. Thus, we are able to get a measure of each worker's risk exposure to both work accidents and work-related illnesses at each point in time by assigning the SIR measure to each worker at each point in time.[6] The identification of risk compensation in the econometric model used is dependent on changes in the worker's risk exposure over time. This can occur only if the worker changes jobs. Altogether, there are 857 changes of occupation. There are around 35 changes of occupations each year. The minimum number of changes is in 1973 with 21 changes and the maximum is in 189 with 62 changes of occupation. In the era before the reform, i.e., $1970-1977$, there were exactly 227 changes and the era after the reform contains 628 changes in occupation

[6] The risk index differs by gender.

Table 3: Occupational injuries (Acc. = Accidents and Dis. = Diseases) by occupational group on a one-digit level. Number of work injuries per one million manhours in 1983.

Occupational group	Males			Females		
	Acc.	Dis.	n	Acc.	Dis.	n
Professional, technical and related work	0.441	0.290	61	0.855	0.309	55
Administrative and managerial work	0.214	0.191	237	0.409	0.084	1325
Book-keeping and clerical work	0.242	0.294	323	0.452	0.466	701
Sales work	1.389	1.983	619	0.869	0.686	1318
Agricultural, forestry and fishing work	1.610	1.490	42	0.387	0.262	55
Mining and quarrymen	0.787	1.637	1230	0.573	0.468	478
Transport and communications work	2.281	2.328	3735	2.344	0.729	442
Production work	1.821	2.040	1393	2.162	0.970	650
Service work, armed forces	0.833	1.605	494	0.859	0.661	2370
All	1.310	1.282	8134	0.923	0.557	7394

4 Empirical Specification and Estimation

4.1 Modeling Worker Mobility and Measuring Compensating Wage Differentials

Most empirical assessments of compensating wage differentials, as e.g. the influential work of Thaler and Rosen (1976),[7] depart from an economic model of a static equilibrium on the labor market. In this framework, workers are assumed to value safety at the workplace but to be heterogenous in their risk preferences. Employers are assumed to have heterogenous costs for providing safety at the workplace. In equilibrium, workers who are less averse to taking high risks select firms with high costs for providing safety at the workplace and workers with preferences for safety match with firms with low costs for providing such working conditions. This model generates a path of tangencies

[7]See Rosen (1986) for a review of this literature.

between different firms' offer curves and different workers' constant expected utility loci which, in turn, can be estimated in an ordinary wage equation where a measure of risk exposure is added to the specification. Since this is a general equilibrium framework, the compensating wage differentials can be interpreted as market prices.

One limitation of the static equilibrium model is that it does not explain why workers move from one job to another; which indeed is the case. This restricts the usefulness of this model. Instead, we will depart from the worker's job mobility decision. Assume that, in each period of time, each worker receives a job offer from a multivariate distribution, $F(W, \mathbf{m})$, where W is the wage rate and $\mathbf{m}$ is a $(L \times 1)$ vector of characteristics. The worker accepts a job offer if it yields a higher utility in terms of consumption and job characteristics than the current job. This process enables the worker to get an improved match over his or her career.

An empirical regularity in labor economics is that workers employed in large firms have higher wages compared to those hired by smaller firms (see e.g. Oi and Idson, 1999, for an overview). There are several explanations to these wage differentials, such as efficiency wage theory and the fact that highly efficient workers tend to match with able entrepreneurs to minimize the sum of wage and monitoring costs. They can also be considered as compensating wage differentials from working at a large workplace. We will not try to differentiate between different explanations. However, as firm size is a characteristic likely to affect earnings and will also change over time, we will include it in the vector of job characteristics along with the risk exposure variables.

Wages and job characteristics are assumed to be determined by the following model. The first equation determines wages[8]

$$w_{it} = \boldsymbol{\beta}_0 \mathbf{x}_{it} + \boldsymbol{\gamma}_i \mathbf{m}_{it} + u_{it}, \tag{1}$$

where w_{it} is the logarithm of individual $i's$ wage rate at time t; $\mathbf{x}_{it}$ is a vector of individual characteristics that may change over time and $\boldsymbol{\gamma}_i = \boldsymbol{\gamma} + \mathbf{c}_i$, where $E(\mathbf{c}_i) = \mathbf{0}$, $COV(\mathbf{c}_i) = diag(\sigma_l^2), l = 1, ...L$. The unobservables, u_{it}, consist of two components, i.e.,

$$u_{it} = \mu_i + \phi_i t + \varepsilon_{it}, \tag{2}$$

where μ_i measures the individual's absolute advantage, or "ability", on the labor market, ϕ_i allows for heterogenous earnings growth rates, which can reflect heterogeneity in time preferences as suggested by e.g. Hause (1980) or Lillard and Wiess (1979): workers with low preferences for immediate payoff are able to choose a job with a high element of on-the-job training and a steep earnings growth rate compared to a job with high initial pay and a low element of learning; ε_{it} is a completely random term which represents specification and measurement errors.[9]

Assume the demand for characteristics j to be determined by

$$m_{it}^j = f(\mathbf{z}_{it}; \boldsymbol{\theta}) + \chi_{it}^j, j = 1, ..., L \tag{3}$$

where f is a general function; $\boldsymbol{\theta}$ is a parameter vector; and $\chi_{it}^j = \xi_i^j + \varepsilon_{it}^j$,

[8] This is a similar framework to that of Topel (1991). However, we will not attempt to estimate structural parameters for returns to tenure and general labor market experience, which would, of course, be possible, given the information in the data. We will, however, concentrate on the returns to risk exposure.

[9] This is a formulation used in e.g. MaCurdy (1982).

where ξ_i^j are error terms due to the optimization behavior of the individual, ε_{it}^j are pure measurement errors and $\mathbf{z}_{it}$ is a vector of exogenous variables.

The worker's overall ability, μ_i, may be correlated with risk exposure for two reasons (see Viscusi, 1993). First, μ_i is likely to be the main determinant of the worker's wealth over his life time. If safety is a normal good, the worker's demand for safety is an increasing function of lifetime wealth and the level of risk and μ_i will be negatively correlated. Second, it is plausible that workers with a high μ_i have a larger element of firm-specific training. As training is often an investment made by employers, they have more incentives to protect these workers from risks in the work environment.

It can be argued that $\mathbf{c}_i$ in the random specification are likely to depend on $\mathbf{m}_{it}$ through the optimization behavior in ξ_i^j, i.e., $E(\mathbf{c}_i|\mathbf{m}_{it}) \neq 0$. For instance, Rosen (1986) shows very convincingly that workers in jobs with high risk exposure are, on average, likely to have preferences making them less risk averse. It can be hypothesized that these workers are more productive in jobs with high risk exposure. An extreme example is window cleaners on sky scrapers: those who are not averse to being exposed to the risk of high heights are probably more efficient in performing their job.

In social medicine, it is a well-known result that workers in jobs with high risk exposure, both as concerns accidents and work-related diseases, on average have a better health status than workers exposed to low risks in their work environment, despite the detrimental effect of the work environment to their health.[10] Workers with good health are, of course, likely to perform bet-

[10] The so-called "healthy worker effect" (see e.g. Östlin, 1989, for a review of these results).

ter in physically demanding jobs, which most often have a high risk exposure to work-related diseases.

To sum up, this model considers both endogeneity and selection into jobs with high risk exposure. It is a partial in the sense that it does not consider the production side and the costs of providing safety at the workplace. The focus of this study is to estimate the average worker valuation of risk exposure, i.e., the effect of risk exposure on wages.

5 Estimation

We observe a restricted set of characteristics at the workplace; The risk exposure to work accidents (π_{it}^1), the risk exposure to work-related diseases (π_{it}^2) and size of workplace (A_{it}). In the following we choose to included the risk variables $\boldsymbol{\pi}_{it} = (\ln \pi_{it}^1, \ln \pi_{it}^2)$ in logarithmic form while the firm size is measured by a factor in eight levels by the number of employees at the workplace. The reduced form model is formulated as

$$w_{it} = \mu_i + \phi_i t + \boldsymbol{\beta}\mathbf{x}_{it} + \boldsymbol{\gamma}_i \mathbf{m}_{it} + \varepsilon_{it}, \tag{4}$$

where $\boldsymbol{\gamma}_i = \boldsymbol{\gamma} + \mathbf{c}_i$, $\boldsymbol{\gamma} = (\gamma^1, \gamma^2, \gamma^3)'$ and $\mathbf{c}_i = (c_i^1, c_i^2, c_i^3)'$.

In estimating this model, we follow the approach of MaCurdy (1982). Taking the differences of (4), we get

$$\Delta w_{it} = \phi_i + \Delta \mathbf{x}_{it} \boldsymbol{\beta} + \boldsymbol{\gamma} \Delta \mathbf{m}_{it} + u_{it}, \tag{5}$$

where $\Delta w_{it} = w_{it} - w_{it-1}$, $\Delta \mathbf{x}_{it} = \mathbf{x}_{it} - \mathbf{x}_{it-1}$, $\Delta m_{it}^j = m_{it}^j - m_{it-1}^j \neq 0$ $(j = 1, 2, 3)$ and $u_{it} = \sum_{j=1}^3 c_i^j \Delta m_{it}^j + \Delta \varepsilon_{it}$, where $E(c_i^j | m_{it}^j) = 0$ for all j.

Not only are the individual effects μ_i, which caused the endogeneity problem (see Duncan and Holmlund, 1984), removed by differencing, the optimization errors, ξ_i^j, are also removed by differentiating $\mathbf{m}_{it}$ under the assumption that $E(\mathbf{c}_i|\mathbf{m}_{it}-\mathbf{m}_{it-1}) = 0$. This assumption requires that changes in risk exposure and firm size are uncorrelated with the unobservables, i.e., no further optimization based on unobservables correlated with $\mathbf{c}_i$ takes place when changing jobs.

In this respect this model differs from the Fixed effects, or Within, estimator which, starting with Brown (1980), has been used in several studies on compensating wage differentials. The Within estimator is consistent if the covariates are strictly exogenous (i.e. we condition on the whole path of explanatory variables) whereas the First difference estimator is consistent if we can condition on the covariates at time period t and $t-1$. This implies that we need to assume that the optimization errors, ξ_i^j are constant throughout the whole time period in order for the Within estimator to be consistent. For the first difference estimator to be consistent we need to assumes that $\xi_{it}^j - \xi_{it-1}^j$ is constant and independent with $\Delta\mathbf{m}_{it}$ which is a less restrictive assumption.

Gibbons and Katz (1992) gives an example where this requirement does not hold: "workers moving in response to good news concerning their abilities are likely to move to jobs with both higher wages and better working conditions, while the reverse is likely to occur for workers moving in response to bad news concerning their abilities." If this description of worker mobility is empirically important, it will cause inconsistencies for both the Within and First difference estimators. However, following the discussion above, the

Within estimator will be less robust to the violation of the model assumption.

The most important source of shocks to the price of unmeasured ability for blue collar workers on the Swedish labor market is likely to be in relation to firm closure, or if a worker for some other reason loses his or her job. In other contexts, the magnitudes of these chocks are likely to be very modest on this highly unionized labor market. To minimize the effect of this endogeneity problem in the empirical analysis we have excluded work spells immediately following unemployment spells in the empirical analysis.

Finally, if the earnings growth rate heterogeneity ϕ_i is uncorrelated with the other explanatory variables, we may gain efficiency by treating it as random. On the other hand, if $\phi_i \neq 0$ and it were correlated with e.g. $\ln \pi_{it}^1$ and $\ln \pi_{it}^2$, this estimator would not be consistent. In this case, the within estimator, i.e., a fixed effect for each ϕ_i, would be a consistent estimator.

The empirical literature on compensating wage differentials distinguishes between measurement and perception errors of workplace risk exposure (see e.g. Viscusi, 1993, or Smith, 1979). If these errors are purely random, they are likely to have the same effects on the compensating wage differential estimates, i.e., attenuate the relationship between risk exposure and compensation. The interpretation of the result is, nevertheless, very different: in the case of measurement errors, it is a technical problem of biased estimates; in the case of perception errors, it is a feature of the labor market that the relationship between risk exposure and compensation appears to be weaker than the actual returns to risk exposure. The perception errors can also be systematic. In psychological studies, it has been found that people tend to overestimate the probability of unlikely events (like airplane accidents) and underestimate the probability of comparatively likely events (like having a heart attack). This will cause a systematic error and a downward bias in the estimates of the compensating wage differentials.

The data on risk are likely to contain both perception and measurement errors. First, since they are objective measures, there is likely to be a discrepancy between those and the subjective ones, and thus a perception error. Second, in addition to the difficulties in measuring risk exposure, there will most likely be two sources of measurement errors. Since the number of occupations is so large, some occupations will be very narrow and the risk of mis-classification is large. Moreover, as the risk exposure data are matched by occupational code, there is likely to be a within group variation that is not measured.

As described in Section 3, the data provide us with measures of two different kinds of risk exposure: π^1 which is the risk exposure to accidents and π^2 which is the risk exposure to work-related diseases. Assume that the risk measure used measures the true (subjective) risk up to proportionality, i.e., $p_{it}^1 = \psi_{it}^1 \pi_{it}$ for risk exposure to work accidents and $p_{it}^2 = \psi_{it}^2 \pi_{it}^2$ for risk exposure to work-related diseases, where p_{it}^1 and p_{it}^2 are the occupational measures of risk and ψ_{it}^1 and ψ_{it}^2 the measurement errors. Taking the logarithm, we obtain the traditional measurement-error specification i.e., $\ln(p_{it}^1) = \ln(\pi_{it}^1) + \ln(\psi_{it}^1)$ and $\ln(p_{it}^2) = \ln(\pi_{it}^2) + \ln(\psi_{it}^2)$. Inserting this into equation (4), we get

$$w_{it} = \phi_i t + \mathbf{x}_{it}\boldsymbol{\beta} + \gamma^1 \ln p_{it}^1 + \gamma^2 \ln p_{it}^2 + \gamma^3 A_{it} + \eta_{it}, \tag{6}$$

where $\eta_{it} = c_i^1 \ln \pi_{it}^1 + c_i^2 \ln \pi_{it}^2 + c_i^3 A_{it} - \gamma_i^1 \ln \psi_{it}^1 - \gamma_i^2 \ln \psi_{it}^2 + \alpha_i + \varepsilon_{it}$.

At present, assume no heterogeneity. We then have a classical measurement error and the OLS estimator of (6) will be biased downwards. Under the assumption that the errors ($\ln(\psi_{it}^1)$ and $\ln(\psi_{it}^2)$) do not change the ordering of the risks, we can use $q_{it}^1 = rank(\ln p_{it}^1)$ and $q_{it}^2 = rank(\ln p_{it}^2)$ as instruments and estimate the returns to risk exposure consistently.

Taking the differences of (6), we get

$$\Delta w_{it} = \phi_i + \Delta \mathbf{x}_{it}\boldsymbol{\beta} + \gamma^1 \Delta \ln p_{it}^1 + \gamma^2 \Delta \ln p_{it}^2 + \gamma^3 \Delta A_{it} + \Delta \eta_{it}, \tag{7}$$

where $\Delta \ln p_{it}^1 = \ln(p_{it}^1/p_{it-1}^1), \Delta \ln p_{it}^2 = \ln(p_{it}^2/p_{it-1}^2)$, $\Delta A_{it} = A_{it} - A_{it-1}$ and

$$\Delta \eta_{it} = c_i^1 \Delta \ln \pi_{it}^1 + c_i^2 \Delta \ln \pi_{it}^2 + c_i^3 \Delta A_{it} - \gamma_i^1 \ln(\psi_{it}^1/\psi_{it-1}^1) - \gamma_i^2 \ln(\psi_{it}^2/\psi_{i-1}^2) + \Delta \varepsilon_{it}. \tag{8}$$

Following the above discussion, c_i^1, c_i^2 and c_i^3 are independent of $\Delta \ln p_{it}^1$, $\Delta \ln p_{it}^2$ and ΔA_{it}. The third and fourth terms on the right-hand side are correlated with $\Delta \ln p_{it}^1$ and $\Delta \ln p_{it}^2$ because of the errors in variables and hence, the OLS estimator is biased. However, the differentiated wage equation can be consistently estimated under the assumption that the errors do not change the ranking in risk exposure of the two occupations involved when a worker moves from one job to another, if $q_{it}^1 = sign(\Delta \ln p_{it}^1)$ and $q_{it}^2 = sign(\Delta \ln p_{it}^2)$ are used as instruments.

Note the difference between the information requirements for these two estimators: the instrument corresponding to the Levels estimator requires that the ranking in risk exposure for all occupations is maintained when the errors are introduced, while the instrument for the difference estimator only requires that the ranking of the two occupations *involved in a job change* is maintained. This is of fundamental importance for the perception error. It is plausible that the worker is able to compare and rank the risk exposure when moving from one job to another. However, it is not likely that workers in general are able to make a complete ranking of risk exposure for different occupations.

6 Results

Table 4 shows sample descriptive statistics of the included variables. Since we use differentiated data, we are basically identifying the risk compensation using only the workers who changed their occupational code in the time period covered by the panel. Therefore, Table 4 reports descriptive statistics - separately for the females and males - for two sub-samples: one containing individuals who have actually changed their occupational code (C) and one with those who have not (NC). This enables us to see if the sample used in identifying the compensating variation differs radically from the rest on the observable characteristics.

As can be seen in Table 4, does almost 55 percent of the males change occupation while ony 42 percent of the femals change occupation. The mean log wages for the NC are a somwhat larger (however not statistically significant) for both the females and males than for the C subsample. However, the average wage increase, measured by the first difference in log wages, is somewhat higher in the both C sample. These differences can, to some extent, be explained by that years of work experience ($EXPER$) is larger among the NC than among the C for both genders.

Furthermore, the comparison shows that the risk indices are higher for the males than for the femals and that both risk indices - for both genders - are slightly smaller for the changers compared to non-changers. The difference is somewhat - for both genders - larger for work accident, although there is no significant difference between the two groups. The changes for both risk indices, $\Delta \ln p^1$ and $\Delta \ln p^2$, are negative. This means that, on average, workers choose safer jobs when they become older.

Firm size is measured by a factor in eight levels by the number of employees at the workplace ($A_1 = 1$, $A_2 = 2 - 9$, $A_3 = 10 - 19$, $A_4 = 20 - 49$ $A_5 = 50 - 99$, $A_6 = 100 - 499$, $A_7 = 500 - 999$ and A_8 represents more than 1,000 employes). There are no large gender differences with respect to the firm size variable. For both genders we can see that there is a tendency that on average, the workers in the C sample go to larger firms, while the same tendency can not be seen anong the NC sample.[11]

As the number of observations over the years 1971-1991 is quite equally distributed, we have excluded descriptive statistics for the indicator variables for each year, which are also included in the specification.

The first set of results is shown in Table 5 and Table 6. Table 5 shows OLS and the Within estimator ("fixed effects") on both levels as well as first difference data. Table 6 shows the corresponding IV results. For the two models in levels, we use heteroscedasticity consistent estimators of the covariance matrix (cf. White, 1980 and Arellano, 1987). For the models in first difference, a first-order Newey and West (1987) estimator is used to take

[11] Observe that the individuals in the NC sample change jobs, however not occupation.

Table 4: Sample descriptive statistics for the two sub-samples: "occupation-changers" (C) and "non occupation-changers" (NC).

	Males				Females			
	$C; n = 4,060$		$NC; n = 3,389$		$C; n = 2,794$		$NC; n = 3,774$	
	$\overline{y}$	s	$\overline{y}$	s	$\overline{y}$	s	$\overline{y}$	s
w	5.148	0.338	5.188	0.343	4.748	0.524	4.792	0.430
$\ln p^1$	0.181	0.864	0.311	0.781	-0.388	0.835	-0.413	0.802
$\ln p^2$	0.424	0.809	0.475	0.747	-0.957	0.973	-0.969	0.965
Δw	0.033	0.297	0.018	0.252	0.059	0.358	0.048	0.294
$\Delta \ln p^1$	-0.013	0.372	0.000	—	-0.006	0.390	0.000	—
$\Delta \ln p^2$	-0.008	0.347	0.000	—	-0.000	0.418	0.000	—
C	0.116	0.321	0.000	—	0.138	0.345	0.000	—
A_1	0.013	0.116	0.002	0.042	0.044	0.206	0.025	0.157
A_2	0.164	0.371	0.119	0.324	0.194	0.395	0.155	0.362
A_3	0.105	0.306	0.099	0.299	0.127	0.333	0.109	0.311
A_4	0.154	0.361	0.218	0.413	0.172	0.378	0.216	0.411
A_5	0.120	0.325	0.167	0.373	0.084	0.278	0.153	0.360
A_6	0.239	0.426	0.235	0.424	0.213	0.409	0.203	0.402
A_7	0.060	0.238	0.054	0.226	0.054	0.225	0.046	0.209
A_8	0.144	0.351	0.106	0.307	0.113	0.317	0.093	0.291
ΔA_1	0.000	0.068	0.000	0.030	-0.004	0.121	-0.000	0.036
ΔA_2	-0.001	0.184	0.002	0.103	-0.006	0.207	0.000	0.086
ΔA_3	-0.003	0.178	0.001	0.109	-0.002	0.178	0.000	0.095
ΔA_4	-0.002	0.197	0.001	0.124	0.004	0.191	0.000	0.100
ΔA_5	0.002	0.164	-0.002	0.100	0.001	0.149	0.000	0.065
ΔA_6	0.002	0.188	-0.001	0.104	0.001	0.197	0.001	0.081
ΔA_7	0.001	0.113	-0.001	0.062	0.003	0.104	0.001	0.051
ΔA_8	0.001	0.139	0.000	0.075	0.003	0.136	-0.002	0.061
$EXPER$	17.925	10.497	19.975	10.740	15.723	9.311	17.064	9.479

Table 5: Results for the OLS and within estimator for the wage equation in level and difference. Standard errors are calculated using robust HAC estitmators (cf. Davidson and MacKinnon, 1993, ch. 17). All models below also include an indicator variable for each year included in the sample (fixed time effects).

	Males							
	Level $n = 8,134$				Difference $n = 7,449$			
	OLS		Within		OLS		Within	
	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$
α	4.592	124.663						
$\ln p^1/\gamma^1$	0.042	2.357	0.010	0.364	0.066	2.589	0.067	1.666
$\ln p^2/\gamma^2$	-0.059	-3.029	-0.003	-0.091	-0.047	-1.489	-0.044	-0.865
A_1	-0.139	-2.501	-0.142	-2.412	-0.093	-0.685	-0.076	-0.379
A_3	0.096	3.200	-0.030	-0.787	-0.065	-1.626	-0.061	-0.992
A_4	0.095	3.540	-0.001	-0.015	0.039	0.981	0.053	0.835
A_5	0.148	3.663	0.061	1.768	0.056	1.375	0.061	0.996
A_6	0.146	5.367	0.020	0.399	0.058	1.464	0.064	1.053
A_7	0.158	3.848	-0.037	-0.664	-0.004	-0.074	0.011	0.119
A_8	0.166	5.519	0.090	2.074	0.063	1.524	0.061	0.963
$EXPER$	0.038	14.641	-0.075	-2.556	0.003	0.111		
$EXPER^2$	-0.001	-11.613	-0.001	-12.581	-0.001	-13.496	0.080	8.134
C					0.027	1.502	0.022	0.775
	Females							
	Level $n = 7,394$				Difference $n = 6,568$			
	OLS		Within		OLS		Within	
	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$
α	4.055	64.321						
$\ln p^1/\gamma_1$	-0.035	-1.341	0.046	1.026	-0.006	-0.217	-0.025	-0.587
$\ln p^2/\gamma_2$	-0.025	-1.373	-0.010	-0.281	0.012	0.499	0.033	0.894
A_1	-0.140	-1.417	0.057	0.413	-0.062	-0.940	-0.087	-0.838
A_3	0.114	2.097	0.213	3.067	0.116	2.795	0.126	2.056
A_4	0.135	2.817	0.261	3.094	0.129	3.200	0.112	1.948
A_5	0.188	3.795	0.397	4.114	0.088	1.815	0.074	1.089
A_6	0.207	4.043	0.278	3.378	0.108	2.826	0.079	1.362
A_7	0.182	3.069	0.247	2.327	0.163	1.580	0.193	1.122
A_8	0.354	7.161	0.289	3.452	0.140	2.384	0.114	1.343
$EXPER$	0.019	4.504	-0.022	-0.296	-0.039	-0.935		
$EXPER^2$	-0.000	-2.408	-0.001	-7.052	-0.002	-9.158	0.009	10.581
C					-0.014	-0.640	-0.042	-1.240

Table 6: Results for the IV estimator for the wage equation in levels and difference wage equation. The standard errors are calculated using robust HAC estitmators (cf. Davidson and MacKinnon, 1993, ch. 17) In all models below, we also control for fixed time effects

	Males							
	Levels				Difference			
	IV		IV-Within		IV		IV-Within	
	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$
α	4.596	7.575						
$\ln p^1/\gamma_1$	0.043	2.122	-0.050	-1.210	0.055	1.406	0.109	1.590
$\ln p^2/\gamma_2$	-0.068	-1.629	0.047	0.984	-0.045	-1.020	-0.102	-1.350
A_1	-0.140	-0.878	-0.166	-2.887	-0.098	-0.729	-0.071	-0.480
A_3	0.096	2.507	-0.028	-0.709	-0.065	-1.601	-0.064	-1.431
A_4	0.094	1.999	-0.001	-0.029	0.040	0.976	0.052	1.145
A_5	0.149	3.393	0.064	1.754	0.056	1.370	0.060	1.370
A_6	0.145	2.806	0.022	0.416	0.059	1.463	0.062	1.411
A_7	0.157	3.053	-0.032	-0.543	-0.003	-0.051	0.010	0.157
A_8	0.166	3.074	0.100	2.204	0.067	1.548	0.057	1.195
$EXPER$	0.038	10.127	-0.077	-2.651				
$EXPER^2$	-0.001	-8.575	-0.001	-11.965	-0.001	-12.940	0.076	7.740
C					0.026	1.447	0.023	1.083
	Females							
	Levels				Difference			
	IV		IV-Within		IV		IV-Within	
	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$
α	4.080	14.469						
$\ln p^1/\gamma_1$	-0.031	-0.684	0.034	0.812	-0.009	-0.236	-0.053	-1.130
$\ln p^2/\gamma_2$	-0.001	-0.021	0.024	0.633	0.042	1.150	0.089	2.051
A_1	-0.139	-0.964	0.060	0.436	-0.057	-0.843	-0.084	-1.110
A_3	0.116	1.875	0.211	2.909	0.112	2.695	0.125	2.796
A_4	0.134	1.275	0.264	3.041	0.128	3.219	0.116	2.819
A_5	0.188	1.367	0.394	3.918	0.083	1.750	0.073	1.514
A_6	0.206	1.260	0.278	3.321	0.102	2.644	0.078	1.769
A_7	0.184	1.585	0.250	2.230	0.158	1.578	0.194	1.652
A_8	0.349	2.979	0.288	3.315	0.133	2.297	0.111	1.818
$EXPER$	0.019	2.741	-0.022	-0.279				
$EXPER^2$	-0.000	-1.584	-0.001	-6.772	-0.002	-8.641	0.009	14.897
C					-0.016	-0.762	-0.043	-1.852

to the first-order correlation created by differentiating the data considered.[12]

As is evident from Section 5 are these estimators consistent under particular set of assumptions concerning worker heterogeneity and measurement errors. (1) If there are neither measurement errors nor endogeneity and selection all estimators are consistent. (2) If there are no measurement errors and no selection, the OLS estimator is not consistent. (3) If there are no measurement errors, the Within estimators on first difference data are consistent. (4) If measurement errors are present, the corresponding IV Within estimator is consistent.

It is possible to test between the different models using Durbin-Hausman-Wu specification tests and we will do such tests. We have, however, chosen to also present results from the estimates of all the different models, for two reasons. First, the power of such tests is known to be very low. Presenting the results from estimations under different sets of assumptions enables us to judge the robustness of the estimators. Second, by studying in which direction and by what magnitude the estimates change, we can study to what extent endogeneity, selection and measurement errors are present.

There are three main sets of variables. First, the two measures of risk exposure, second a vector of indicator variables, $\mathbf{A}$, for different firm sizes measured as the number of employees at the worker's workplace and third, a variable for general labor market experience and its square. Finally, we have included an indicator variable, C, which take the value one for those who

[12] We experimented with the lag length in the estimation of the Newey and West covariance matrix. However, very small changes (third decimal) in the estimation of the standard errors of the estimates were found.

cahange occupationel code, i.e., it measures the average returns of changing occupation.

The focus of this study is on the two measures of risk exposure. Let us begin by examining the results from the male sub-sample. Columns two and three in Table 5 show that the OLS model gives significantly *negative* compensating wage differentials for the risk for work-related diseases. This unexpected effect disappears, however, when fixed effects are included to control for endogeneity and selection in the Within estimator and it cannot be found in the subsequent estimators.

The first difference Within estimator and corresponding IV estimator, removes individual-specific wage profiles. Based on a Durbin-Hausman-Wu test, a random coefficient specification of ϕ_i is rejected.[13] The results from these estimators are similar to the OLS (IV) estimator in difference, however with less precision. The effect of $\ln p^1$ has increased from the within estimators. This implies that all estimators except for the First difference-Within estimator are biased (even if there is no measurement error). The effect of neglecting ϕ_i would be that the compensating variation is underestimated. The risk measures are not significantly different from zero in any of these models.

The estimates on the female sub-sample provides a somewhat different picture. The coefficient for work accident risk exposure is not significantly different from zero in any of the estimated models. However, the effect of risk exposure to work-related diseases is monotonous increasing with the less restrictions put on the estimator. The effect is significantly positive in the

[13] The Hausman test is 49.26 with 31 degrees of freedom gives a p-value less then 0.02.

first difference IV Within estimator. Given the assumed bias of endogeneity, selection and perception (or measurement error) this is what can be expected.

Although secondary in this study, the estimates of the **A** vector give several significant results. A_2, workplaces between 2 and 9 employees, is the omitted category. The OLS estimates show a monotonically increasing wage premium for being employed by a large employer. For the male sub-sample, this seems mostly to be an effect of endogeneity and selection, as the estimates are not significantly different from zero when the first difference Within estimator is used. This does not seem to be the case for the female sub-sample, however: The monotone increase remains, although on a slightly lower magnitude, also when we control for endogeneity and selection.

The estimates for work experience may, at first sight, seem somewhat confusing as they "change signs" from being significantly positive in the OLS model, to being significantly negative in the Within estimator model. However, remember that the specification also includes an indicator variable for each year included in the panel. As these extract every possible trend, the negative coefficient for work experience tells us that earnings increase at a decreasing rate over the life cycle, i.e., the experience-earnings profile is concave.

Finally, let us turn to the effect of the 1977 reform of the compulsory Work injury insurance. There were around 35 changes of occupations each year before the reform in 1977. In the era before the reform, i.e., $1970 - 1977$, there were exactly 227 changes and the era after the reform contains 628 changes in occupation. In order to save degrees of freedom, we have limited the additional variable to an interaction between an indicator variable for the

Table 7: Estimated effect (IV-Within estimator on the differences wage equation) of the 1977 reform. Male and female sub-samples, respectively.The standard errors are calculated using robust HAC estitmators (cf. Davidson and MacKinnon, 1993, ch. 17) In both models, we also control for fixed time effects

	Males			Females		
	$\widehat{\theta}$	$\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}$	$\widehat{\sigma}_{\widehat{\theta}}$	$\widehat{\theta}/\widehat{\sigma}_{\widehat{\theta}}$
$\Delta \ln p^1$	0.107	0.068	1.580	-0.051	0.046	-1.102
$\Delta \ln p^2$	-0.118	0.082	-1.439	0.159	0.098	1.617
ΔA_2	0.068	0.150	0.454	0.090	0.076	1.185
ΔA_3	0.006	0.145	0.044	0.221	0.082	2.702
ΔA_4	0.122	0.142	0.861	0.212	0.073	2.909
ΔA_5	0.130	0.138	0.937	0.162	0.082	1.980
ΔA_6	0.132	0.140	0.940	0.172	0.082	2.095
ΔA_7	0.081	0.150	0.537	0.276	0.126	2.194
ΔA_8	0.128	0.145	0.881	0.203	0.092	2.210
$\Delta EXPER^2$	0.076	0.010	7.458	0.008	0.001	14.825
C	0.024	0.021	1.113	-0.040	0.023	-1.741
$\ln p^2 * REFORM$	0.024	0.062	0.389	-0.093	0.096	-0.967

reform ($REFORM$), which takes the value one after 1977 and zero before that year, and the risk variable for work-related illness.

The results - using the IV-Within estimator on the differences wage equation - are shown in Table 7. Standard errors are again estimated using the White (1980) and Newey and West (1987) procedures.[14] The key result here is of course the coefficient for the interaction between the indicator for the implementation of the new work injury insurance ($REFORM$) and risk exposure to work-related diseases ($\ln p^2$). Table 7 shows that the estimates of this parameter are insignificantly different from zero for both males and females.

7 Conclusions

The results obtained in the study show that there are compensating wage differential for risk exposure to work-related diseases in the female sub-sample. Women report more work-related diseases and men more work accidents. As pointed out by e.g. Smith (1979), the workers' perception of the risk exposure is vital for the existence of compensating wage differentials. The worker may ask for compensation for the risk he or she consider to be most important. This is likely to be the explanation to why there are significant compansating wage differentials for work-related diseases to female workers.

Several results indicate that not considering endogeneity, selection and measurement errors may give misleading results. For females, the index for

[14] We experimented with the lag length in the estimation of the Newey and West covariance matrix. Very small changes (third decimal) in the estimation of the standard errors were found.

risk exposure to work-related diseases turned out to be significantly negative in the OLS estimates, but switched signs and became significantly positive when using the first difference IV-Within estimator. The OLS coefficient estimate for the risk exposure to work-related illnesses is also significantly negative for the male sub-sample.

The estimates of the effect of the introduction of the insurance for work-related diseases turned out to be insignificantly different from zero for both males and females. However, in this context it should be noted that assessing the *change* in the compensations is empirically much more subtle than just estimating compensating wage differentials. Another explanation to the insignificant changes in compensating wage differentials is that the increased information on risk exposure for work related diseases, which was also an element of the reform, counteracted the "crowding out" of compensating wage differentials.

Appendix. Changes in Work Injury Compensation

The work injury insurance[15] gives economic compensation to workers with permanent as well as transitory health deficiencies due to work injuries. The first 90 days, a worker suffering from a work injury will receive benefits from the compulsory sickness insurance, which provides income compensation for all sick leaves, regardless of cause. For suspected work injuries persisting after the end of the coordination period, an evaluation of the claim will be made by the social insurance office. If the health deficiency is classified as a work injury, it will be classified as either a temporary or a permanent injury.

For temporary work injuries, the work injury insurance compensates forgone earnings in addition to the sickness insurance up to 100 percent of foregone earnings. Workers with permanent health deficiencies caused by a work injury get an annuity which will depend on the annual income and the degree of incapacity. If the worker is disabled due to the work injury, i.e., can carry out no work at all, he or she will get an annuity corresponding to the earnings at the job where the work injury was acquired. If the worker is not disabled, but restricted to taking a less paid work due to the work injury, the annuity from the work injury insurance will compensate for the wage loss.

The level of economic compensation from the work injury insurance has also undergone some changes during the time period analyzed in this study. The compensation level was increased in the reform of 1977. Under the

[15] The major form of compensation is income compensation. Health expenses are only covered by the work injury insurance in cases where these are not covered by the official health insurance.

previous law, a percentage of the wages[16] was multiplied by the degree of incapacity to obtain the annuity amount. The new work injury insurance fully compensated for the income loss for incomes up to 7.5 basic amounts.

Some additional compensation is also available from the TFA insurance. After 1974, an individual suffering an accident at work resulting in a sick leave of more than eight days can receive compensation so as to fully compensate for the income loss. For victims of work-related illnesses, no benefits are paid until the claim has been evaluated by the social insurance office. In practice, workers being incapacitated due to work injury have received full income compensation from 1974 and onwards.[17]

[16] The calculation was as follows: income falling within two basic amounts was fully compensated, income falling within the third basic amount was compensated at 75 percent and income falling within four and five basic amounts was compensated by half. Income above five basic amounts was not compensated at all.

[17] In the case of a fatal outcome, an annuity will be paid to widows and children. Burial costs will also be covered by the official work injury insurance.

References

1. Arellano, M. (1987), "Computing robust standard errors for within-groups estimators", *Oxford Bulletin of Economics and Statistics* **49**, 431-434.

2. Brown, C. (1980), "Equalizing differences in the labor market", *The Quarterly Journal of Economics* **94**, 113-134.

3. Duncan G. and B. Holmlund (1983), Was Adam Smith right after all? Another test of the theory of compensating wage differentials", *Journal of Labor Economics* **1**, 366-377.

4. Erikson R. and Åberg Y. (1987), "*Welfare in transition - Living conditions in Sweden 1968-1981*", Oxford: Clarendon Press.

5. Garen, J. (1988), "Compensating Wage Differentials and Endogeneity of Job Riskiness", *Review of Economics and Statistics*, **70**, 9-16.

6. Gibbons, R. and L. Katz (1992), "Does unmeasured ability explain inter-industry wage differentials", *The Review of Economic Studies* **59**, 515-535.

7. Hause, J. C. (1980), "The fine structure of earnings and on-the-job training", *Econometrica* **48**, 1013-1029.

8. Hwang, H-S, R. Reed och C. Hubbard (1992), "Compensating wage differentials and unobserved productivity", *Journal of Political Economy* **100**, 835-858.

9. Lillard L. and Weiss, Y. (1979), "Components of variation in panel earnings data:American Scientists 1969-70", *Econometrica* **47**, 437-454.

10. MaCurdy, T. (1982), "The use of time series process to model the error structure of earnings in a longitudinal data analysis", *Journal of Econometrics* **18**, 83-114.

11. Newey, W. and K. West (1987), "A simple positive semi-definite, heteroscedasticity and autocorrelation consistent covariance matrix", *Econometrica* **55**, 703-708.

12. Oi, W. and T. Idson (1999) "Firm size and wages", in O. Aschenfelter and D. Card (eds.) *Handbook of Labor Economics vol 3*, 2165-2214, Amsterdam: North Holland.

13. Östlin, P. (1989), "*Occupational career and health : methodological considerations on the healthy worker effect*", Stockholm : Almqvist & Wiksell International.

14. Rosen, S. (1986), "The theory of equalizing differences", in O. Aschenfelter and R. Layard (eds.) *Handbook of Labor Economics*, Amsterdam: North Holland.

15. Smith, R. (1979), "Compensating Wage Differentials and Public Policy: a Review", *Industrial and Labor relations Review* **32**, 339-352.

16. Thaler, R. and S. Rosen (1976), "The value of saving a life: Evidence from the labor market", in R. Terlekyj (ed.) *Household production and consumption*, Princeton: NBER.

17. Topel, R. (1991), "Specific capital, mobility and wages: Wage rise with seniority", *Journal of Political Economy* **99**, 145-176.

18. Vågerö, D and A. Gullberg (1996), "*Yrke och dödlighet under 1980-talet*", EpC-rapport 1996:3, Stockholm: Socialstyrelsen.

19. Viscusi, W. K. (1993), "The Value of Risk to Life and Health" *Journal of Economic Literature* **21**, 1912-1946.

20. White, H. (1980), "A heteroscedasticity-consistent covariance matrix estimator and a direct test of heteroscedasticity", *Econometrica* **48**, 817-838.