Wage-risk relationship tests in hedonic wage models in the Czech Republic[#]

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Introduction

The idea that higher risk of occupational mortality may result in higher wage payment to the worker is quite plausible.[1] The economists have therefore been focusing their effort to reveal a trade-off between money and fatality risk in order to derive a compensating wage differential. Such a wage differential is then used to derive the so-called value of statistical life.

Viscusi and Aldy (2003) documented more than 50 labour market studies that provide a value of statistical life (VSL) derived from the wage compensating differential. According to their comprehensive literature survey, most of these studies are dominated geographically by the US labour market. Only six of them were conducted in developing Asian countries (Hong Kong, India, Taiwan), and another six in Europe; however, five of those were conducted in the UK (with the one in Austria). There is, however, an amount of studies that do not confirm any statistical relationship between the workplace risk and the wage level even when their authors treated properly risk endogeneity and corrected unobserved heterogeneity.[2]

The VSL estimated form of the hedonic wage differentials range between \$0.5 to \$21 million (2000 dollars) in the US, \$4 to \$74 million in the UK, or \$0.2 to \$4.1 million in Asia (excluding Japan). The central estimate of the VSL value provided by a meta-analysis by Mrozeck-Taylor (2002) yields \$1.6 to \$2.7 million; by CSERGE (1999) it is as high as €6.5 million and Viscusi-Aldy (2003) provide a mean VSL of €5 million.

Most hedonic wage studies estimate the wage differential econometrically on individual worker data. There is also a group of empirical studies that examine the relationship between the statistical rate of occupational injuries and the wage for industries. For instance, Jennings and Kinderman (2003), using industry-specific data, examine the statistical relationship between changes in occupational mortality rate and in hourly wages in the USA.

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[1] Adam Smith in his well-known book 'The Wealth of Nations' (1776; Chapter X, part I) has already noted that "*The wages of labour vary with the ease or hardship, the cleanliness or dirtiness, the honourable or dishonourableness of the employment… A journeyman blacksmith, though an artificer, seldom earns so much in twelve hours as a [labourer] does in eight. His work is not quite so dirty, is less dangerous…"*.

[2] For instance, Hintermann et al. (2007) do not confirm statistical relationship between workplace risk and wage level in a panel dataset of UK workers.

Considering the econometric problems related to risk endogeneity and unobserved heterogeneity, an estimation of a wage compensating premium might indeed be a challenge, particularly when work-related injuries decline over time. In fact, working conditions have been significantly improving in the Czech Republic since 1990. While the official statistics of the State Labour Inspection Office (SUIP) recorded almost 300 cases of fatal injuries and about 100,000 cases of non-fatal injuries annually in the mid nineties, there are only 137 fatal injuries and less than 80,000 cases of non-fatal injuries recorded just recently.[3]

The aim of our paper is threefold. Firstly, we aim to examine the statistical relationship between changes in occupational mortality rate and average wages while controlling an effect of labour productivity. We follow here a similar logic as Jennings and Kinderman (2003) who examined the relationship between the changes in occupational mortality rates and in hourly wages in order to examine the reliability of using the WTP/WTA concept for valuing life. We assume that statistically significant evidence for the relationship between risks and wages being found in an individual employee's behaviour could be, on average, also found for the economic industries. Secondly, we estimate the hedonic wage differential from hedonic wage models in order to be able to derive a value of statistical life. We intend to estimate a wage compensating differential from three datasets in total. Finally, we would like to compare our VSL estimates with those obtained using other methods in the Czech Republic and/or abroad.

The structure of the paper is as follows: first, we describe the econometric model, then we describe our datasets and results of our model estimates. The last chapter concludes.

Econometric Model

Econometric estimation of a wage compensating differential from a hedonic wage function is a well-documented exercise. The wage-risk relationship in labour markets is mostly estimated from the following equation (Viscusi-Aldy, 2003; or Haab-McConnell, 2002):

$$w_i = \beta_0 + \beta_1 WORKER_i + \beta_2 JOB_i + \beta_3 RISK_i + \beta_4 RISK \cdot COMP_i + \beta_5 X_i + \varepsilon_i \qquad (1)$$

where **WORKER** is a vector of personal characteristic variables including human capital measures such as education, experience and skills for worker *i*, **JOB** is a vector of job characteristic variables for the concerned worker, **RISK** might be a vector of variables describing risks of fatal and non-fatal injuries and occupational illnesses, **COMP** describes compensations (pecuniary or in-kind) provided to this worker, and **X** might include other variables including interactions of the fatality risk and personal characteristics (gender, age, trade union status) to capture the heterogeneity in the risk perception and aversion; ε_i is the random error capturing unmeasured factors affecting the worker's wage rate.

Most hedonic wage studies have estimated the wage equation using linear and semi-logarithmic specifications. Although, as argued by Rosen (1974), choosing a preferred functional form from these specifications cannot be determined on theoretic grounds, one can employ a flexible functional form given by the Box-Cox transformation to identify the specification with the greatest explanatory power (Moore and Viscusi, 1988).

[3] In relative terms, while SUIP statistics recorded 0.6 cases of fatal and almost 230 non-fatal injuries per 10,000 employees per year in 90's, job-related risks declined at 0.3, respectively 180 injuries per 10,000 in 2005.

Transformation of the dependent variable in our hedonic wage models is the typical form for Box-Cox models and its form is as follows:

$$w(\lambda) = \begin{cases} \dfrac{w^{\lambda}-1}{\lambda} & \text{for } \lambda \neq 0 \\ \ln(w) & \text{for } \lambda = 0. \end{cases} \qquad (2)$$

Then, the marginal effect of fatal risks obtained from the hedonic wage function (1) is given as (see e.g. Haab-McConnell, 2002):

$$\frac{\partial w_i}{\partial RISK_i} = w_i^{1-\lambda} \cdot \beta_3 \qquad \textit{… for a linear form of fatal risk, or}$$

$$= w_i^{1-\lambda} \cdot (\beta_3 + 2\beta_{3q}) \qquad \textit{… for a quadratic form of fatal risk} \qquad (3)$$

where β_{3q} is a coefficient for the square of fatal risk being estimated in the hedonic model.

The value of statistical life can then be derived as:

$$VSL = \frac{w^{1-\lambda} \cdot (\beta_3 + 2\beta_{3q})}{R} \qquad (4)$$

where the β's are the coefficients estimated for the fatal risk variable(s), *w* is the annual average wage, λ is the best parameter for the Box-Cox transformation of the dependent variable, and R describes a denominator of fatal risk, i.e. 1 in 10,000 per year.

Data

We estimate the hedonic wage differentials for the Czech labour market on three datasets. In this section we describe each of these dataset briefly.

Statistical averages of industry performance indicators

We gather the following statistical data compiled by the Czech Statistical Office:

- fatal injuries, non-fatal injuries with working disability longer than 3 days and without any incapacity to work[4],
- financial compensations provided by the firm to its employees and industry expenditures on labour safety and occupational risk prevention,

[4] We also experimented with 'new cases of job-related illness' and 'days of sickness due to job-related illnesses'. These variables do not significantly contribute to explain employee's wage.

- economic variables such as the added value, paid wages and the number of employees.

These data cover the period 2003 to 2005 and 57 industries in the Czech Republic based on the NACE 2-digit level. We leave out industry 13 *"Mining and quarries of iron materials"* in that production, i.e. quarrying, was finished in mid of nineties what yields in total 3*56, i.e. 168 observations for each variable.

Variables describing various types of *relative risk, i.e. 'fatal', 'injur3', 'injury'* and so on, are expressed per 1,000 employees per year and a given industry and are calculated as the number of injuries per year divided by the number of employees working in the given sector and year. Similarly, we derive the average annual gross wage per employee from the labour costs per year. Using information on the tax regime, we then also obtained a *net annual wage* per employee in a given sector and year. The effect of productivity and technological change is controlled by industry-specific labour productivity (variables, i.e. *'LP'* variables) given as GVA per employee in millions of Czech crowns, or the '*Year'* variable respectively. Expenses on labour safety prevention – *'kcprevent'*, and compensation payments paid to workers – *'kcpain'*, are expressed in thousands of CZK per employee; these data are, however, reported only for two years (2004-2005), which can yield statistically less significant estimates. All financial data are recalculated at the 2005 price level by CPI. Any effect of industry is controlled by *industry dummies*; see Appendix for more details.

We then experiment with three sub-samples assuming different behaviour pattern within these industries; we construct the following sub-samples that we have the observations for:

- manufacturing, construction and transport industries (24 industries giving us 72 observations) – 'INDUSTRY',
- industries with positive fatal workplace injury rates (86 observations over 3 years) – 'POSITIVE',
- industries with positive rates of fatal injury excluding service industries, i.e. NACE 65+ is left out (giving us 68 observations) – 'MANUAL POSITIVE'.

On average, wages decline with manual industries, while fatal risk increases. Labour productivity, wages, and fatal risk rates are the lowest in the manufacturing, construction and transport industries. Non-fatal injuries appear, however, most often in these industries. As one would expect, fatal risks are the largest in the MANUAL sub-sample.

Individual data from "Quality of Occupational Life – 2006 Survey"

Individual data from a survey on the "Quality of Occupational Life" is used in our second hedonic wage model testing. The survey was conducted jointly by the Sociological Institute of the Academy of Sciences – Public Opinion Research Centre, Occupational Safety Research Institute, and Charles University Environment Center in October 2006 with a quota sampling strategy applied to the economically active population of the Czech Republic. The dataset consists of 2,043 observations. The following figure displays some of the descriptive statistics. Urban and Ščasný (2007a; 2007b) describe the survey in more detail.

After identifying the respondent's occupation (from nine categories) and the industry she works (17 categories), we attribute objective, statistical say, risk of fatal and non-fatal injuries. Risk rates expressed per 10,000 employees are based on SUIP database.

Using data from the survey, we create a variable that indicates whether the respondent is believed to be exposed to risks[5]. We use this variable as a filter to create our sub-sample on exposed to risk that have 1,373 observations (67% of all respondents). TABLE A2 reports some of the descriptive statistics.

Individual data from "Working Conditions – 2000 Survey"

A working conditions survey was conducted by STEM/MARK. The questionnaire contains questions on physical factors affecting the quality of working conditions, working time, work organisation, social workplace environment and other measures describing the subjective perception and objective factors of the workplace. All the questions are related to the respondent's full-time job ignoring working conditions of part-time jobs.

The risk character of the job can be measured by question Q34, which explicitly asked the respondent whether s/he thinks that her/his job brings her/himself any danger to safety and health. If answered positively, s/he is asked about 23 kinds of effects that might be related with this exposure. Using this information, we create two variables on exposure to physical factors and "psychological" risks. The dichotomous variable on occupational risk due to physical factors *('risk_fyz')* considers the respondent's suffering from health problems related to hearing, eyesight, skin, respiration or the cardiovascular system, or her/his aches in the back, head, stomach, muscles, legs or hands, or allergies caused by the work. Psychic causes such as stresses, tiredness, sleep deficit, anxiety, being on the edge, or having a trauma from the job constitute the dichotomous variable *'risk_psy'*. Moreover, awareness of physical aggression stemming from other people or her/his colleagues in the job makes the third variable *'risk_aggres'*.

Similarly to our previous dataset, we use statistical data on fatal and non-fatal risk rates for each of the nine professions and five economic sectors (aggregated in agriculture, industry, construction, transport, and services) expressed in 10,000 per year.[6]

We use other variables describing exposure to a variety of physical factors (7-level Lickert scale) such as vibrations from hand-equipment and machinery, noise, high temperature, low temperature, breathing waste products, vapours from toxic substances and dust, manipulation with dangerous products or x-radiation, etc..

The reported average net monthly wage is normalised to full-time, i.e. 42 hours of work per week. Our data only allows the establishment of dichotomous variables for a wage compensation for risk exposure (*'wage supplement'*) and extra payments for working weekends (*'weekend'*) and nights (*'night'*). We control the effect of experience (*'working experience'*) and whether the respondent has subordinates (*'boss'*). We use binary variables for economic industries and professions (following the standardised Classification of Occupations).

We experiment with several sub-samples: first of all, we analyse the hedonic wage differentials for the full data set (N=887) and, then, on a dataset from which we laeve out (i) independent earners, (ii) employees working less than 40 and more than 70 hours per week,

[5] We use three dichotomous variables for detecting whether i) she/he is in contact with machineries while working, ii) she/he travels by car for business travel (as a driver or a passenger), or iii) she/he is in contact with persons who can physically attack her/him, i.e. situations dominating causes of fatal injuries reported in the official Czech statistics.

[6] There is a weak correlation between *'risk_fyz'* – *'risk_psy'* (Pearson coeff.=0.52), and *'fatal_risk'* – *'nonfatal_risk'* (Pearson=0.44). Except these two one, we confirm no correlation between our three measures of subjective perception of job risks and objective fatal and non-fatal risks (Pearson coeff. is lower than 0.1).

and (iii) those having more than one job (it results in new sub-sample of 634 observations). Then, from these two samples, we construct other sub-samples that consist only of males (N=439, or N=318), blue-collars workers (N=350, or N=266), and blue-collars males (N=232, or N=179). The mean reported annual net wage for our sub-samples ranges between 9,000 and 11,600 (2000 Czech crowns), while it is higher for males and lower for blue-collars workers.

Model Estimation

In each dataset, we estimate econometrically the risk premium in the wage as in eq. (1). The dependent variable in the hedonic wage function, i.e. gross or net annual wage, is first transformed by the Box-Cox approach as in eq. (2). We tried power parameters of the lambda between -2 to +2 by 0.005 to get a shape of the log likelihood function, particularly looking at the region around 0 and -1. We identify whether a power parameter like $\lambda=0$ or $\lambda=1$ is found to be in the confidence interval. If this is the case, these values are used in the VSL calculations instead of the optimal power parameter. To be able to compare VSL's estimated by the optimal power parameter, we also estimate the hedonic wage function for $\lambda=0$ or $\lambda=1$, i.e. assuming semi-logarithmic or linear specification of the model. Hedonic wage models are estimated by maximum likelihood in SAS.

The value of a statistical life is then derived – as in eq. (4) – from the hedonic wage differentials estimated from equation (3). The VSL is calculated for an average of 2005 wages either from the net or the gross one[7], while the risk rates are expressed in 1,000. If a linear form of fatal risk was represented in the model, a VSL would be derived as $(1{,}000 * \beta_3)$ for a linear hedonic wage model, i.e. $\lambda=1$, whilst it would be $(w * 1{,}000 * \beta_3)$ for a semi-logarithmic specification of the hedonic wage model.

Industry-specific performance indicators

In line with one's intuition, labour productivity is the strongest predictor of the wage in the sectors with a positive and significant coefficients. The trend variable is only significant in few of our models with an intuitively correct sign (+). Investing in labour safety prevention also decreases wage compensating premiums. The robustness of our models is increased by using industry dummies.

There is no statistically significant relationship between work-related fatalities and the wage level if the hedonic wage differential is estimated from the full sample, i.e. considering all the industries of the Czech economy. After transforming the dependent variable, i.e. the net annual wage with the optimal power parameter, i.e. $\lambda=-0.455$, the VSL is about €4.3 million. The estimate of the fatal risk coefficient is, however, not significant even at 10% (p-value is at least 0.13; Adj.$R^2=0.19$). A semi-logarithmic model specification yields even less significant estimates of the hedonic differential; the linear specification yields the least significant one. Still not significant, VSL's get smaller if derived from linear or semi-log model specifications rather than by using the optimal power parameter of the Box-Cox transformation; see Table 1.

[7] We apply the exchange rate of 29 CZK per €, and 14 CZK per €, while purchasing power parity is applied.

We also do not find any relationship between fatal risk and wages when only manufacturing, construction and transport industries, i.e. the ‘INDUSTRY’ sub-sample, are considered.[8]

Table 1: Estimation results – ‘FULL SAMPLE’

	best lambda (gross wage)		best lambda (net wage)		convenient lambda (net wage)		semi-log (net wage)		linear (net wage)	
Intercept	1.885	>= <.0001	2.019	>= <.0001	1.873	>= <.0001	5.539	<.0001	266.753	<.0001
fatal	0.031	>= 0.1051	0.038	>= 0.1317	0.030	>= 0.1270	0.408	0.184	70.884	0.422
LP	0.006	>= 0.0005	0.007	>= 0.0005	0.006	>= 0.0005	0.092	0.000	23.763	0.002
nace_agri	-0.021	>= <.0001	-0.027	>= <.0001	-0.021	>= <.0001	-0.332	<.0001	-87.267	0.000
nace_ind	-0.008	>= 0.0006	-0.010	>= 0.0008	-0.008	>= 0.0008	-0.132	0.000	-40.036	0.000
lambda	-0.5		-0.455		-0.5					
LogL	-731.6		-680.7		-680.7		11.59		-939.4	
Rsq.	0.210		0.207		0.207					
Adj.Rsq.	0.191		0.187		0.187					
No Obs.	168		168		168		168		168	
VSL (mil.€)	**6.34**		**4.29**		**4.35**		**3.70**		**2.44**	

Table 2: Estimation results – ‘POSITIVE’

	best lambda (gross wage)		convenient lambda (gross wage)		best lambda (net wage)		convenient lambda (net wage)	
Intercept	68.69	>= <.0001	301.07	>= <.0001	2.05	>= <.000	5.69	>= <.000
fatal	22.16	>= 0.0345	145.25	>= 0.0333	0.04	>= 0.040	0.55	>= 0.042
injur3	-0.39	>= <.0001	-2.67	>= <.0001	0.00	>= <.000	-0.01	>= <.000
kcprevent	57.24	>= <.0001	407.33	>= <.0001				
LP					0.02	>= <.000	0.34	>= <.000
year								
textil	-16.90	>= <.0001	-98.26	>= 0.0003	-0.04	>= <.000	-0.42	>= 0.000
chemie	-10.62	>= 0.0597	-79.85	>= 0.0307				
vehicles	-8.82	>= 0.1155	-67.82	>= 0.0644				
metalurg					0.02	>= 0.005	0.22	>= 0.005
tran					-0.01	>= 0.056	-0.15	>= 0.035
lambda	0.675		1		-0.45		0	
LogL	-186.7		-187.1		-334.3		-335.7	
Rsq.	0.8		0.816		0.533		0.531	
Adj.Rsq.	0.774		0.792		0.497		0.497	
No. Obs.	53		53		86		86	
VSL (mil.€)	**4.96**		**5.01**		**6.08**		**6.04**	

[8] Linear model specification, i.e. $\lambda \approx 1$ fits these data best. The best lambda ranges around +0.4 for gross wage and +0.6 for net wage. VSL derived from gross wage differential is about 6.8 mil. € (p-value of β coefficient is 0.25, adj.R^2=.48), VSL derived from net wage is about 5.0 to 5.4 mil. € (p-value ~ .22, adj.R^2=.49).

Table 3: Estimation results – 'MANUAL POSITIVE'

	best lambda (gross wage)		convenient lambda (gross wage)		best lambda (net wage)		convenient lambda (net wage)	
Intercept	6134.82	>= <.0001	182.55	>= <.0001	-3204389.1	>= <.0001	-5902363.4	>= <.0001
fatal	12419.98	>= 0.0021	108.21	>= 0.0064	12994.70	>= 0.0004	24082.50	>= 0.0003
injur3	140.48	>= 0.0001	1.54	>= <.0001	123.70	>= 0.0001	222.20	>= 0.0002
injury	95.33	>= 0.0011	0.90	>= 0.0020	86.10	>= 0.0009	158.10	>= 0.0009
LP	9079.38	>= <.0001	93.34	>= <.0001	7982.30	>= <.0001	14477.90	>= <.0001
year					1602.80	>= <.0001	2951.50	>= <.0001
lambda	1.815		1		1.89		2	
LogL	-197.9		-199.7		-172.4		-172.4	
Rsq.	0.929		0.92		0.94		0.941	
Adj.Rsq.	0.909		0.867		0.921		0.922	
No. Obs.	68		68		68		68	
VSL (mil.€)	**4.08**		**3.73**		**3.33**		**3.37**	

Note> Industry dummies used: agric, food, textile, wood, chemie, vehicles, furniture, energy, water, wholesale, and telecom. All are significant at the 5% level, except 'vehicles' for gross wage that is significant at 10%.

We confirm a significant wage-risk relationship at 95% significance level when all industries with zero fatal rates were excluded from our dataset ('POSITIVE'). Controlling for the effect of expenditures on labour safety prevention (*'kcprevent'*) but on the other hand having data only for 2004-2005, VSL becomes about 10 to 20% smaller than without such control. The models also hold to be very powerful with Adj.R^2=0.80 (gross wage), or Adj.R^2=0.95 (net wage). Exclusion of this variable decreases Adj.R^2 to 0.49. We find that a linear specification, i.e. convenient λ=0, fits better our hedonic model with the gross wage as the dependent variable, while it is the semi-log specification that fits better the model explaining the net wage. Using the convenient lambda rather than the optimal power specification decreases the VSL only up to 1% in our best models. If the effect of *'kcprevent'* is not controlled, the VSL is about €6.04 million (from gross wage), or €4.25 million (from net wage); see Table 2.

A wage-risk relationship is confirmed at a 99% level if we examined only industries with positive fatal risk rates and excluded the service branches ('MANUAL POSITIVE'). This holds, however, only if the entire dataset is used (or when the effect of *'kcpevent'* is not controlled). The VSL derived from the gross wage is about €4.1 million with the optimal power specification with λ=+1,815 (Adj.R^2=0.91), while it is €3.7 million for the convenient lambda λ=1 (Adj.R^2=0.87). The VSL derived from a linear model estimated by LIFEREG is €5.7 million. The VSL derived from the net wage is lower; it is about €3.4 million with the convenient λ=+2 and Adj.R^2=0.92; see Table 3 for more detail.

We display a statistically significant wage-risk relationship for non-fatal injuries only if industries with positive fatal risk rates are included and services excluded. Wage compensations for non-fatal injuries are two orders of magnitude lower than the compensations for fatal injuries. The value of a statistical injury with more than 3 days' incapacity to work is about €0.05 million, while it is about €0.03 million for an injury without work incapacity. These values would be about 30% lower if the net wage was used to estimate the wage differentials for non-fatal injuries.

Quality of Occupational Life – 2006 Survey

We regress the net wage on fatal and non-fatal occupational risks for the full sample and two sub-samples established that consist of those exposed to risks, either all or only male.

In all models, non-fatal risks are not significant, while the fatal risk and the fatal risk square are significant at almost a 99.9% level for the full sample, and at a 98% level for the sub-samples of the exposed respondents. All the coefficients of covariates have the right signs and are significant at 99% level. The net wage is higher if the respondent is managing people (boss), makes business trips by car (CARTRAVELLING), is male, has a university degree or A-level, has more children, or brings higher share of money to the family (BREADWIN). Variables described by KZAM denote type of profession (following the nine categories of Classification of Occupations), and those by OKEC denote classes of economic branches (NACE 1-digit level); see Table A2 for more detail.

The VSL calculated from the net monthly average wage is as high as €5.9 million (full sample), or €6.6 and 8.9 million, respectively, for the sample of those exposed to risks and for the exposed males. Semi-logarithmic specifications with $\lambda=0$ yield similar estimates of the VSL; see Table 4 for some of our estimation results.

Working Conditions – 2000 Survey

First, we examine the relationship between the subjective perception of risks (*'risk_fyz'*, *'risk_psy'*, and *'risk_aggres'*) and the reported wage. Our strong model which explains the net wage (adjusted $R^2=0.68$), however, does not contain any variable on subjective perception of risks. The wage is thus left to be explained by type of profession, economic sector and years of experience. A hedonic wage model that consists of our three variables is very weak (adjusted $R^2<0.1$) and subjective risk perception explains the wage variance by 1 to 3%. Only the effect of *'risk_fyz'* is weakly significant, while the effect of the other two is not statistically significant at all. Moreover, in some cases, our hedonic wage models yield the wrong signs. This could be due to the fact that the respondents do not consider these factors in their choice or due to the unobserved heterogeneity in labour productivity that we have not been able to reveal so far (see e.g. Hwang et al. 1992; Dorsey 1983; and Dickens 1984, who report wrong signs for risk coefficients).

We also do not confirm a positive relationship of an interaction of perceived risk and compensation paid with wages; the p-value is 0.16 for the relationship. Using these data, we do not confirm any statistically significant effect of the fatal injury rate on the wages; the p-value of the square of the fatal injury rate is about 0.18.

Table 4: Estimation results> datasets from the 2006 Survey.

	Full sample				All but exposed to risks				Males exposed to risks			
	Coeff.	Liberal p	Coeff.	Pr > ChiSq	Coeff.	Liberal p	Coeff.	Pr > ChiSq	Coeff.	Liberal p	Coeff.	Pr > ChiSq
Intercept	1.768	>= <.0001	1.718	<.0001	1.692	>= <.0001	1.657	<.0001	1.700	>= <.0001	1.770	<.0001
fatal	**0.148**	**>= 0.0015**	**0.136**	**0.001**	**0.157**	>= 0.0045	**0.145**	0.004	**0.138**	>= 0.0061	**0.163**	**0.005**
fatal2	**-0.021**	**>= 0.0016**	**-0.019**	**0.001**	**-0.024**	>= 0.0019	**-0.022**	0.001	**-0.017**	>= 0.0201	**-0.020**	**0.018**
boss	0.166	>= <.0001	0.150	<.0001	0.154	>= <.0001	0.141	<.0001	0.098	>= 0.0014	0.115	0.001
BUILDWOK					0.151	>= 0.1031	0.137	0.102	0.148	>= 0.0571	0.179	0.047
Cartravelling	0.082	>= 0.0001	0.073	0.000	0.109	>= <.0001	0.100	<.0001	0.080	>= 0.0031	0.095	0.003
MALE	0.185	>= <.0001	0.168	<.0001	0.189	>= <.0001	0.174	<.0001				
University	0.347	>= <.0001	0.312	<.0001	0.367	>= <.0001	0.335	<.0001	0.258	>= <.0001	0.307	<.0001
A-level	0.145	>= <.0001	0.132	<.0001	0.151	>= <.0001	0.140	<.0001	0.095	>= 0.0031	0.112	0.003
BREADWIN	0.561	>= <.0001	0.509	<.0001	0.603	>= <.0001	0.554	<.0001	0.385	>= <.0001	0.458	<.0001
KIDS	0.035	>= 0.0010	0.032	0.001	0.038	>= 0.0028	0.035	0.002	0.046	>= 0.0002	0.053	0.000
kzam1	0.562	>= <.0001	0.506	<.0001	0.551	>= <.0001	0.502	<.0001	0.526	>= <.0001	0.628	<.0001
kzam2	0.509	>= <.0001	0.461	<.0001	0.406	>= <.0001	0.372	<.0001	0.468	>= <.0001	0.556	<.0001
kzam3	0.342	>= <.0001	0.313	<.0001	0.286	>= <.0001	0.264	<.0001	0.308	>= <.0001	0.361	<.0001
kzam4	0.311	>= <.0001	0.286	<.0001	0.262	>= 0.0003	0.243	0.000	0.251	>= 0.0034	0.291	0.004
kzam5	0.241	>= <.0001	0.221	<.0001	0.234	>= <.0001	0.216	<.0001	0.299	>= <.0001	0.351	<.0001
kzam6	0.198	>= 0.0030	0.181	0.003	0.204	>= 0.0131	0.189	0.011	0.134	>= 0.0520	0.155	0.054
kzam7	0.305	>= <.0001	0.279	<.0001	0.280	>= <.0001	0.258	<.0001	0.282	>= <.0001	0.331	<.0001
kzam8	0.343	>= <.0001	0.313	<.0001	0.327	>= <.0001	0.301	<.0001	0.320	>= <.0001	0.376	<.0001
nace1	-0.108	>= 0.0538	-0.096	0.055	-0.120	>= 0.0820	-0.109	0.080				
nace4	-0.085	>= 0.0070	-0.076	0.007	-0.052	>= 0.1704	-0.047	0.171				
nace6	-0.042	>= 0.2679	-0.037	0.284	-0.145	>= 0.0708	-0.130	0.072	-0.123	>= 0.0701	-0.150	0.057
nace7	-0.129	>= <.0001	-0.118	<.0001	-0.137	>= 0.0005	-0.128	0.000	-0.071	>= 0.0794	-0.083	0.081
nace13	-0.103	>= 0.0156	-0.091	0.017	-0.097	>= 0.0754	-0.087	0.080	-0.087	>= 0.1727	-0.105	0.158
nace14	-0.065	>= 0.1122	-0.059	0.109								
nace15	-0.053	>= 0.1808	-0.048	0.169								
N	1 462		1 462		997		997		640		640	
λ used	**0.038**		**0**		**0.050**		**0**		**0.050**		**0**	
LogLikelih	-2212.0*		-406.3		-1603.7*		-313.7		-1096.3*		-201.0	
Adj R-Sq.	0.49				0.47				0.37			
VSL (mil.€)	5.91		6.04		6.57		6.67		8.87		8.80	

* Loglikelihood of lambda estimate.

Note: Exchange rate used 28.34 CZK/€ (2006).

Table 5: Estimation results> the datasets from the 2000 Survey.

dataset **dependent var**	**males (restricted)** *normalized (42.5 h/week)*			**blue-collars (restricted)** *as reported*			**blue-collars (restricted)** *as reported*			**blue-collars (full dataset)** *normalized (42.5 h/week)*		
Intercept	9,763	> =	<,0001	55,112	> =	<,0001	52,596	> =	<,0001	152,122	> =	<,0001
fatal	0,135	> =	0,097									
fatalsq				0,450	> =	0,003	0,386	> =	0,006	0,467	> =	0,087
fatalbreadwin	-0,157	> =	0,047	-2,155	> =	0,002	-1,839	> =	0,004			
fatalfemale				6,434	> =	0,063						
nonfatal				-0,005	> =	0,000	-0,005	> =	0,000	-0,017	> =	0,002
working experience	0,026	> =	<,0001	0,395	> =	<,0001	0,379	> =	<,0001	1,821	> =	<,0001
boss	0,108	> =	0,000	3,512	> =	<,0001	3,212	> =	<,0001	11,970	> =	<,0001
night				0,072	> =	<,0001	0,067	> =	<,0001	0,327	> =	<,0001
breadwin	0,148	> =	0,003									
age	0,025	> =	0,000									
age2	0,000	> =	<,0001	-0,002	> =	<,0001	-0,001	> =	<,0001	-0,008	> =	<,0001
female				-4,583	> =	<,0001	-4,057	> =	<,0001	-12,472	> =	<,0001
person				-0,661	> =	0,001	-0,598	> =	0,001	-3,324	> =	<,0001
eaperson				0,565	> =	0,010	0,516	> =	0,013	3,965	> =	<,0001
pecovatel				0,766	> =	<,0001	0,686	> =	<,0001	2,898	> =	<,0001
nace_prum	0,154	> =	0,001									
nace_slu	0,105	> =	0,020									
nace_stav	0,190	> =	0,000									
nace_dopr	0,188	> =	0,000	1,132	> =	0,032	1,063	> =	0,033	5,815	> =	0,013
KZAM4	-0,115	> =	0,038									
KZAM5	-0,151	> =	<,0001									
KZAM7	-0,127	> =	0,000									
KZAM8	-0,094	> =	0,011									
KZAM9	-0,332	> =	<,0001	-2,568	> =	<,0001	-2,352	> =	<,0001	-11,177	> =	<,0001
city1	-0,169	> =	<,0001	-2,920	> =	<,0001	-2,700	> =	<,0001	-13,524	> =	<,0001
city2	-0,142	> =	<,0001	-2,647	> =	<,0001	-2,478	> =	<,0001	-14,000	> =	<,0001
city3	-0,113	> =	0,000	-2,127	> =	<,0001	-1,979	> =	<,0001	-9,048	> =	<,0001
lambda	-0,02			0,215			0,21			0,335		
LogL	-3216			-2645			-2645			-3539		
Rsq,	0,48			0,66			0,65			0,62		
Adj,Rsq,	0,45			0,64			0,63			0,60		
VSL (2000 mil.€)	**5.2**			**10.0**			**8.8**			**3.0**		

Note: We use 35.61 CZK/€, which was the average exchange rate in 2000.

"Restricted" sub-sample denotes dataset from which we left out independent earners, employees working less than 40 and more than 70 hours per week, and those having more than one job.

We do confirm a statistically significant relationship between wages and objective fatal risks. This holds, however, only for the sub-sample consisting of either males or blue-collar workers in our 'restricted' sample. Moreover, 'fatal risk' has become a significant predictor of wages with a negative sign after controlling risk endogenously, i.e. entering the interactions of fatal risk and the respondent's personal characteristics. Wages are well predicted by 'working experience', being a boss or receiving additional wage supplements if working nights and/or weekends. Professions, industry dummies, and the size of the city predict the wages well too; see Appendix 3 for more detail.

The VSL varies significantly among the sub-groups (sub-samples say) of employees. The VSL for males is about 5 million €2000. The magnitude of the VSL estimate for blue-collar workers is larger – about 10 million €2000; this holds, however, only either for males or those who bring larger part of the income to the family. The VSL for the blue-collar workers is about 3 million €2000 if derived from the full dataset.

Concluding Remarks

We confirm a statistically significant effect of objective fatal risk rate on the employee's wages on the Czech labour market. Based on an estimation of the hedonic wage function, we derive the wage differential from which the VSL on the Czech labour market was obtained.

The VSL obtained from industry performance indicators ranges between 3.4 to 4.3 million €2005, while the latter holds for industries with positive fatal risk rates.[9] The VSL obtained from the wage differentials estimated from 2006 survey data is about 6 million €2005 (full sample), 6.6 million €2005 for those exposed to fatal risks, and 8.9 million €2005 for risk-exposed males. The VSL estimates from the 2000 survey dataset range between 5 million €2000 (males) and 8 to 10 million €2000 for blue-collar workers.

Due to heterogeneity in employees and relevant labour markets, the VSL estimates provided by empirical literature used to lay in wide interval. A review by Viscusi (1992) supports a range of VSL between $0.8 to 17.7 million; more recent estimates of VSL lie between $0.2 million (Loomis and du Vair, 1993) to $87.6 million (Arabsheibani and Marin, 2000). The latest comprehensive review of hedonic wage studies by Viscusi and Aldy (2003) displays a VSL range between $0.5 to 21 million in the US, $4 to 74 million in the UK, or 0.2 to 4.1 million $\$_{2000}$ in Asia. Based on 197 VSL estimates, Kochi et al. (2006) display a mean composite distribution of empirical Bayes-adjusted VSL as high as $5.4 million with a standard deviation of $5.4 million. Our results, that range between €3 to €10 million, lay in this wide interval. Moreover, Giergiczny (2006) – who is the only researcher to have conducted a hedonic wage study in the CEE region – displays a sample mean of VSL of 2.26 million $€_{2005}$ obtained from a wage differential estimated for Polish blue-collar workers.

Our VSL estimates obtained from hedonic wage models are also practically comparable with the VSL just obtained from our contingent valuation study on the willingness to accept compensations paid through higher wages for risk rates increased by 50%. Urban and Ščasný

[9] If hedonic wage differentials were derived from gross wage, VSL's would range between 3.7 to 4.1 million €2005 (manual industries) and about 6 million €2005 (for the industries with positive fatal risks).

(2007a) found a mean VSL as high as €10.7 million (with a median of €8.4 million)[10]. Moreover, the VSL derived from the WTP for a mortality risk reduction from cardiovascular and respiratory diseases by the contingent valuation method is about €1.3 million (mean), or €0.58 million (median) in the Czech Republic (Alberini et al., 2006).[11,12]

We note that the hedonic differentials and VSL's were difficult to estimate from full datasets or when taking into account all industries. Particularly, we do not confirm a statistical significant effect of fatal risk on employee's wage, when all industries, or only some of them are included in the hedonic models using industry-specific performance indicators or dataset from the 2000-Survey. This fact implies that proper estimation techniques have to be used in order to treat risk endogeneity and unobserved heterogeneity properly in any of our further econometric models. Better understandings of the role of subjective perception of job related risks in valuation can also improve the models being tested. These model extensions remain, however, for our future research.

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[10] One should be aware of the fact that values based on willingness to accept approach used to yield higher values than those derived from willingness to pay. Hanemann (1991) for instance argues that the differences between the compensating surplus, i.e. minimum WTA to consent higher occupational risks in our case and the equivalent surplus, i.e. maximum WTP to prevent increase of the risks, need not be insignificant as counter-argued by Randall and Stoll (1980). Empirical evidence suggests that the minimum WTA can exceed the maximum WTP several times over. Carson (1991) argues that when individuals are asked to state their minimum WTA, they tend to state their expectation of the maximum they could hope to extract as compensation rather than their true minimum WTA (cited in Markandya et al., 2002; p. 425).

[11] The fact that two valuation methods do not necessarily provide the same outcome is supported on theoretical grounds: while the hedonic wage approach estimates a local trade-off, the CV approach approximates a movement along a constant expected utility locus (Viscusi and Evans, 1990). In other words, the marginal utility of changing risks from its optimal level analysed by the hedonic model can be expected to be the highest because the marginal utility declines with marginal risk 'located' farther from the optimal risk, i.e. probably described in the contingent (hypothetical) scenario.

[12] Applying human capital method, the value of preventing fatality obtained from macroeconomic labour productivity of the Czech Republic is as high as 0.5 milllion € for 40 years old man (d.r.=3%) (Ščasný, 2005). Máca (2005) reviewed the costs per QALY for CEEC countries and brings the range between 370 € to 16,000 €. If we considered 2,900 € per QALY for acute myocardial infarction as found by Máca for the Czech Republic, we get VSL as high as 0.2 million € for average life expectancy, while VSL obtained from QALY for Statins following pericutaneous coronary intervention (Fluvastatin) in Hungary gets 1.2 million €.

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Appendix: Descriptive statistics of three datasets.

Table A1: Industry-specific performance indicators; a mean of variables.

Variable	Unit	FULL SAMPLE	INDUSTRY	POSITIVE	MANUAL positive
Gross wage	thousands CZK per employee	325.16	286.47	316.16	301.98
Net wage	thousands CZK per employee	262.73	235.45	256.34	246.45
Fatal risk	cases per 1000	0.030	0.023	0.059	0.065
Injuries (3days+ work incapacity)	cases per 1000	17.39	22.73	21.29	24.61
Injuries (without work incapacity)	cases per 1000	8.39	12.75	10.22	12.24
Kcpain	thousands CZK per employee	0.140	0.073	0.088	0.104
Kcprevent	thousands CZK per employee	0.177	0.176	0.171	0.176
LP (l_productivity)	million CZK per employee	0.705	0.473	0.617	0.656
labour force	number of employees	71 040	69 736	105 226	88 774
nace_agri	dummy	0.05	0.04	0.07	0.09
nace_ind	dummy	0.47	0.92	0.44	0.56
nace_ener	dummy	0.04	n.a.	0.06	0.07
nace_constr	dummy	0.02	n.a.	0.03	0.04
nace_service	dummy	0.35	n.a.	0.33	0.15
nace_tran	dummy	0.07	0.04	0.07	0.09

Table A2: Quality of Occupational Life - 2006 Survey.

Variable	Variable type	whole sample			only exposed to risks			only males exposed to risks		
		N	Mean	s.d.	N	Mean	s.d.	N	Mean	s.d.
wage	CZK per month	1 616	**15 380**	8.32	1 085	**16 420**	9.20	694	**17 890**	9.71
fatal	cases per 10.000	2 037	**1.24**	0.80	1 367	**1.29**	0.86	906	**1.41**	0.92
nonfatal	cases per 10.000	2 037	**14.71**	15.10	1 367	**16.15**	15.81	906	**19.52**	16.78
boss	dummy	2 042	**0.25**	0.43	1 373	**0.30**	0.46	909	**0.33**	0.47
BUILDWOK	dummy	2 043	**0.07**	0.25	1 373	**0.09**	0.29	909	**0.13**	0.34
car_traveling	dummy	2 043	**0.44**	0.50	1 373	**0.65**	0.48	909	**0.73**	0.44
EXPERIEN	years	2 043	**7.17**	8.15	1 373	**7.20**	8.36	909	**7.16**	8.52
MALE	dummy	2 043	**0.56**	0.50	1 373	**0.66**	0.47	909	**1.00**	0
University	dummy	2 043	**0.14**	0.35	1 373	**0.15**	0.35	909	**0.14**	0.35
A-level	dummy	2 043	**0.37**	0.48	1 373	**0.36**	0.48	909	**0.31**	0.46
AGE	years	2 036	**40.38**	29.37	1 370	**40.46**	29.32	906	**40.52**	29.67
BREADWIN	dummy	1 467	**0.62**	0.23	1 001	**0.64**	0.23	642	**0.68**	0.21
KIDS	no of children	2 043	**0.69**	0.89	1 373	**0.72**	0.91	909	**0.70**	0.91

Table A3: Working conditions 2000.

Variable	Description	N	Mean	Std Dev	Min	Max
Net wage	Net monthly wage per month	786	9,728	7,155	2,125	119,000
wage supplement	dummy=1 if wage supplement provided	892	0.12	0.33	0	1
night	dummy=1 if compensation for night work	891	6.97	11.64	0	90
weekend	dummy=1 if compensation for weekend working	892	1.89	2.29	0	9.33
working experience	Working practise	890	8.32	2.50	0	12.58
boss	Employee who has subordinates	892	0.17	0.38	0	1
RISK	dummy=1 if subjectively perceived job risks	892	0.42	0.49	0	1
RISK_fyz	dummy=1 if perceived physical risks	892	0.36	0.48	0	1
RISK_psy	dummy=1 if perceived psychological risk	892	0.21	0.41	0	1
RISK_fn	dummy=1 if perceived risk due to aggression	892	0.07	0.25	0	1
female	dummy=1 if female	892	0.51	0.50	0	1
age	Age	886	39.84	11.21	15	76
married	dummy=1 if married	892	0.56	0.50	0	1
eaperson	Number of economic-active person in household	892	1.74	0.79	0	6
kids	Number of children in household	892	0.65	0.87	0	4
person	Number of person in household	892	2.94	1.19	0	7
breadwin	dummy=1 if brings large part of money to family	892	0.61	0.49	0	1
city1	dummy=1 if small village	892	0.25	0.44	0	1
city2	dummy=1 if small town	892	0.29	0.45	0	1
city3	dummy=1 if larger city	892	0.24	0.43	0	1
city4	dummy=1 if city with more than 100,000 inhabitants	892	0.22	0.41	0	1

Hedonický mzdový model: vztah mezi výši mzdy a pracovním rizikem v ČR

Milan Ščasný - Jan Urban

ABSTRAKT

Cílem příspěvku je analyzovat vztah mezi výší mzdy a četností smrtelných pracovních úrazů. Z hedonického mzdového modelu je ekonometricky odhadnuta mzdová riziková prémie. Následně je odvozena hodnota statistického života (VSL) a ta je srovnána s hodnotami odvozenými v zahraničí nebo metodami analyzujícími stanovené preference. Mzdová prémie je odhadnuta pro celkem tři soubory dat; jednak ze dvou souboru individuálních dat ze šetření provedených v letech 2000 a 2006 v České republice a ze statistických indikátorů ekonomických odvětví. Náš výzkum potvrzuje statisticky významný efekt rizika smrtelných úrazů na mzdu pracovníků. VSL odvozená z odvětvových indikátorů činí kolem 3,4 až 4,3 mil. €. VSL odhadnutá z dat ze šetření kvality pracovního prostředí pracovníků se pohybuje kolem 6 mil. €, přičemž pro pracovníky, kteří jsou vystaveni rizikům, je VSL vyšší. K obdobným výsledkům docházíme, jestliže je VSL vypočtena ze mzdové prémie odhadnuté z dat ze šetření z roku 2000. Statistický efekt pracovních rizik na mzdu však nepotvrzujeme pro všechna odvětví a všechny pracovníky. Na endogenizaci pracovních rizik i nepozorovanou heterogenitu musí ekonometrický odhad mzdového modelu klást zvláštní důraz. Naše výsledky také potvrzují, že volba specifického tvaru hedonické funkce může mít také vliv na odhad hedonické mzdové prémie, a tím i na hodnotu VSL.

Klíčová slova: Hedonický mzdový model; Pracovní rizika; Hodnota statistického života.

Wage-risk relationship testing in hedonic wage models in the Czech Republic

ABSTRACT

The aim of this paper is to analyse the relationship between the wage level and job-related fatal risks. The wage differential is estimated econometrically from a hedonic wage model. The value of statistical life is obtained and then compared with VSL estimates obtained abroad and/or using methods aimed at sated preferences. The wage differential is estimated from three datasets in total: two individual datasets come from surveys conducted in 2000 and 2006 in the Czech Republic, and industry-specific statistical performance indicators. Our research confirms a statistically significant effect of occupational fatal risk on employees' wages. The VSL obtained from industry performance indicators ranges between €3.4 and 4.3 million. The VSL obtained from the wage differentials estimated from 2006 survey data is about €6 million, while the VSL is even higher for those exposed to fatal risks in their jobs. We arrive at similar results if the VSL is estimated from the 2000 survey dataset. We do not, however, confirm any statistically significant effect of fatal job risks on wages for all industries and employees. We support the notion that risk endogeneity and unobserved heterogeinty need to be treated properly in any wage model estimation. Moreover, our results confirm that the choice of a specific functional form of the hedonic wage model might affect the hedonic differential and the VSL so estimated.

Key words: Hedonic wage model; Job-related risk; Fatality; Value of statistical life.

REVIEW

The paper reviewed analyses the statistical relationship between changes in occupational mortality rate and average wages. Then it estimates the hedonic wage differential from hedonic wage models in order to be able to derive a value of statistical life (VSL). The research and its results described in the submitted paper are unique in the Czech Republic. The outcome (esp. VSL) may well be fructified in decision processes where VSL is needed. I with no other remarks recommend the paper to pe published.

doc. Ing. Jiří Hnilica, Ph.D.