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Estimated hedonic wage function and value of life in an African country

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Abstract

This paper reports the first study of compensating wage differentials for work-related fatalities in an African country. Using original data from the 2002 Tunisian *Caisse nationale de la sécurité sociale*, statistically significant compensating wage differentials are found. The implied value of life is \$ 643800 (US \$ 2000).

Keywords: Compensating wage differentials; Value of life

JEL classification codes: J17; J28; J31

Résumé

Ce texte rapporte les résultats de la première étude sur les différentiels compensatoires de salaire liés au risque de mortalité au travail dans un pays africain. À partir d'une banque de données originale de la *Caisse nationale de la sécurité sociale* de Tunisie en 2002, nous détectons l'existence de différentiels compensatoires de salaire significatifs. La valeur de la vie que l'on en déduit est de \$ 643 800 (US \$ 2000).

Mots clés : Différentiel de salaire compensatoire; Valeur de la vie.

1. Introduction

Many public projects for better road or workplace safety impose costs on society in exchange for reducing the risk of death and injuries. To determine whether a project is socially desirable, one has to compare the value of reducing risks to the costs of such reductions. The value of reducing risks can be estimated by the *revealed preference approach*, which has been used extensively to deduce a value of a statistical life (VOSL).

The majority of the revealed-preference studies conducted to date have been of the wage-risk type. *Wage-risk studies* or *hedonic wage function* estimate the wage premium associated with greater risks of death on the job. This premium is deduced by regressing the wage on the risk of death, accounting for factors, like traditional human capital variables, that may also influence the wage. The premium indicates that there is a trade-off between wealth and physical risk, and may be used to compute the VOSL².

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² See Dionne and Lanoie (2004) for a more complete discussion.

Over the past three decades, there have been extensive discussions on this topic with a variety of data sets used in the empirical literature, mainly in developed countries. Generally, this literature shows that occupational or industry fatality rates enter the wage function with a positive and statistically significant coefficient. However, the VOSL estimates vary dramatically across studies, perhaps because of differences in the definitions of job risk (industry risk or occupational risk) and in risk preferences among samples of workers. For instance, Dionne and Lanoie (2004) review 42 studies in industrialized countries and find a range of VOSL between 0,4 to 25,7 million with a mean of \$ 8 million (CND \$ 2000). Bellavance et al. (2009) review 39 studies in developed countries and find a range between 0,5 and 53,6 million with a mean of \$ 8,4 million (US \$ 2000).

The purpose of this paper is to test the existence of a wage-risk premium in Tunisia using original labor market administrative data from the *Caisse nationale de la sécurité sociale* in 2002. To our knowledge, this is the first study which investigates the wage-risk relationship in an African country. This paper also provides estimates of the value of life and compares them with estimates for developed countries.

2. The hedonic wage model and data sources³

2.1. The hedonic wage model

The basic framework for hedonic wage analysis requires data on workers' wages, job risks and other characteristics. The hedonic wage model treats jobs as various combinations of risk, working conditions, and other attributes. The wage that the worker is willing to accept reflects the utility expected from the job characteristics. A worker's indifference curve shows his tradeoffs between the wage rate and the risk of death in the workplace. Since workplace safety influences firm productivity and costs, the isoprofit curve measures the tradeoffs between wages and job risk for an employer. The hedonic wage function is the envelope of mutual tangencies between worker indifference curves and firm isoprofit curves.

Thus, the reduced form of the hedonic wage function can be specified as follows:³

³ This section is inspired by Liu et al. (1997).

$$(1) \ln W_i = g(X_{li}, X_{ji}) + \mu_i$$

where $\ln W_i$ = the natural logarithm of the i th individual worker's wage rate, X_{li} = i th individual worker's characteristics⁴, X_{ji} = i th individual worker's job characteristic⁵ including RISK (mortality rate measured at the firm level), and μ_i = random error term.

Furthermore, as first suggested by Garen (1988), we consider RISK as an endogenous variable. Indeed, it is arguable that, in the individual's choice of job riskiness, safety should be considered as a normal good. Consistent with this notion is that individuals with greater human capital and earning potential will experience an income effect and select jobs with less risk. If disturbances reflect unobserved heterogeneity among individuals, then those with unobserved characteristics which enable them to earn higher wages will also lead them to find safer jobs. Therefore, the endogeneity of job risk implies that ordinary least squares (OLS) estimates of the wage equation may be biased and this should be corrected. Furthermore, Hausman tests performed with our dataset also rejected the exogeneity of the RISK variable (see below).

2.2. Data source

The data in this study are taken from one main source, the *Caisse nationale de la sécurité sociale*. This organization is in charge of workplace accidents in Tunisia. It compensates the victims of accidents, administers an experience rating scheme to finance the system, and is responsible for accident prevention (monitoring and enforcement of safety regulations, training, subsidies for protective measures, etc). The year 2002 is chosen because it is the last year that was made available to us. We have data on all the 48371 employees working in the private sector and covered by the *Caisse*.

⁴ These include EDUCATION, EDUCATION², EXPERIENCE, EXPERIENCE², GENDER, AGE, PERMANENCE STATUS, MARITAL STATUS, UNION STATUS.

⁵ These also include INDUSTRIES (manufacturing, extractives, agriculture, construction, service and trade is default) and LOCATION (shore, interior, South-West, Tunis area is default)

3. Empirical results

Four variants of equation (1) have been estimated (the complete model, one without industry dummies, one without location dummies, one without industry and location dummies), and results are reported in Table 1. The explanatory power of the regressions is fairly good. Because of space limitations⁶, we report only the IV (instrumental variables) regression estimates for the RISK variable. The coefficients are stable, positive and significant, and the control variables are mostly significant with the expected sign.

Table 1: Risk variable estimations in hedonic wage regressions

	Mean and standard deviation	Model (1)	Model (2)	Model (3)	Model (4)
VARIABLES					
Log(RISK)	4.17 (0.35)	0.185*** (0.00557)	0.159*** (0.00611)	0.196*** (0.00633)	0.171*** (0.00679)
Workers' characteristics		Included	Included	Included	Included
Industry dummies		Included	Not included	Included	Not included
Location dummies		Included	Included	Not included	Not included
VOSL (US \$ 2000)		643800	553320	682080	595080
Hausman exogeneity test		1590***	963.41***	853***	853.71***
Observations		48371	48371	48371	48371
R-squared		0.702	0.644	0.61	0.559

Mean and standard deviation of dependent variable (3480 US \$; 179.2), standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

⁶ Complete results are available upon request.

The risk coefficients can be interpreted as the average willingness to pay for a marginal decrease in mortality risk. These results provide strong evidence of a compensating wage differential for jobs with greater fatality risk in the Tunisia labor market. The implied values of a statistical life are calculated at the sample mean wage. The figures are obtained by multiplying (1) the risk coefficient, (2) 12 months per year, (3) 1 000 (the denominator of the risk measure) and (4) the monthly average wage rate. The estimates range from 553 320 to 682 080 (US\$ 2000). These figures are considerably lower than those generally found for industrialized countries.

To compare these values more precisely with estimates for developed countries, we used a regression presented in Bellavance et al. (2009) to explain the 29 VOSL estimates from 29 different studies in a meta-analysis. This exercise is inspired from Liu et al. (1997), who used a regression done with 17 VOSL estimates presented in Viscusi (1993). Taking specification (4) in Bellavance et al. (2009) Table 5, we find:

(2) $VOSL = -9.96 (10)^8 + 475\,149 * YEAR \text{ of PUBLICATION} + 5606813 * Ln \text{ INCOME} - 1239987 * RISK + 12\,120\,680 * ENDOGENEITY - 4216413 * UNION$
 where YEAR of PUBLICATION is the year the study was published; INCOME is annual income; RISK is annual fatality risk per 10 000 workers; ENDOGENEITY captures the fact that the RISK variable was considered endogenous in a given study; and UNION captures the fact that the study has accounted for unionization.

Substituting the appropriate information from our study in this equation yields a predicted value of life for Tunisian workers, presented in the last column of Table 2, of \$3,7 million, about six times⁷ the estimate we found of \$643 800 (from the complete model in Table 1).

The comparatively small value of life estimated from the Tunisia data suggests that there may be fundamental differences in the value of risk reduction between developing and developed countries, perhaps because information about occupational risks may be less accessible to workers in developing countries. Labor market structures, institutional factors and magnitudes of industrial risk that vary across countries may also explain variations in the estimates. Overall, the comparison suggests that a simple benefit-

⁷ The results are even larger when we use specifications (2) or (3) of Bellavance et al. (2009).

transfer equation from the existing literature is inadequate for estimating the value of life in developing countries, and that complete estimations of a VOSL in each country is required. This result confirms that of Liu et al. (1997) who obtain a value of \$ 461 000 (US \$ 1990). Actually, the value we have for Tunisia is in the same range as those found in India, i.e. \$ 0,8 million (US \$ 2000) (Madheswaran, 2007), or in Thailand, i.e. \$ 1,48 million (US \$, 2000) (Vassanadumrongdee and Matsuoka, 2005).

Table 2: Values of a statistical life⁸

Categories	Total sample	Experienced workers	Non-experienced Workers	Permanent Workers	Non permanent Workers	Manufacturing industries	Other industries	Predicted VOSL
Total	643800	1266008	518372	575931	660749	814830	614771	3704913
Non-unionized	547172	1242827	436929	411951	655294	788091	440051	7724576
Unionized	656476	1508061	529655	604844	657310	952206	643410	4793491

Furthermore, Table 2 shows how the VOSL can vary among different groups of workers, suggesting that preferences and risk information may vary across them. Everything else being equal, it appears that unionized workers have a larger VOSL than non-unionized. Among other things, this may be due to the fact that workers within unions can collect better information about job risks, a result consistent with that of Siebert and Wei (1994). In the same vein, experienced workers have a higher value than non-experienced workers⁹, which may also be related to their better knowledge of actual risks. Somewhat surprisingly, non-permanent workers seem to have a higher VOSL than permanent ones. This may be due to the fact that, being non-permanent, they worry more about the consequences that an accident could have on their link with their employer and ask for a higher risk premium. Finally, the workers in the manufacturing industry have a higher VOSL than in the other industries, probably because they face higher risk. Overall, the difference between various groups can be fairly large¹⁰. For instance, the VOSL for non-experienced non-unionized workers may be three times less than that for experienced and unionized workers.

⁸ These estimations are done by running specific regressions with each of these subsamples.

⁹ Experienced workers are those with more than 10 years of work experience.

¹⁰ All the differences across sub-groups are statistically significant.

Conclusion

This paper provides the first estimates of the marginal value of job hazards for the Tunisian labor market in 2002. We find evidence of compensating wage differentials for industrial risk in Tunisia. The implied value of statistical life is found between \$553 320 and \$682 080 (US \$ 2000), smaller than the value estimated from developed country data. The estimate may be useful for evaluating the benefits of regulations that reduce the risk of death in developing countries.

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