Measuring the Value of Life and Limb: Estimating Compensating Wage Differentials among Workers in Chennai and Mumbai

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Abstract

Policy makers confronted with the need to introduce health and safety regulations often wonder how to value the benefits of these regulations. One way that a monetary value could be placed on reductions in health risks, including risk of death, is through understanding how people are compensated for the different risks they take. This approach, referred to as the compensating wage differentials method, estimates the wage premium a worker would need to be paid to accept a small increase in his/ her risk of dying, or, equivalently, what a worker would pay to achieve a small reduction in risk of death. Wage premiums can be estimated from observed labor market data and converted to the value of a statistical life (VSL) — a number that summarizes what a population may be willing to pay to reduce the risk of one death in a statistical sense.

While there is an extensive literature on VSL and compensating wage differentials for the developed countries, few such studies exist when it comes to developing countries. Our study is an attempt at obtaining estimates of VSL that reflects Indian risk preferences. Based on a survey of 550 workers in Chennai and 535 workers in Mumbai, we find the value of a statistical life in India to be approximately Rs. 15 million. The value of statistical injury ranges from Rs. 6000 to Rs. 9000. Policy makers interested in programs to decrease environmental and health risks could use these numbers as one bench-mark against which costs can be assessed.

Key words: Compensating Wage Differentials, Hedonic Price, Valuations of Life/ Injury
JEL Classification: J17, J28, J31.

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1. Introduction

There is no doubt that economic development through the use of environmental resources can have a positive impact on the lives of people in areas such as power, energy, industrial growth and transportation. However, exposure to environmental contaminants can also cause risks to human life and health. In order to reduce these risks, governments undertake various projects that impose costs on society. To determine whether a project is socially desirable, one needs to compare the value of reducing risks to the cost of such reductions.

Several methods have been proposed in the literature for estimating implicit prices for reduced risks to life and health. They include the cost of illness approach, the human capital approach, the willingness-to-pay approach, the insurance approach, the court awards and compensation approach and the portfolio approach (Linnerooth, 1979). The willingness-to-pay (WTP) approach, however, is increasingly considered as the most relevant method. WTP is typically measured by analyzing prices paid for goods and services. The prices paid for preventing health and death risks cannot, of course, be directly obtained because prevention of these risks is not purchased in the market. However, there are instances when these prices can be indirectly observed or measured.

There are two principal methodologies for measuring WTP for risk reductions. The first, known as the contingent valuation approach, rests on data generated through questionnaires (Alberini, et. al., 1977; Gerking, et. al., 1988). In this approach, individuals are directly asked how much they would be willing to pay to reduce, for instance, their death risks at work or in traffic accidents. The second is the revealed preference approach. This method infers the hedonic (that is, quality adjusted) value of an environmental good, such as air quality, affecting the value of a market. This method relies on property values and wage data. The approach using wages is popular because the availability of information on work-related environmental risks and associated wages enable the estimation of the market-generated wage-risk trade-off.

Several empirical studies have emerged in recent years that estimate the value of life or injury but most of them deal with developed countries (Viscusi, 1993; Viscusi and Aldy, 2002). Studies on this aspect are very rare when it comes to developing countries, mainly due to data constraints. Researchers valuing the health impacts of projects in developing countries have two options. Firstly, they could develop monetary value estimates based on data from developed countries by making appropriate adjustments (using per capita GDP). This simple transfer mechanism however does not take into account differences in WTP values between different countries due to differences in factors such as living standards, culture and educational attainments. Secondly, they could rely on the human capital approach such as loss of earnings. But this approach provides no guide to action when there are a variety of impacts on unknown value and ignores the quality of life lengthened. New research on valuing health and death risks in developing countries is the only way to resolve this problem (Asian Development Bank, 1996).

In this study, we estimate the statistical value of life and health in India based on primary surveys of workers in Chennai (in the southern part of India) and Mumbai (in the western part of India). India implements many environmental programs and spends large sums of money on health and safety programs. Since resources are scarce, it is essential to evaluate these programs and to reallocate funds, if need be, to achieve maximum benefits to society. In this context, the study, it could be said, provides necessary information on the value of life and injury in India.

2. Theoretical Framework

Workers consider a multitude of pecuniary and non-pecuniary job characteristics in the job selection process. Wage rates, pension benefits, convenience of work hours and health and safety risks are but a few of the pertinent job characteristics considered. Almost inevitably, a worker must trade off some valued characteristics for other job attributes when selecting among his job opportunities. The wage- and job-related risks are likely to be the most important job components to workers considering potentially dangerous jobs (Viscusi, 1978a, 1978b, 1979). If a worker takes a job and knows that it is risky, there must be some other valued characteristics to compensate for the risk. If other non-monetary attributes of the job are equivalent to those for less risky jobs, this compensation will take the form of a higher wage. This wage-risk relationship is the central component of the theory of compensating or equalizing differentials, originally conceived by Adam Smith (1776). He observed that "the whole of the advantages and disadvantages of the different employment of labor and stock must in the same neighborhood be either perfectly equal or continually tending to equality" (chapter 10). This simple proposition and its reconstruction by Rosen (1974) form the basis of recent economic analyses of job risks. The methodology adopted in this approach is called the hedonic (that is, the quality-adjusted) wage function approach.

The hedonic approach posits that jobs with bad characteristics require a wage premium to attract workers, other things remaining equal. This extra wage or premium is called a compensating wage differential. These premiums are the result of the interaction of both the labor demand by firms and the labor supply decisions of workers. This approach specifies an earning function that includes both worker and job characteristics and forms an empirical tool for the analysis of the determination of wage rates. The theory is helpful in interpreting the coefficients of risk variables on the wage equation estimates.

In recent years, the hedonic approach has received a considerable amount of attention in the labor economics literature. In part, this attention has resulted from the recognition of two important policy implications. Firstly, this wage mechanism leads to an efficient level of job safety and to optimal match-ups of jobs and workers. Therefore, the argument for government intervention involving occupational safety and health has become less compelling. Secondly, the estimated wage premium for employment-related death and injury risks is useful in order to place a monetary value on the value of a statistical life and limb of workers. However, the fundamental issue involved in an assessment of risk compensation is whether or not workers are aware of the risk they face. The advocates of this approach argue that most workers have many sources of information for making some judgments about job risks. Before taking up the job, they can use the information regarding the firm's reputation, the nature of the job and the experience of friends who have worked there, etc., in order to make up their minds about whether to accept the job. Some risks, particularly newly discovered carcinogenic hazards, have been highly publicized and are familiar to the general public as well as to the workers themselves. Moreover, once the worker is on the job, he can observe workplace conditions and the effects of the job on his well-being and that of his co-workers (Viscusi, 1983).

The hedonic approach views labor market transactions as a tied sale. On the one hand, workers sell their services for wages. At the same time, they purchase non-pecuniary work attributes. These attributes may vary from job to job. Hence, the workers exercise a choice over preferred job attributes by choosing an appropriate job. On the other hand, firms simultaneously buy the services and characteristics of workers and sell attributes of jobs in the open market. Since worker characteristics too may differ, firms have to exercise choice. An acceptable match occurs when the preferred choices of both the employer and the employee are mutually consistent. The actual wage, therefore, embodies a series of implicit prices for both workers' characteristics and job attributes such as pace of work and probability of injury/death. In this sense, the labor market is viewed as an implicit market for job and worker attributes. Controlling for other aspects of a job, one can estimate the wage premium that workers receive for job-related risks.

An example will suffice to illustrate the properties of the optimal job choice of a worker who is choosing from a set of job opportunities that involve the same number of work hours but have different probabilities when it comes to adverse consequences. Consider a state dependent utility model. It is a single period, static model. Let Y be the initial assets of a worker and W be the schedule of wage earnings for jobs. Let p_1, p_2, and p_3 be the probabilities for no injury, injury with no fatal outcome, and injury with fatal outcome respectively. These probabilities will of course add up to 1. Let the utility of having no injury be U(Y+W), of having an injury which is not fatal V(Y+I), and of having a fatal accident D (for death). Here W is the wage function, which is a function of the probabilities. Consumption x is equal to Y+W (p). It is assumed that the wage and utility functions are continuous and twice differentiable. Each job is associated with a probability p of a worker's death or injury. It will be an equilibrium outcome on a perfect labor market. "I" is the insurance one receives after an injury. It will be independent of the risks. It is also assumed that the worker would rather be healthy than not; the marginal utility of consumption is positive and greater in health state than in ill-health state (i.e., $U_x > V_x > 0$); and the marginal utility of consumption is diminishing or the workers are either risk averse or risk neutral (i.e., U_{xx} , $V_{xx} \leq 0$). The expected utility can now be written as:

$$p_1U(Y+W) + p_2V(Y+I) + p_3D \quad \text{(1)}$$

Expected utility is maximized over the three probabilities (i.e., the worker chooses a job with the optimal risks). The first order conditions are:

$$U - \lambda = 0 \quad \text{(2)}$$

$$p \frac{\partial U}{\partial x}\frac{\partial W}{\partial p_2} + V - \lambda = 0 \quad \text{(3)}$$

$$p_1 \frac{\partial U}{\partial x}\frac{\partial W}{\partial p_3} + D - \lambda = 0 \quad \text{(4)}$$

Where λ is a Lagrange multiplier. These first order conditions can be rewritten as:

$$\frac{\partial W}{\partial p_2} = \frac{U - V}{p_1 \frac{\partial U}{\partial x}} \quad \text{(5)}$$

$$\frac{\partial W}{\partial p_3} = \frac{U - D}{p_1 \frac{\partial U}{\partial x}} \quad \text{(6)}$$

Equation (5) and (6) can be interpreted in the following manner: if the probability of being injured increases marginally, the loss in utility units to the individual is U-V. In order to convert this loss in utility to a loss in consumption, one has to divide equations (5) and (6) by the marginal utility of consumption. Thus the left-hand side of equation (5) can be interpreted as the marginal loss in consumption units from a marginal change in the probability of being injured, and the left-hand side of equation (6) is the counterpart for the probability of a fatal accident.

The term U-D in equation (6) may seem rather odd, but from an ex-ante viewpoint, individuals are trading off the risk of dying with increased consumption, which implies that there is a utility equivalent to dying. The right-hand sides of these conditions (5) and (6) suggest that the workers will choose jobs such that their willingness-to-pay for a marginal risk reduction is equal to what the market can offer. If we could make a linear approximation of U-V and U-D, we would find that these utility differences would depend on two factors: i) differences in income between being healthy and having an accident; ii) differences because of different amenity values in the three cases (no injury, injury, injury with death). The first factor is the change in human capital because of the accident, while the second factor captures the suffering from the accident.

The discussion so far has been completely static. However, intuition tells us that we would get the same result in a dynamic context -- in a perfect market, current wage differentials between different risks will also reflect the present value of consequences from work-related accidents. Nonetheless, there are limitations to this analyses in that hedonic studies of this kind do not capture the cost to family, relatives, and friends and costs to society in general (losses of tax revenues), as a result of death or injury. It would be interesting to know how important these costs are.

To assure that a solution to equation (5) is indeed a maximum, the second order condition also must be satisfied. In mathematical terms, the marginal rate of change of W_p with respect to a further rise in p must be negative or positive, but not too large. Totally differentiating the first order conditions and solving for resultant equations using Cramer's rule, the second order condition can be shown as:

$$W_{PP} < \{-(W_P)^2 [p_1 U_{XX} + p_2 V_{XX}] - 2 W_P [U_X - V_X]\} \{p_2 V_X + p_1 U_X\}^{-1} \quad \ldots\ldots (7)$$

In equation (7), the RHS is positive due to plausible restrictions stated above on the utility functions. Thus, the compensating wage differential presented in (5) implies that the curve relating to W and p must have a positive slope if workers are to be attracted to jobs along with it. The choice of a job will satisfy the second-order conditions for an optimum given by (7) if the wage premium per unit of risk with the level of p is constant or increases at a not too great rate. In the empirical section, we determine the compensating wage premium by estimating equation (5) empirically.

Wealth Effect and the Optimal Job Risk

An objection raised against the validity of the theory is that the best jobs in the society also tend to be the highest paid (Wildavsky, 1980). Thus, is it likely that wages rise with increased job risks (Arrow, 1974). To resolve this apparent paradox, it is useful to understand the effect of wealth on job risks. Because safety is a normal good, those with more assets will choose safer jobs. Let us investigate the role of worker's wealth in influencing the optimal job risk level by totally differentiating the first order condition, and solving for dp/dY using Cramers's rule:

$$\frac{dp}{dY} = \frac{-[p_1 U_{xx} + p_2 V_{xx}] W_p - [U_x - V_x]}{(W_p^2)[p_1 U_{xx} + p_2 V_{xx}] + 2W_p [U_x - V_x] + W_{pp}[p_2 V_x + p_1 U_x]} < 0 \quad \ldots\ldots\ldots \quad (8)$$

Since the numerator is clearly positive, the sign of dp/dY is the same as that of the denominator. Hazardous jobs will be an inferior occupational pursuit if:

$$(W_P)^2 [p_1 U_{XX} + p_2 V_{XX}] + 2 W_P [U_X - V_X]\} + W[p_2 V_X + p_1 U_X] < 0 \ldots\ldots\ldots\ldots \quad (9)$$

If equation (9) is solved for W, the condition reduces to equation (7) - the second order condition for maximum. Consequently, the extent of the job hazard one chooses necessarily decreases with one's wealth. This result is empirically estimated in section 4.2.

3. Source of the Data

In this study, we used a multi-stage random sampling technique. Firstly, the Chennai and Mumbai metropolitan areas were selected because they have the largest number of registered factories and workers. Secondly, blue-collar male workers in manufacturing industries were chosen because, according to the administrative report of the Chief Inspector of Factories, only male workers have incurred employment injuries (both fatal and injury accidents) in recent years. Other industrial workers and females in manufacturing industries appear to have faced no employment accidents in recent years. Here, "other workers" are defined as workers in other industries that come under the Factories Act such as the service industry. Moreover, workers in industries such as coal mines, railways, etc., were not considered because they do not come under the Factories Act. Similarly, workers in the unorganized sector were not considered because details of accidents were not available for these workers.

Blue-collar male employees in manufacturing industries were stratified into 17 groups using the National Industrial Classification (NIC) Codes. It was decided to choose a 1% sample from each stratum. This required a sample of 463 in each city. However, it was decided to collect information from 550 workers in Chennai and 535 workers in Mumbai with the expectation that information may be incomplete for a few samples. It was decided that a maximum of four sample workers from each factory would be selected randomly from the address list of factories maintained at the offices of the Chief Inspector of Factories in Chennai and Mumbai.

First, a questionnaire was prepared and pre-tested (*see Appendix-II*). The interview method was adopted to collect the required information from workers. The required number of factories and workers for interview was randomly selected. The sample factories/workers are distributed in all four divisions of Chennai and Mumbai. No weighting was given to the firm size. However, the minimum number of the workforce is 10 according to the Factories Act.

The data pertaining to wages, allowances, work hours and days, experience and firm size were collected from wage bills and records of firms where the respondents work. In the absence of wage bills /records, the recall method was used. Respondents' answers were tested for accuracy with cross examinations by the associates.[1] The respondents were directly asked to provide details about family demographics, sources of income, asset holdings, working conditions, taxes, benefits and social security schemes.

The data source for 'job risk' is the Administrative Report of the Chief Inspector of Factories, Chennai and Mumbai. The report provides data pertaining to the total number of male workers and the number of death and injury accidents to them on an annual basis at 2-digit NIC level. Since these risks may vary substantially across

[1] However, the accuracy of this information depends on the respondents' recall memory.

years, particularly when there is a major catastrophe resulting in multiple deaths, we computed the average probability of job-related fatal risks per 1 lakh[2] workers (RISK) and the average probability of injury risk per 100 workers (INJURY) over the years 1999-2001. The computed average measures eliminate the distorting influence of random fluctuations. These risk measures were then matched to the workers in the sample using NIC code. Obviously, there is a measurement problem common to this type of study because not all the workers in the same industry face the same level of risks. This problem seems most acute in the case of white-collar workers since they encounter much different and much safer working conditions (Garen, 1988). Since this study covers only blue-collar workers, the problem may not be as serious as in other studies. Besides, a third measure of risk, ENVDANGER, was used, which is a subjective variable indicative of whether or not the worker's job exposes him to any environmental problems and unhealthy conditions.

4. Empirical Estimation

In this section, we discuss empirical aspects of the estimation of valuation of statistical life. First, the hedonic wage equation (equation 5) is estimated separately for Chennai and Mumbai. Second, the job risk equation (equation 7) is estimated to identify various determinants of risk. Some of the empirical measures of key variables are discussed below.

Wage rate: The dependent variable in the analysis is the worker's after-tax hourly wage rate, assuming 2000 annual hours worked (WAGE).[3] According to the Workmen's Compensation Act (1923), "Wages include any privilege or benefit which is capable of being estimated in money, other than a travelling allowance or the value of any travelling concession or a contribution paid by the employer of a workman towards any pension or provident fund or a sum paid to a workman to cover any special expenses entailed on him by the nature of his employment" (Subramanian, 1986). The above definition is used to construct the wage variable in this study.

Risk Variables: Three job risk variables are used in this analysis. The first two are FATAL and INJURY. Fatal risk (FATAL) is measured as job-related fatalities per 1,00,000 blue-collar manufacturing male workers. The non-fatal injury risk (INJURY) is measured by the number of non-fatal accidents per 100 workers. These objective index measures of risks involve a low probability of death and injury, even at this level of aggregation (2 digit level). Further, death and injury risks may vary substantially across years, particularly if there is a major catastrophe that results in multiple death and injury. So the study averaged fatality and injury statistics over a three year period (1999, 2000 and 2001) to eliminate the distorting influence of random fluctuations.

The type of manufacturing industry, the sample workers from each industry, and the average probability of fatal and injury accidents to blue-collar male workers in Chennai and Mumbai for the years 1999 to 2001 are depicted in Tables 1 and 2. From Tables 1 and 2, it is evident that both fatal and non-fatal rates are higher in cotton textile, chemical and basic metal industries. On average, workers face between 11-13 fatal accidents per 1,00,000 laborers per year. The average injury rate is approximately 9% in Chennai and Mumbai.

As previously noted, this study also uses a third measure of risk, namely, ENVDANGER. ENVDANGER measures workers' subjective perception of job risk. It is assessed by the workers in the sample and takes a value of 1 if the worker's job exposes him to environmental or unhealthy conditions and a value of 0 otherwise.

[2] 1 lakh = 100,000.

[3] This measure is superior to the annual earnings frequently used in compensating differentials studies. Viscusi and Moore (1987, 88, 89a, b) and Moore and Viscusi (1988a) used this measure.

For the purposes of this study, this variable is not of interest in its own right, but is used rather as an alternative measure of job hazards to examine how workers' subjective judgments compare with objective measures. In the present study, 90% of workers considered their job to be hazardous.

We note that the objective measures of risk, FATAL and INJURY, are at the 2-digit industry level. Thus, unlike ENVDANGER, they do not pertain to a worker's particular job. Moreover, accident rates are reported on a voluntary basis and may involve substantial measurement error. However, the strong correlation between wages and these variables, as depicted in Table 3, provides evidence of the plausibility of worker's prior probability assessments of job risks.

Table 1: Distribution of Workers: Fatal and Non-Fatal Injury Rates According to Industry, Chennai (average of 1999-2001)

Sl.No.	NIC	NAME OF INDUSTRY	FATAL RATE (per 1 lakh workers)	INJURY RATE (per 100 workers)	SAMPLE in Primary Data
			Average based on data from 1999-2001, secondary data		
1	20-21	Manufacture of Food Products	19.248	3.733	36
2	22	Manufacture of Beverages, Tobacco and Tobacco Products	0.003	2.347	6
3	23	Manufacture of Cotton Textiles	27.854	60.230	48
4	24	Manufacture of Wool, Silk and Synthetic Fibre Textiles	0.010	1.11	1
5	26	Manufacture of Textile Products	9.778	1.27	45
6	27	Manufacture of Wood, Wood Products, Furniture and Fixtures	0.033	2.212	5
7	28	Manufacture of Paper, Paper Products and Printing Publishing and Allied Industries	18.116	1.5567	60
8	29	Manufacture of Leather and Leather & Fur Products	21.936	1.459	31
9	30	Manufacture of Rubber, Plastic, Petroleum & Coal Products	0.023	0.674	24
10	31	Manufacture of Chemicals and Chemical Products	22.124	1.989	26
11	32	Manufacture of Non-metallic Mineral Products	19.749	4.208	6
12	33	Manufacture of Basic Metal and Alloys Industries	22.456	3.230	34
13	34	Manufacture of Metal Products and Parts	0.0220	2.555	50
14	35	Manufacture of Machinery, Machine Tools and Parts	0.0187	2.237	70
15	36	Manufacture of Electrical Machinery, Apparels, Apparatus and Supplies	9.239	2.531	39
16	37	Manufacture of Transport Equipment and Parts	6.973	4.759	64
17	38	Manufacture of Other Manufacturing Industries	0.036	3.012	5
		Total (average)	11.35	8.67	550

Source: Administrative Report of Chief Inspector of Factories 1999-2001

Table 2: Distribution of Workers: Fatal and Non-Fatal Injury Rates according to Industry, Mumbai (Average of 1999-2001)

Sl.No.	NIC	NAME OF INDUSTRY	FATAL RATE (per 1 lakh workers)	INJURY RATE (per 100 workers)	SAMPLE in Primary Data
			Average based on data from 1999-2001, secondary data		
1	20-21	Manufacture of Food Products	21.142	3.663	37
2	22	Manufacture of Beverages, Tobacco and Tobacco Products	0.400	2.897	31
3	23	Manufacture of Cotton Textiles	32.524	64.150	16
4	24	Manufacture of Wool, Silk and Synthetic Fibre Textiles	0.300	1.611	74
5	26	Manufacture of Textile Products	9.962	1.267	30
6	27	Manufacture of Wood, Wood Products, Furniture and Fixtures	0.267	3.808	15
7	28	Manufacture of Paper, Paper products and Printing Publishing and Allied Industries	21.216	2.236	53
8	29	Manufacture of Leather and Leather & Fur Products	22.485	1.998	54
9	30	Manufacture of Rubber, Plastic, Petroleum & Coal Products	0.113	2.611	20
10	31	Manufacture of Chemicals and Chemical Products	29.923	1.931	30
11	32	Manufacture of Non-metallic Mineral Products	19.749	3.876	10
12	33	Manufacture of Basic Metal and Alloys Industries	28.533	4.549	3
13	34	Manufacture of Metal Products and Parts	0.231	3.637	20
14	35	Manufacture of Machinery, Machine Tools and Parts	0.897	2.349	14
15	36	Manufacture of Electrical Machinery, Apparels, Apparatus and Supplies	9.982	2.531	56
16	37	Manufacture of Transport Equipment and Parts	8.973	4.759	60
17	38	Manufacture of Other Manufacturing Industries	1.234	3.012	12
		Total	12.55	9.32	535

Source: Administrative Report of Chief Inspector of Factories 1999-2001

Table 3: Correlation and Chart between Wages and Risk Variables

SL.NO.	VARIABLES	WAGE - Chennai	WAGE – Mumbai
1	FATAL	0.61	0.69
2	INJURY	0.58	0.63
3	ENVDANGER	0.32	0.29

In order to estimate the compensating wage differential, our analysis includes several variables that influence wages. The definition of the variables included and their mean and standard deviations are reported in Table 4.

From Table 4, it is observed that the average sample employee has an hourly after-tax wage of Rs.7.9 in Chennai and 8.33 in Mumbai. About 90% employees feel that their job exposes them to danger or unhealthy conditions.

Table 4: Variable Definition, Mean and Standard Deviations: Chennai and Mumbai

VARIABLE'S SYMBOL	DEFINITION	Chennai Mean (S.D)	Mumbai Mean (S.D)
LWAGE	Computed hourly after tax wage rate (in Rs.) in logarithm	7.8904 (0.421)	8.3336 (0.69855)
FATAL	Annual average fatalities per 1 lakh workers	11.35 (9.00)	12.55 (7.98)
INJURY	Annual average non-fatal injuries per 100 workers	8.63 (11.23)	9.32 (6.86)
ENVDANGER	Job hazard perceptions = 1. : 1 – if job exposes the worker to environmental problems and unhealthy conditions; 0 – otherwise	0.90 (0.29)	0.92 (0.18)
EDN	Years of schooling completed	10.00 (2.46)	9.98 (3.48)
EXP	Years worked fulltime since started work	13.25 (7.20)	14.99 (6.34)
CASTE	Worker's social status=1: 1-if he belongs to backward class and SC/ST**; 0 – otherwise	0.61 (0.38)	0.67 (0.22)
DC	The number of dependent children, aged 0-16	1.37 (1.16)	1.78 (0.98)
UNION	Union status =1: 1 – if he is a union member; 0 – otherwise	0.52 (0.50)	0.49 (0.67)
WSIZE	Total workforce of the firm where he works	91.22 (173.16)	102.12 (217.89)
HOUSE	The value of the house, if the worker owned (in Rs.)	50452.45 (3004.47)	45854.23 (2563.0)
DIST	Distance to house from workplace (in km)	6.78 (7.22)	10.56 (6.32)
INCOME	Income of the family other than respondent's wage (in Rupees)	648.24 (86.46)	785.45 (56.56)
TRAIN	Training program =1: 1 – if on-the-job training is available; 0 – otherwise	0.21 (0.38)	0.32 (0.89)
NHP	No physical work =1.: 1 – if the work requires no hard physical work; 0 – otherwise	0.11 (0.19)	0.22 (0.76)
OT	Overtime =1.: 1 – if worker has overtime work; 0 – otherwise	0.16 (0.44)	0.28 (0.26)
HECTIC	Hectic =1.: 1 – if he says hectic; 0 - otherwise	0.88 (0.61)	0.78 (0.48)
PHCOND	Pleasant physical condition =1 : 1 – if the work surroundings are pleasant; 0 – otherwise	0.50 (0.50)	0.49 (0.56)
IRREG	Irregular work hours =1: 1 – if the worker has shift-hour work; 0 – otherwise	0.42 (0.49)	0.58 (0.69)
SECUR	Job security =1.: 1 – if the worker's job security is good; 0 – otherwise	0.60 (0.55)	0.64 (0.45)
MENT	Mental requirement =1: 1 if the job requires mental work; 0 – Otherwise	0.70 (0.87)	0.78 (0.99)
DEC	Worker decisions on job =1: 1 – If the worker is the decision maker; 0 – otherwise	0.49 (0.48)	0.52 (0.56)
NOMIS	Job requires no mistakes =1: 1 – if job requires that worker never makes a mistake; 0 – otherwise	0.67 (0.44)	0.56 (0.85)

VARIABLE'S SYMBOL	DEFINITION	Chennai Mean (S.D)	Mumbai Mean (S.D)
FAST	Fast work =1: 1 – if the worker's employment requires fast work; 0 –otherwise	0.79 (0.73)	0.89 (0.45)
PRIVE	Sector =1.: 1-if the worker's employment is in private sectors; 0-otherwise	0.90 (0.34)	0.89(0.56)
SUPER	Supervisor =1: 1 – if worker supervises anyone as part of his job; 0 – otherwise	0.35 (0.56)	0.43(0.78)
FITTER	Fitter =1: 1 if worker is a fitter; 0 – otherwise	0.15 (0.33)	0.17(0.42)
BINDER	Binding worker =1.: 1 – if the worker's occupation is binding; 0 – otherwise	0.11 (0.04)	0.11(0.02)
TECH	Technical work =1 : 1 – if the worker is a technician; 0 – otherwise	0.10 (0.12)	0.04(0.02)
ASSIST	Assist. Machinist =1: 1 – if the worker reports that occupation is assist machinist; 0 – otherwise	0.04 (0.12)	0.06(0.04)
REGION1	Regional =1: 1 – if worker's firm belongs to division 1 of the office of Chief Inspector of Factories; 0 –otherwise	0.12 (0.14)	0.09(0.05)
REGION2	Regional =1.: 1 – If worker's firm comes under division 2 of the office of Chief Inspector of Factories; 0 – otherwise	0.45 (0.40)	0.36(0.23)
REGION3	Regional =1.: 1 – if worker's firm belongs to division 3 of the office of Chief Inspector of Factories; 0 – otherwise	0.34 (0.36)	0.38(0.41)
IND1	Industry =1.: 1 – if worker's industry is manufacturer of transport equipment and parts; 0 – otherwise	0.12 (0.33)	0.18(0.42)
IND2	Industry =1.: 1 – if worker's industry is manu. of machinery, machine tools and parts; 0 - otherwise	0.13 (0.34)	0.23(0.23)
IND3	Industry =1.: 1 – if the industry is manu. of Rubber, Plastic, Petroleum and Coal Products; 0 – otherwise	0.05 (0.21)	0.11(0.05)
IND4	Industry =1.: 1 – if the worker works in food products industry; 0 – otherwise	0.04 (0.20)	0.09(0.23)
AGE	Age of worker	35.34 (8.69)	33.23(5.63)

Note: Since the SC/ST (Scheduled Caste and Scheduled Tribe) sample is very small, it has been clubbed with backward class

4.1 Estimation of the Hedonic Wage Equation

Although most wage-equation studies in labor economics utilize LnWAGE (i.e., the natural logarithm of wage variable) as the dependent variable, there is no comparable theory specifying the functional form linking wages and death risks because of the nature of the theoretical relationship between wages and human capital variables (Moore and Viscusi, 1988a). The functional form of the dependent variable (linear or log linear) in the compensating differential model is an unresolved problem. Following the work of Moore and Viscusi (1988a), we estimated WAGE (absolute) and LnWAGE (semi-logarithmic) models in the flexible functional form given by the Box-cox transformation. This enabled us to ascertain which transformation of the wage variable has the highest explanatory power. We concluded that neither the linear nor semi-logarithmic model is ideal. However, LnWAGE regression is more compatible with the functional form that best fits the data. So our discussion below focuses primarily on the LnWAGE equation results. The standard semi-logarithmic wage equation is written as:

$$Lnwage = \beta_0 + \beta_1 X_{1i} + \beta_2 Fatal_i + \beta_3 Injury + e_i \quad \text{.........................} \quad (28)$$

where e_i is the error term, the vector X_1 contains the determinants of earnings other than job hazards. X_1 includes: i) human capital variables such as education (EDN), experience (EXP) and its square (EXP^2)[4]; ii) variables pertaining to enterprise characteristics, namely, the size of the firm (WSIZE) and union status (UNION); and iii) the dummy variables for caste of the worker (CASTE), location of firm ($REGION_1$, $REGION_2$ and $REGION_3$) and occupation (SUPER, FITTER, BINDER, TECH, ASSIST).

Table 5 reports the OLS estimates of the wage equation. Columns1 and 3 present the results of standard semi-logarithmic wage (Ln WAGE) equation estimates for Chennai and Mumbai and include FATAL and INJURY as regressors as well as other determinants of earnings.

Columns 2 and 4 display the regression estimates of LnWAGE with ENVDANGER, a self-assessed hazard perception variable, as the risk variable in the explanatory variables set. The overall performance of the variables accords with the prediction of the wage equations in the literature both in terms of magnitudes and direction of the coefficients.

Table 5 shows that as expected workers' wages rise with education-that is, better-educated workers earn more. The rate of return to education is about 4 and 5 per cent. As expected, earnings increase at a declining rate with experience. Both EDN and EXP (and EXP2) coefficients are statistically significant at 1% level, confirming the expectations of human capital theory.

The dummy variable representing a worker's caste (CASTE) is included in order to see whether there is any wage discrimination against backward class and SC/ST workers. CASTE has a positive sign and is statistically significant at 1% level, indicating that backward class workers and SC/ST enjoy a premium in the blue-collar jobs compared to other caste (OC) workers.

The positive coefficient of UNION implies that union workers receive higher wage rates. Also, increases in work-force significantly increase the wage, i.e., larger the firm size, the larger will be the earnings that workers receive. This result is consistent with earlier studies in the U.S.A (Brown and Medoff, 1989; Idson and Feaster, 1990).

As expected, supervisors, fitters and technical workers receive more wages. All of these 3 dummy variables are statistically significant at 1% level. Since binders and assistant machinists are subordinates in the main production process, the results confirm the expectation of a negative correlation between these jobs and the wage rate. The regional dummies all have a negative impact on wages and are statistically significant at 1% level. This implies that workers in all of these three regions are paid lower wages than those in the fourth region.

[4] The extensive set of education and training variables precludes the inclusion of an age variable (Viscusi and Moore, 1989b). The term EXP^2 is included to allow for the standard non-linearity in earnings profile over the working life of the individual, i.e., it is included because the increments to earnings from additional years of work experience appear to reach a plateau and become a linear declining function of time' (Kumar and Coates, 1982).

Table 5: Ordinary Least Squares Estimates of Hedonic Wage Equations Dependent Variable: Logarithm of Hourly Wage Rate

Notes:

INDEPENDENT VARIABLES	CHENNAI (1)	(2)	MUMBAI (3)	(4)
FATAL	0.0098*	-	0.0089*	-
	(4.380)		(10.597)	-
INJURY	0.0041*	-	0.0054*	-
	(5.185)		(7.321)	
ENVDANGER	-	0.2993*	-	0.4695**
		(3.695)		(2.434)
EDN	0.0483*	0.0394*	0.0510*	0.1920*
	(5.735)	(6.818)	(4.463)	(5.674)
EXP	0.0365*	0.0397*	0.1206*	0.1479*
	(6.544)	(6.005)	(4.001)	(3.822)
EXP^2	-0.0005*	-0.0005*	-0.0005*	-0.0006*
	(3.299)	(2.678)	(2.628)	(2.566)
CASTE	0.0580*	0.0345	0.2759**	0.1406
	(2.699)	(1.359)	(2.380)	(0.945)
UNION	0.1967*	0.1981*	1.0263*	1.1102*
	(8.555)	(7.402)	(8.276)	(7.093)
WSIZE	0.0002*	0.0001*	0.0009*	0.0009*
	(4.211)	(3.272)	(4.640)	(3.414)
SUPER	0.1510*	0.1236*	0.9280*	0.7586*
	(5.650)	(3.911)	(6.436)	(4.103)
FITTER	0.1713*	0.1290**	0.7937**	0.5421***
	(3.646)	(2.321)	(2.131)	(1.668)
BINDER	-0.0018**	-0.0101**	-0.0813**	-0.0637**
	(2.014)	(2.063)	(1.990)	(2.068)
TECH	0.2916*	0.3065*	1.9772*	2.0329*
	(2.968)	(2.665)	(3.732)	(3.023)
ASSIST	-0.3164*	-0.2540*	-1.2386*	-0.8838*
	(8.882)	(6.005)	(6.446)	(3.572)
REGION1	-0.1174*	0.0562	-0.7702*	-0.432**
	(2.759)	(1.178)	(3.345)	(2.550)
REGION2	-0.1102*	-0.0342	-0.4713*	-0.0145***
	(3.393)	(0.892)	(2.689)	(1.765)
REGION3	-0.1124*	-0.0433	-0.5605*	-0.1107***
	(3.286)	(1.080)	(3.036)	(1.671)
CONSTANT	0.6769*	0.4416*	1.017**	-0.2436
	(8.415)	(4.407)	(2.344)	(0.416)
R-Square	0.6995	0.5786	0.6999	0.5051
F	73.4969	46.3267	73.6354	34.4335
VALUE OF LIFE (in Rs.)	1,54,65,184	-	1,48,33,808	-
VALUE OF INJURY (in Rs.)	6470.128	-	9000.288	-
VALUE OF DANGER (in Rs.)	-	2361.59	-	3912.62

1. Values in the parentheses indicate absolute *t* ratios.
2. * Coefficient significant at 1 % level, ** Coefficient significant at 5% level and *** Co-efficient significant at 10% level

The main variables of interest are fatal and injury. According to the prediction of the theoretical model, we expect job risk variables (FATAL, INJURY) to have a positive effect on earnings. As predicted, both variables have significant and positive influence on a worker's wage rate. The results show that earnings in the Indian labor market do compensate for the disadvantage of a higher occupational death and injury risk, which is consistent with the hypothesis that the workers are paid positive compensating wage differentials to work at jobs with greater risk of health or injury.

The premiums estimated for job risks in Table 5 are used to estimate the implicit value of life and limb.[5] In order to estimate the value of a statistical life based on the coefficients obtained, the values of the coefficients need to be scaled up. For Chennai, for example, Table 5 shows us that the effect of a unit increase in FATAL on the value of the log of worker's earnings is 0.0098. Evaluating the wage premium at the mean level of wage of Rs. 7.89 per hour yields an estimated trade-off of 0.077 between hourly wage rate and fatal risk. A unit increase in FATAL actually increases annual death risk by 1/100,000. Multiplying 0.077 by 2000 hours to annualize the figure, and by 100,000 to reflect the scale of the FATAL variable, results in the value of Rs.154,65,184 (or Rs.15.4 million) per statistical life for the workers in Chennai. The same calculation shows that the value of a statistical life of workers in Mumbai is Rs.1,48,33,808 (or Rs.14.8 million).

Table 5 shows that a unit increase in injury (which amounts to a 1% increase in the injury rate) in Chennai and Mumbai results in a 0.4% and 0.5% increase respectively in wages. Using the same methodology, the implied value of a statistical injury is estimated as Rs.6470 and Rs.9000 respectively for Chennai and Mumbai workers.

The results obtained are instructive. The annual average wages of Chennai workers and Mumbai workers are Rs.32,000 and Rs.49,000 respectively. Thus, the value of a statistical life is 487 and 302 times higher than annual average wages in Chennai and Mumbai respectively. Further, these results suggest that in monetary terms the probability of death is regarded as being about 3000 times worse than an equal probability of a non-fatal injury.

Columns 2 and 4 of Table 5 include ENVDANGER as the risk variable. It is assumed that workers act as if the objective hazard indices correspond to their subjective assessments. ENVDANGER has a positive coefficient and is statistically significant at 1% level. Thus, workers in jobs which they perceive as being dangerous earn an annual earnings premium of Rs.2362 and Rs.3913 in Chennai and Mumbai respectively. Though this amount represents 15% and 24% of worker's mean earnings at Chennai and Mumbai respectively,[6] it is plausible in the view of the large percentage of laborers (90%) who claim that their jobs expose them to dangerous or unhealthy conditions.

An instructive check on the plausibility of the job risk premium implied by ENVDANGER can be made by comparing its magnitude with the average premium implied by INJURY. The value implied by INJURY is roughly three times greater than that implied by ENVDANGER - a discrepancy that is well within the bounds of errors associated with the imperfect information workers have when assessing job risks.

[5] Conceptually, the wage/risk trade-off is interpreted as the … amount of wages that a worker requires to face a small additional amount of risk. The risk coefficient measures the required compensation for a risk increase, so that it is a willingness-to-accept measure. For small changes in risk, this willingness to accept an increased risk equals the willingness to pay for risk reductions (Moore and Viscusi, 1990a).

[6] Annual wages equal Rs. 7.89 x 2000 = Rs. 15,781 for Chennai and Rs. 8.33 x 2000 = Rs.16,667 for Mumbai workers.

Table 6: Ordinary Least Squares Estimates of Hedonic Wage Equations: Alternative Specification Including Job Attributes Dependent Variable: Logarithm of Hourly Earnings

EXPLANATORY VARIABLES	MUMBAI	CHENNAI
FATAL	0.0088 * (8.545)	0.0096* (8.820)
INJURY	0.0053 * (4.089)	0.0040* (3.960)
EDN	0.0510 * (4.460)	0.0238* (4.538)
EXP	0.1206* (4.000)	0.0382 * (5.993)
EXP^2	-0.0005* (2.586)	-0.0006 * (3.486)
CASTE	0.2567 ** (2.445)	0.0668 * (3.073)
DC	-0.0186 (1.623)	-0.0174 (1.521)
UNION	1.1989* (8.047)	0.1924 * (7.629)
WSIZE	0.0009 * (4.017)	0.0002 * (4.328)
TRAIN	0.0132 (0.461)	0.0128 (0.447)
NHP	-0.0944 (0.795)	-0.0962 (0.811)
OT	-0.019 (0.610)	-0.0062 (0.188)
HECTIC	-0.0122 (0.437)	-0.0164 (0.590)
PHCOND	-0.012 (0.561)	-0.0126 (0.588)
IRREG	0.0268 (1.204)	0.0354 (1.586)
SECUR	-0.0505** (2.140)	-0.0452 *** (1.875)
MENT	-0.0178 (0.646)	-0.0113 (0.409)
DEC	0.0996* (3.373)	0.1005 * (3.371)
NOMIS	0.0677 ** (2.519)	0.0629 ** (2.329)
DIST	0.0003 (0.141)	0.0004 (0.221)
FAST	-0.0201 (0.783)	-0.0212 (0.810)
SUPER	0.0886 * (2.723)	0.0864 * (2.635)
FITTER	0.1501 (3.184)*	0.1614 * (3.410)
BINDER	0.0790 (0.576)	0.0472 (0.344)
TECH	0.2558 * (2.598)	0.2751 * (2.803)
ASSIST	-0.3015 * (8.145)	-0.2995* (8.109)
PRIVE	0.0258* (2.989)	0.0074 ** (1.989)
REGION1	- 0.0456* (3.325)	-0.0686 (1.559)
REGION2	-0.4713 * (2.682)	-0.0996* (2.949)
REGION3	-0.5605 * (3.025)	-0.0946* (2.657)
CONSTANT	1.6014* (6.682)	0.6611* (7.147)
R^2	0.7117	0.7172
F	45.1685	415095
THE VALUE OF LIFE (In Rs.)	1,46,67,136	1,51,49,568
THE VALUE OF LIMB (In Rs.)	8833.61	6312.32

Notes:

1. Values in parentheses indicate absolute *t* ratios.
2. * Coefficient significant at 1 % level, ** Coefficient significant at 5% level and *** Co-efficient significant at 10% level

Table 6 presents results from an alternative specification of the hedonic wage equation that includes job attributes. These variables allow us to reduce bias in the coefficients of the job hazard variables by controlling for a variety of job attributes. Moreover, they provide additional tests of the validity of the theory of compensating differentials (Viscusi, 1979).

Three job characteristics that are significant are DEC, a dummy that indicates that the worker is a decision-maker, NOMIS, a dummy that signifies jobs which require workers to make no mistakes, and SECUR, a dummy that signifies good job security. The results show that workers who make decisions and whose jobs require them not to make mistakes tend to be paid somewhat more. SECUR is significant and negative. The higher earnings of individuals with job security is quite consistent with the greater security associated with upper level blue-collar positions. This variable may also be capturing the relative ranking of the worker's job rather than any particular job attribute. The implicit value of life and injury estimated from this alternative specification is also reported in Table 6. These numbers do not change much from those reported in Table 5. The value of life estimates are Rs.14.6 million and Rs.15.1 million while the value of limb are Rs.8,833 and Rs.6,312 for Chennai and Mumbai workers respectively.

4.2 Estimation of the Determinants of Job Risk

As mentioned in the theoretical framework section, willingness to pay for or willingness to accept risk will be different for different individuals and will be affected by wealth. A separate account is made in this section to test whether the optimal job risk would necessarily decrease with the workers wealth.

In order to understand the effect of wealth and other factors that determine job risks, ordinary least square (OLS) estimates of the risk[7] equations were undertaken and are reported in Table 7. Here the dependent variables are FATAL and INJURY. The explanatory variables included are: (a) variables which affect earnings such as education, age, union status and occupational dummies; (b) variables denoting non-labor income and the value of assets such as home ownership; (c) proxies for the degree of risk aversion (since measures of the stability of worker's life-style are inversely correlated with the degree of risk aversion, the following proxy measures of stability are included: the number of dependents (DC); the marital status and a dummy capturing the employment status of the spouse); and, (d) the industrial dummies to capture the differences in production process which presumably influence the safety levels of the firms.

The human capital variables are expected to have a negative relation with job risk variables. As expected, education has a negative and statistically significant impact. CASTE is included to test the hypothesis that the workers belonging to backward class and SC/ST's are subject to higher risks of their jobs. Such a discrimination hypothesis is supported by the result.

A potentially important determinant of job risk is the presence of a UNION to bargain for workers' interests. The role of unions derives from the advantage of collective action. First, they can serve as a coordinating body to promote a pattern of work effort and safety precautions that further the employees' group interest. Second, the unions have a major impact on working conditions. Unions also provide job hazard information to workers. For these reasons, unions are predicted to have a negative impact on job risk. As expected, UNION influences fatal risk negatively. However, contrary to our prediction, UNION has a positive impact on INJURY. These results suggest that unions play a significant role in reducing fatal risks but do not concern themselves too much about injuries.

[7] Because the job risk variables are constrained to lie between zero and one, we transform them with the inverse cumulative normal distribution, following Garen (1988). So their range is negative to positive infinity. However, the results using the risk variables themselves are quite similar to those after the transformation. So the original form is used.

Table 7: Ordinary Least Squares Estimates of Job Risk Equations

INDEPENDENT VARIABLES	CHENNAI		MUMBAI	
	FATAL	INJURY	FATAL	INJURY
EDN	-0.1553**	-0.8363**	-0.2663*	-0.3453**
	(1.963)	(2.416)	(2.963)	(2.526)
AGE	0.1013	0.6695	0.1678**	0.7789**
	(0.489)	(1.505)	(2.489)	(2.505)
AGE^2	-0.0019	-0.0139	-0.0020	-0.0249
	(0.347)	(1.162)	(1.347)	(1.162)
CASTE	-0.9534***	-0.0033**	-0.8564**	-0.0346**
	(1.895)	(2.001)	(1.995)	(2.251)
DC	-0.1304***	-0.6145***	-0.2404**	-0.4589***
	(1.956)	(1.856)	(1.978)	(1.888)
UNION	-0.3627**	5.7623*	-0.2568**	0.4623**
	(2.508)	(3.761)	(2.056)	(2.4589)
Married	-1.216**	-1.118**	-0.4585**	-1.389**
	(2.056)	(2.100)	(1.985)	(2.450)
Spouse	-0.2456***	-0.1456***	-0.1456***	-0.3456***
	(1.856)	(1.795)	(1.789)	(1.856)
WSIZE	0.0024***	0.0036	0.0098***	0.0048
	(1.916)	(1.314)	(1.926)	(1.614)
SUPER	0.4985	-1.0732	0.4985***	1.0732***
	(0.568)	(0.570)	(1.668)	(1.678)
FITTER	-2.5413***	-3.1236	-1.5458***	-1.5660
	(1.696)	(0.971)	(1.789)	(1.601)
BINDER	3.9623	-6.7113	1.9623***	-2.7113
	(0.918)	(0.724)	(1.928)	(0.724)
TECH	3.5312	-13.3410**	1.6512	-1.5410**
	(1.132)	(1.994)	(1.132)	(1.994)
ASSIST	1.2296	1.6336	2.2296**	2.5436
	(1.081)	(0.669)	(2.081)	(0.669)
IND1	-8.5631*	-8.7510*	-3.5631*	-8.7510*
	(7.850)	(3.739)	(4.850)	(3.739)
IND2	-13.475*	-7.0059*	-1.775*	-7.0059*
	(13.574)	(3.290)	(3.574)	(3.290)
IND3	-14.089*	-10.0170*	-4.489*	-10.0170*
	(9.023)	(2.990)	(3.023)	(2.990)
IND4	2.3833	-9.4256*	1.4533**	-9.4256*
	(1.430)	(2.990)	(2.430)	(2.990)
HOUSE	-0.0005E-3**	-0.0008E-3**	-0.0009E-3*	-0.0017E-3**
	(2.074)	(2.060)	(2.785)	(1.998)
INCOME	-0.00016*	-0.0002**	-0.00023*	-0.0010**
	(3.409)	(2.221)	(2.589)	(2.485)
CONSTANT	11.173*	-6.1758	7.8956*	-7.8569**
	(4.582)	(1.181)	(3.332)	(2.181)
R^2	0.3820	0.1105	0.4820	0.2145
F	17.2748	3.4734	19.4588	5.5689

Notes:
1. Values in the parentheses indicate absolute *t* ratios.
2. * Coefficient significant at 1 % level, ** Coefficient significant at 5% level and *** Co-efficient significant at 10% level

As expected, the DC variable, a proxy for risk aversion, is negatively associated with job risks. It implies that more the number of dependent children, less will be the job risk that workers take on. The results are supported by t values. The variable WSIZE reflects the influence of enterprise size on the risks faced by the worker. Viscusi (1979) shows that the productivity losses from job risk are decreased with increases in the scale of the enterprise, suggesting that firm size should have a positive sign. As expected, it influences both fatal and injury equations positively. Occupation dummies are expected to have positive impact on risk. In FATAL equation, all have a positive relationship except FITTER. But these coefficients are not statistically significant at the 5% level. In the injury equation, it is shown that only assistant workers face more non-fatal accidents whereas others have a negative relation with injuries. However, t values are not significant.

Considering industrial dummies, it is noted that they all have a significant negative impact on both fatal and injury equations, except IND4 which is not statistically significant at 5% level in the FATAL equation.

The most interesting findings have to do with the impact of wealth and income on job risks. Our results show that the INCOME variable has a strong negative impact on job risks. HOUSE, our measure of assets of wealth, also has a negative association with job hazards. The estimates, thus, confirm the theoretical result that the optimal job risk would necessarily decrease with workers' wealth.

For comparative purposes, maximum likelihood estimates of the logit parameters pertaining to the probability of ENVDANGER are estimated in Table 7. Initially, six equations were estimated specified in alternative ways. Different groups of variables have been added to each of the six equations in an effort to measure the relative contribution of variables observable at different points in the employment process. Specification (1) includes only the human capital variables (EDN, EXP, EXP2) to ascertain the total effects of these variables on assessed job hazards. Specification (2) includes social characteristic variables (CASTE, DC). The third specification introduces enterprise characteristics, namely, UNION and WORK and specification (4) includes occupational dummies. Finally, specification (5) and (6) introduce industrial dummies and income variables.

Whether the addition of each of these sets of variables significantly affects the explanatory power of the regression can be determined by using Likelihood Ratio Tests (see explanation and Table - A1 and A2 in Appendix-I). We reject the hypothesis that the coefficients in each set of variables added to equation (3), (5) and (6) equal zero. However, it is seen that for equation (2) and (4), the estimated values are less than x2 at 5% level. Hence, it is concluded that the set of social characteristic variables and the set of occupational dummy variables have no significant impact on hazard perception (i.e. ENVDANGER).

Table 8: The Determinants of Environmental Danger Perceptions: The Logit Estimates Dependent Variable (1 if job exposes the worker to environmental problems and unhealthy conditions; 0 - otherwise)

EXPLANATORY VARIABLES	MUMBAI	CHENNAI
SCHOOL	-0.1214	-0.1027
	(1.555)	(1.274)
AGE	0.0755	-0.0084
	(0.914)	(0.095)
AGE^2	-0.0029	-0.0006
	(1.374)	(0.258)
CASTE	0.4921	0.4331
	(1.466)	(1.262)
DC	-0.0254	-0.0526
	(0.141)	(0.301)
UNION	1.7757*	1.8034*
	(4.309)	(4.267)
WSIZE	0.0013**	0.0015**
	(1.961)	(1.994)
SUPER	0.8064	1.0719***
	(1.553)	(1.925)
FITTER	0.8431	0.6503
	(0.969)	(0.771)
BINDER	10.97	10.731
	(0.023)	(0.022)
TECH	10.250	9.9511
	(0.030)	(0.029)
ASSIST	-0.9783**	-1.1973*
	(2.252)	(2.650)
IND1	-1.3161*	-1.406*
	(2.735)	(2.768)
IND2	-1.7223*	-1.744*
	(3.980)	(3.899)
IND3	10.217	10.036
	(0.063)	(1.062)
IND4	-1.9530*	-2.0023*
	(2.873)	(3.016)
HOUSE	-0.14E-5**	-0.0003E-2**
	(1.998)	(2.103)
INCOME	-0.0011*	-0.0004*
	(3.164)	(2.791)
CONSTANT	2.716**	3.499*
	(2.413)	(2.9320)
LOG-LIKELIHOOD	-130.391	-125.3577

Notes:

1. Values in parentheses indicate absolute *t* ratios
2. * Coefficient significant at 1 % level, ** Coefficient significant at 5% level and *** Co-efficient significant at 10% level

The results in Table-7 indicate that the personal and social characteristic variables have the least impact on danger perception. UNION is positively related with ENVDANGER implying that union workers are able to identify the hazards they face because they have gained awareness through collective bargaining. The enterprise size variable is positively associated with hazard perception and is statistically significant at 5% level. Except ASSIST, all others have a positive sign. ASSIST shows a negative influence on DANGER and is statistically significant at 5% level. This result is plausible since these workers are assistants to the main machinist and are therefore safer.

Most of the industrial dummies are significant. IND1 and IND2 influence ENVDANGER negatively and are statistically significant at 5% level. IND3 has a positive impact but it is not statistically significant. The final matter of empirical interest is the influence of worker's assets (or income) on optimal job risks. The two variables included are INCOME AND HOUSE (it is also a proxy for risk aversion). As expected, both are negative. INCOME and HOUSE are statistically significant at 1% level confirming the result that the optimal job risk would necessarily decrease with the worker's wealth.

5. Conclusion and Policy Implications

Whether or not we can measure the value of risks to life and health in pure economic terms will always remain debatable. However, we would argue that workers routinely make the trade-off between health risks and economic gains, and this trade-off can be identified by studying wages associated with different industries. A second issue is whether policy makers should base any particular decisions on such economic values. If specific risks are being ascertained in order to save the life of a particular individual, economic values are clearly not the only consideration. They may also be less relevant if the goal is to deter future harmful acts or in deciding whether to impose risks on others. However, if the goal is to compensate victims in monetary terms, economic values become important. They are also important for undertaking benefit cost analyses of public sector projects that change health risks faced by individuals. Thus, economic values are one pertinent factor in deciding whether to accept individual or collective risks. It is in this context that we analyze the role of compensating wage differentials in job risks.

Our findings validate the assumption that workers make rational decisions about their jobs and take job risks into account in accepting different types of jobs. Thus, the greater the job risks, the higher the wage demanded. We estimate that workers in Chennai and Mumbai are willing to trade-off job risks at an economic price of Rs. 15.4 million and Rs. 14.8 million per statistical life respectively. Using the same terminology, the implied value of a statistical injury is estimated as Rs. 6470 and Rs. 9000 for Chennai and Mumbai workers respectively.

The estimated VSL exceeds the workers' lifetime earnings. The estimated values also exceed the amounts paid in Employee Insurance Schemes and the Workmen's Compensation Act. However, this is not inconsistent since VSL represents the rate of risk-money trade off for very small risks, not the amount that workers would pay for a certain extension of life. Further, these numbers suggest that compensation required for facing increased risks are higher than what can be estimated by simply looking at life time wages lost.

It is useful to compare our findings with results from other countries. While estimated life values in developed countries vary dramatically, two important reviews provide a range (*see Table A3 in appendix-I*)[8]. Cropper and Freeman (1991) argue, based on a survey of 17 studies, that wage risk estimates range from $1.9 million to $6.4 million (in 1990 USD) per statistical life. Viscusi (1993, 2002) finds that recent estimates of the value of life are clustered in the range of $3 - 7 million in 1990 USD. When we convert our estimates of Rs. 15.4 and

[8] The variation is likely to be a result of errors in either specification or variables chosen.

Rs. 14.8 million for Chennai and Mumbai respectively into dollars at 1990 prices, the value is approximately $0.8 million. As expected, this number is lower than that for developed countries.

Studies undertaken within the Indian context also suggest that our numbers are credible. Simon, et al., (1999) estimate compensating wage differentials for fatal and non-fatal injuries in India's manufacturing industry and identify a range of Rs. 6.4 to Rs. 15 million for the value of a statistical life.[9] Shanmugam's (1996, 1997, and 2001) estimates of the VSL in India are slightly higher. He estimates the VSL to range between Rs. 14 to 19 million ($0.76 - $1.026 million), while that of injury varies from Rs. 2014 to Rs. 7632 (or $112 - $422 in 1990 USD).

Our study provides some interesting insights into the Indian labour market. For instance, the study implies that an average worker employed in the manufacturing industry must be paid approximately Rs.240 in annual earnings for an 1/100000 increase in the risk of death at work. This result suggests that the Indian labour market does compensate workers for work related accidents. Safety incentives created by market mechanisms are often stronger than those imposed by government regulations. However, the private sector is likely to provide too little information about risks to generate optimal outcomes. Hence, the best role for the government may be in providing information about job risks to workers and ensuring that adequate compensation is provided in the event of fatal and non-fatal accidents.

The estimated values of statistical life and injury from this study can be used by industrial safety programs or environmental health programs to value reductions in risk of death. It should, however, be noted that this study is not free from limitations. Estimates from this study may be biased because of failure to include the impact of insurance benefits and discount rates for long-term health related job risks on wage premiums. We hope to pursue some of these issues in a forthcoming paper.

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[9] They estimate a hedonic wage equation using the most recent Occupational Wage Survey supplemented by data on occupational injuries from the Indian Labour Yearbook. Their estimates amount to roughly $150,000 to $360,000 at 1990 exchange rates.

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Appendix 1

Likelihood Ratio Tests for Estimating ENVDANGER Equation

To estimate the job risk equation, with ENVDANGER as the dependent variable, different sets of variables are added to identify the best fit. Whether the addition of each of the sets of variables significantly affects the explanatory power of the regression can be determined by using Likelihood Ratio Tests. In particular, let θ* be the estimated parameter vector with q elements constrained to be zero and θ** be the unconstrained estimates and if L represents the likelihood of the observed sample, then the test statistics ( ) is given by:

$$\Omega = -2\log[L(\hat{\theta}^{*} / L(\hat{\theta}^{**})] = -2[\log L(\hat{\theta}^{*}) - \log L(\hat{\theta}^{**})]$$

Ω is approximately chi-square with q degrees of freedom. The log-likelihood from the alternative specifications is used to calculate the test values for this equation. These magnitudes are compared with the critical x^2 (q) for 95 percent confidence levels, which are given in the last column of Table A1 and A2.

Table A1: Summary of Likelihood Ratio Tests: Chennai

EQUATION	VARIABLES ADDED	Q(d.f)	Likelihood values	χ^2 (0.05) (q)
2*	CASTE, DC	2	1.7900	5.991
3	UNION, WSIZE	2	15.8284	5.991
4*	SUPER, FITTER, BINDER, TECH, ASSIST	5	10.2582	11.070
5	IND1, IND2, IND3, IND4	4	25.5410	9.488
6	HOUSE, INCOME	2	10.0672	5.991

* Note: the calculated Ω value is less than χ^2 Table value.

Table A2: Summary of Likelihood Ratio Tests: Mumbai

EQUATION	VARIABLES ADDED	Q(d.f)	Likelihood values	χ^2 (0.05) (q)
2*	CASTE, DC	2	2.8880	5.991
3	UNION, WSIZE	2	10.8458	5.991
4*	SUPER, FITTER, BINDER, TECH, ASSIST	5	9.5689	11.070
5	IND1, IND2, IND3, IND4	4	36.4578	9.488
6	HOUSE, INCOME	2	13.4568	5.991

* Note: the calculated Ω value is less than χ^2 Table value.

Table A3: Selected Labour Market Studies on the Value of Life and Injury

Note: Values of life and injury except Alberini, et. al., (1977) were converted in 1990 US dollars.

Author/Year	Sample	Source for risk variable	Value of life ($ Million)	Value of injury ($)
Alberini et.al (1997)	Primary survey, Taiwan, 1992	Acute respiratory illness	----	39.20
Brown (1980)	National Longitudinal Survey (1966-71, 1973)	Society of actuaries	0.8	--
Cousineau, Lacroix and Girard (1992)	Labor Survey, Canada, 1979	Quebec compensation board	3.6	--
Dillingham (1985)	Quality of employment Survey, 1977	Bureau of Labor Statistics	2.5 - 5.3	--
French and Kendall (1992)	CPS Survey, USA, 1980	Federal Rail road administration injury data	--	38159
Garen (1988)	PSID, USA, 1981-82	Bureau of Labor statistics (BLS)	13.5	21021
Gerking et.al (1988)	Mail survey, USA, 1984	WTP and WTA change in job risk	3.4(WTP) 8.8(WTA)	---
Hersch and Viscusi (1990)	Primary survey in Eugene, 1987	Worker's assessed injury rate	--	30781(smokers 92245(seat belt users)
Herzog and Schlottman (1990)	US Census, 1970	BLS	9.1	--
Jones-lee (1976)	Mail Survey, UK	Airline safety	15.6	--
Jones-Lee et.a.l (1985)	Survey on Motor Vechile accidents, UK, 1982	WTP for risk reduction	3.8	--
Kniesner and Leeth (1991)	2-digit manufacturing data, Japan, 1984 2-digit manufacturing data, Australia, 1984 and CPS, USA, 1978	Year book of labor statistics Industrial accident data National traumatic occupation fatality survey	7.6 3.3 0.6	77547 8943 47281
Leigh and Folsom (1984)	PSID, 1974 and Quality of employment Survey, USA, 1977	BLS	9.7 and 10.3	--
Marin and Psacharopoulos (1982)	Population Census and Surveys, UK, 1977	Occupational Mortality Tables	2.8	--
Miller and Guria (1991)	New Zealand Survey 1989-1990	Series of contingent valuation questions on traffic safety	1.2	--
Moore and Viscusi (1988)	PSID, USA, 1982	BLS	2.5 and 7.3	--
Olson (1981)	CPS,1978	BLS	5.2	--
Thaler and Rosen (1976)	Survey of economic opportunity, USA	Society of actuaries	0.8	--
Viscusi (1981)	PSID, USA, 1976	BLS	6.5	46200
Viscusi and O'conner (1984)	Primary Survey in chemical Industry, USA, 1982	Workers assessed injury and illness	--	13890-17761

The values in Alberini's study related to 1992 US dollars.

Appendix 2
Employment Survey

Institute for Social and Economic Change, Nagarbhavi,
Bangalore 560 072

<u>Valuations of Life and Injury Risks</u>

Sample No: Date of Interview:

Industry Code: Name and Address of the Company

1. Household Demographic Information

1.1 Name of the Respondent
1.2 Sex
1.3 Age
1.4 Caste/ Religion
1.5 Education Level (in years)
1.6 Marital Status
1.7 Details of Family Size and Members:

Household Member	Sex	Age	Marital Status	Educational Attainment	Activity Status
1.Spouse					
2.Children 01 02 03 04 05					
3.Father					
4.Mother					
5.Others					

2. Job Characteristics of the Respondent

2.1 Name of the Job:
2.2 Name and address of the firm where the respondents works
2.3 Wage rate per hour/week/month (in Rs.)
2.4 Hours worked last week
2.5 Weeks worked last week
2.6 Date of joining the job:
2.7 Experience in the present job
2.8 Is it a first job: Yes/No

If No, give the following details

No.	Name of the Previous job	Date of joining	Date of Leaving	Wage per Day when left (in Rs.)	Reasons for Leaving
1					
2					
3					

2.9. Age at which worker started earning:

2.10 Are you a Supervisor? Yes/ No

If Yes, number of subordinates working under you:

2.11 Whether the present job is: (a) Full-time/ Part time (b) Permanent/ Temporary

2.12 Whether the job requires that:

a. You must work fast: Yes/ No

b. You should make decisions: Yes/ No

c. You should not make mistakes: Yes/ No

2.13 Are You a Union Member?

2.14. Whether the job requires

a. Over-time work: Yes/ No

If Yes, (1) how many hours: (per day/ week)

(2) Compensation (in Rs.): (per day/ week)

b. On-the-job Training

If Yes, give detail ....

....

2.15 Whether the working firm belongs to:

a. Private Sector/ State Government/ Union Government:

2.16. Number of Employees at Work Place: Male Female

2.17. Do you feel that work hours are irregular: Yes/ No

2.18. Are you allowed to avail of the sick leave days with full pay: Yes/ No

3. Employment Status of Family Members

3.1 Total number of working persons in the family (other than the respondent):

3.2 Details of family members who work

Working Family Member	Name of the Job	Name of the Firm Where employed	Experience in the present job	Monthly/ Weekly Wage in Rs.	Age at which started earnings

4. Family Assets and Asset Income

4.1 Are you living in your own house: Yes/ No
- (i) If Yes, the present value of the house: (in Rs.)
- (ii) If No, the paying rent of the house: (in Rs.)

4.2 Give the following details (other than own living house):

No.	Name of the asset	Value of the asset (in Rs.)	Nature of income (if it gives income)	Annual income from the asset (in Rs.)
1.	Land			
2.	Other Properties a. b. c.			
3.	TV(Colour/BW)			
4	Two wheelers			
5.				
6.				

5. Details about the Working Conditions

5.1 Whether your job exposes you to environmental problems, which lead to unhealthy conditions: Yes/ No

5.2 Whether your job requires hard Physical work: Yes/ No

If Yes, type of hard work:
- (a) Need to lift 60Kg. sometimes once a week or daily: Yes/ No
- (b) The work is physically demanding in ways not covered by heavy lifting: Yes/ No
- (c) The physical activity at work causes daily sweating: Yes/ No.
- (d) Punctuality and carefulness are important: Yes/ No.

5.3 Do you feel that your work is:
- a) Very noisy : sometimes/ often/ always
- b) Exposed to gas, dust, or smoke: sometimes/ often/ always
- c) Exposed to strong shakes or vibrations: sometimes/ often/ always
- d) Other inconvenience/ environmental problems (details……….) sometimes/ often/ always

5.4 Do you feel that the job is so stressful that it is
- a) Mentally Demanding : Yes/ No
- b) Hectic : Yes/ No
- c) Other : Yes/ No

5.5 Did any accident occur in your firm in the last year: Yes/ No
If Yes, give the following details:

Nature of accident	Number of accidents	Reasons for the occurrence	Man-day lost and Compensation Paid (If you know)
1.Fatal 2.Non-Fatal: i) Permanent ii) Temporary			

5.6 Do you feel that the present job has:
a) Pleasant physical surroundings : Yes/ No
b) Good job security : Yes/ No

6. Details about Tax and Benefits

6.1 Are you a taxpayer? : Yes/ No
If Yes, give the following details

NO.	Name of the tax	Tax amount per year	others
1. 2. 3.			

6.2.Give Details on labor social security schemes:

No.	Type of Social Schemes	Value in (Rs.)	Duration	Premium Share Yours Firm's (in Rs.)
1. 2. 3. 4.	State Employee Insurance: Yes/ No Pension: Yes/ No Gratuity: Yes/ No Others like Soap : Yes/ No Uniform: Yes/ No Glass: Yes/ No Clouse: Yes/ No Boots: Yes/ No			

7. Respondent Belief about the Job

7.1 What was the reason to choose the present job:
a) More salary b) Less competitive c) More amenities d) Other (details):

7.2 Did any accident occur to you when at work? Yes/ No
If Yes,
a) Type of accident………….
b) No. of times………….
c) Man-day lost due to it…………
d) Compensation received (in Rs.)……….

7.3 Search for alternative job:
a) Are you satisfied with the present job: Yes/ No
b) Are you thinking of finding a new job: Yes/ No
c) Have you applied for any alternative job: Yes/ No
If Yes, (a) What is the reason?
(b) What is the name of the job applied?
(d) Do you plan to quit your job during this year: Yes/ No

7.4 Are you getting Bonus? Yes/ No
If yes, bonus amount (last year in Rs.):

7.5 Distance from house to work site:

7.6 Do you know anything about labor welfare and social security schemes in India?
Yes/ No
If Yes, give details…………