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Estimating the Value of Statistical Life in Pakistan

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Abstract

The study estimates the Value of Statistical Life and Limb in Pakistan based on the compensating wage differential among blue-collar industrial workers in the city of Lahore. The data for this study is from a survey of 680 workers who were above eighteen years of age with at least one year's work experience. According to the study, the Value of Statistical Life (VSL) in Pakistan ranges from PKR 28 million (USD 321,813) to PKR 67 million (USD 775,193). The variation in the results has to do with the use of different risk measures, that is, actual and perceived risk measures in alternative regression equations. These estimates are consistent with values obtained from studies undertaken in other developing countries. The author concludes that the industrial workers of the formal sector in Pakistan are rational in that they factor in risk when accepting a job.

Key words: Compensating Wage Differentials; Lahore; Blue-collar Workers; Formal Sector; Perceived Risk; Value of Statistical Life.

Estimating the Value of Statistical Life in Pakistan

1. Introduction

Governments across the world adopt different safety measures based on estimates of willingness to pay of the people for a reduction in the probability of death and injury. Using approximations of these trade-offs, they arrive at cost-benefit analyses of environmental issues, public safety measures on highways and roads, medical treatments, etc. Economists term a trade-off between money and fatality risks the Value of a Statistical Life (VSL).

The Value of Statistical Life and Limb is generally predicted using one of three main approaches. The first uses the compensating wage differentials that workers must be paid to take riskier jobs (Viscusi and Aldy, 2003). The second approach examines other behaviors where people weigh costs against risks (Blomquist, 2004) while the third resorts to contingent valuation surveys where respondents report their willingness to pay (WTP) to obtain a specified reduction in mortality risks. The VSL is obtained by dividing the WTP by the risk reduction being valued (Alberini, 2005).

However, to date, most of such studies have been conducted in developed countries while no such estimates based on willingness to pay (WTP) studies are available for Pakistan. A recent World Bank publication[1] has in fact estimates that the annual health effect of ambient air pollution in Pakistan includes 22,000 premature deaths among adults and 700 deaths among children under five. The total health cost of air pollution is estimated to be between PKR 62 billion and PKR 65 billion, which is approximately one percent of the GDP. The paper suggests an implied VSL in the range of PKR 58 billion to 61 billion or approximately three million per statistical life.

The above estimates for Pakistan are however lower than those obtained in other regional and international studies.[2] Moreover, these estimates are based on extrapolated values from other countries, cost of illness approach, and the human capital approaches in the absence of true willingness to pay (WTP) estimates for the country.[3] Economists however see such estimates as representing a lower bound of premature mortality and morbidity. Therefore, the absence of true estimates of VSL poses a serious problem for policy makers when it comes to cost-benefit estimates of different policy options.

The present study is the first study of its kind to address this lacuna. We estimate the value of statistical life and injury in Pakistan based on the compensating wage differential among blue-collar male workers in the manufacturing sector of Lahore. Our study includes an estimate of the wage-risk tradeoff based on the 2-digit industry level as well as the perceived measure of risk. We include perceived risks because they are more plausible, reflecting as they do job- and work-specific risks rather than industry aggregates since the latter simply signals the same level of risks for all occupations and work in a specific industrial classification. However, workers do not typically compute industry risks, only job-specific risks. Hence, the approach hitherto adopted carries the danger of overestimating the results (Hammitt and Ibarraran, 2006). In our study, we have therefore introduced two variants of the perceived fatal risk in order to circumvent this problem. Since this is the first such study in Pakistan, its results may help different agencies and organizations to evaluate the value of different safety programs.

The rest of the paper is organized as follows. In the next section, we discuss the existing theories pertaining to VSL. Section 3 briefly describes the particulars of the study sites. Section 4 contains information on our sampling methods and data collection techniques. Section 5 describes the variables that have been considered for this study while section 6 provides information on the methods used for data analysis. Section 7 carries the results of the study with section 8 concluding the study with policy implications.

1 EPA/ World Bank (2006).
2 See Madheshwaran for estimates of VSL in India (2004).
3 EPA/ World Bank (2006).

2. Existing Theories on VSL

Studies have shown that workers, when making decisions regarding a job, factor in both the pecuniary and non-pecuniary characteristics of work, among them, wages, working hours, career path, ease and hardship of work, pension and benefits, risk to life and health. Nonetheless, as noted by Viscusi (1978a and 1978b), job safety is one of the most important characteristics. According to the theory of compensating wage differentials, if workers know that one job is riskier than others, there should be compensation in the form of some other more valued characteristic for workers to accept the job. And in cases where the non-monetary aspects of all other jobs are equal to the job under consideration, compensation should come in the form of higher wages for workers to consider accepting the riskier job.

It was Adam Smith who first proposed this theory when he stated that "the wages of laborers vary with the ease or hardship, the cleanliness or dirtiness, the honorableness or dishonorableness of the employment". Since then Griliches (1971), Rosen (1974 and 1986), and Thaler and Rosen (1975) have refined and reorganized this concept by developing statistical models to realize the difference in worker productivity and the different components of the job by unraveling wage-risk tradeoff from other factors affecting wages. This approach, now called the Hedonic (quality adjusted) Wage Model, tries to determine the variation in wages due to different factors, including job-related fatal and non-fatal risks.

According to the Hedonic Wage Model, the demand for labor is a decreasing function of the cost of employing laborers, which includes wage, compensation, training and development, rest days, provision of safety measures, etc. Firms are willing to pay less to their workers as the cost of safety for a given level of profit increases. Thus, given the wage-risk offers, workers choose a wage-risk combination in the market offering the highest wages. The supply of labor is fractionally influenced by the wage and risk preferences in addition to numerous other pecuniary and non-pecuniary job characteristics.

The Hedonic Wage Model can be explained with state-dependent utility functions. Let $U(w)$ represent the utility of a worker in good health earning wage w and let $V(w)$ represent the utility of an injured worker at the same wage w. If there is no additional compensation for the injury, it is natural to assume that workers would favor the healthy state over an injured one, that is, $U(w) > V(w)$. As a standard assumption of the utility function, the marginal utility of income is positive, i.e., $U'(w) > 0$ $V'(w) > 0$. Let the probability that the worker gets injured be p, and the worker's utility if he works for the wage rate w be Z. The expected utility can then be expressed as:

$$Z = (1 - p)\, U(w) + pV(w) \qquad (1)$$

The worker chooses to work only when this utility Z is greater than or equal to his reservation utility Z_0. Assuming that he agrees to work when $Z = Z_0$, we can apply the total differentiation to the equality. By re-arranging the total differentiation, we can characterize the wage-risk tradeoff in the equilibrium by:

$$dw/dp = -Z_p / Z_w = \{U(w) - V(w)\} / \{(1 - p)\, U'(w) + p\, V`(w)\} > 0, \qquad (2)$$

Therefore, the wage must increase with the increase in the degree of risk. Consequently, the wage-risk swap equates the differentiation in the utility levels of the two statuses by the expected marginal utility of income. For this trade-off to be realized, workers should be knowledgeable about their working environments when they choose their jobs and the firms should face an elastic labor supply with respect to wages. We need observed market data to study the equality between the two. Hedonic Wage Models trace these points by workers which are by demand and supply in the market where the coefficients match precisely the employee's marginal willingness to accept risk. On the other hand, the model also looks into the demand for more protection and the firm's incremental cost for the provision of increased protection plus the decrease in the marginal cost faced by the firm owing to the higher risk faced by the worker.[4]

[4] This section is based on the Meta Analysis of Viscusi and Aldy (2003).

3. Description of the Study Site

The present study, based on the Hedonic (quality-adjusted) Wage Model, assesses the demand for safety by estimating the relationship between wage and job-related risk using the blue collar male workers of the manufacturing sector in Lahore. Lahore is not the only capital of Punjab Province but is the second biggest city and financial center of Pakistan with large industrial areas including Kot Lakput, Quaid-e-Azam industrial estate, and the new Sundar Industrial Estates among others. According to the information provided by the official website of the province of Punjab[5], the city has around 2652 large, medium-sized and small industries ranging from chemical to textile and engineering. Adding to the reputation of the city is its fame as the hub of hand-woven carpets in Pakistan.

However, a survey conducted by the Centre for the Improvement of the Working Conditions and Environment (CIWCE) based in Lahore[6] found that the industries do not provide basic health and hygiene amenities and that many factories have poor exhaust filters, fire deterrence, health facilities (including basic amenities such as first-aid boxes), emergency transport and waste disposal mechanisms. In many instances, the factories did not even display hazard warning signs. Moreover, according to the report, the use of new chemicals has led to an increase in industrial accidents.

4. Sampling and Data Collection Method

The study deployed the multi-stage sampling technique for data collection. We selected Lahore as the study area because it is the second largest industrial city. We decided to restrict the data collection to blue collar male workers of the manufacturing sector because, according to the Labor Force Survey (2006), the highest number of fatal and non-fatal accidents has been reported from among this sector, which has industrial mechanical workers who are mostly male.

For the purpose of arriving at a representative sample, we adopted the stratified random sampling technique. These strata are the nine industrial groups based on the National Industrial Codes (NIC). However, we collected data from only those factories which were registered under the Factories Act of 1934 in order to ensure that we analyzed the risk-wage tradeoff of only the formal sector laborers. The obvious limitation of restricting the representative sample to the formal-sector manufacturing workers in Lahore is that we leave out the wage-risk trade-off in the informal sector and therefore can only give an incomplete picture of the topic under study. .

Moreover, although the appropriate sample would be a random sample from the population of all workers spread across all factories, in this instance, we chose the factories first and then chose workers from each factory because we found it to be very costly and practically infeasible to do otherwise since we did not have the list of workers pooled over all factories. However, this required us to have a larger sample size since the variation across workers within a factory is smaller than the variation across workers spread over different factories. Since many regional and international studies have opted for a sample size of more than a 1000 workers[7], we decided to set the sample size at 1000 blue collar male workers. However, the sample size was also 10 percent of the labor population of the formal manufacturing sector of Lahore. Therefore, from the nine strata, we selected the number of factories and respondents based on the risk faced by the workers. We computed the risk faced by the worker from the Labor Force Survey (2006) injury results among industrial workers. However, due to the deteriorating law and order situation in some parts of the study area, we were able to interview only 680 respondents in the end as against the target of 1000 workers. Table 2 shows the details of the actual number of respondents as against the target.

For the purpose of collecting data, we conducted in-person interviews with the industrial workers using structured questionnaires. We pre-tested the questionnaire during a pilot study of fifty workers which was helpful in identifying problems with our questionnaire and survey technique. We conducted the survey in four large and small industrial units. Although we first contacted the industrialists and then conducted the interviews on predetermined dates, we found during interviews that the industrialists were hesitant to allow the survey team to interview the workers. The

5 www.punjab.gov.pk
6 www.ciwce.org.pk
7 See Madheshwaran (2004) and Viscusi and Aldy (2003).

observed reluctance may have arisen from multiple causes among which might be the apprehension that a) the information gleaned could reach the internal revenue department, b) a feeling that the survey may uncover some of their business secrets, or c) a fear that it might waste the workers' time. We found out later that the workers had been instructed not to answer some questions. The experience however helped us realize that the survey technique deployed might go against the norms of random selection of workers because the technique required us to resort to some form of reference for the purpose of convincing or contacting employers to persuade them to let us interview their workers.

In order to avoid this problem encountered during the pilot survey, we therefore devised an alternative survey technique for the purpose of randomly selecting the interviewees. We decided that for the final survey we would directly contact the workers in addition to getting at them via the employers. We therefore adopted three different approaches to establish contact with the workers: i) contacting the employers, ii) visiting cafeterias inside industrial zones during lunch or tea time, and iii) going to residential compounds and villages during off days. Table 1 shows the sampling frame and sampling strategy used for the final survey.

We designed this sampling plan based on high- and low-risk categories. The results of the pilot survey helped us to devise the scheme of the sampling frame which rests on interviewing more respondents from the high- and medium-risk categories and fewer workers from the low-risk categories. We used the Labor Force Survey (2006) data set to identify these risk categories based on the injury reports of different Punjab-based industrial groups (See Appendix 1). The final survey commenced in May 2009. We decided to limit the survey to those workers who were 18 years or above at the time of the survey and had been on the job for at least one year. We did this primarily to include only those workers who were familiar with the local job market and were aware of the job-related risks.

We conducted the survey in all parts of Lahore including industrial zones, housing colonies and the villages on the peripheries. The industrial zone included industries situated in Ferozpur Road, Multan Road, Quaid-e Azam industrial estate, Sundar industrial estate situated on Rai Wind Road. We also visited approximately fifty-five villages on the fringes of Lahore for the purpose of interviewing workers.

5. Variables to be Measured

For the estimation of the Hedonic Wage Equation, we have used the take-home hourly wages as a dependent variable. We obtained this directly from the respondents. However, there were no uniform rules for drawing wages, with some respondents drawing their wages monthly, others weekly, and some others after ten or fifteen days. Therefore, we first calculated their monthly wages on the basis of available information and then confirmed it with them. However, in the case of casual workers who worked for a daily wage and therefore were not assured of continuous employment, the unpredictability in terms of availability of work and duration of work made it difficult to arrive at annualized assessments of their wages and working hours. Hence, due to differences in drawing rules and in annual working hours, we decided to use the hourly wages[8] and multiply them by the standard 2000 annual hours of work in order to obtain the value of statistical life (VSL) and value of statistical injury (VSI).[9]

The independent variables include risk measures such as the annual average fatalities per 10,000 workers. To these we added human capital variables (such as age and age square, education, experience, etc.) as covariates. Other covariates include job characteristics (such as whether the job is permanent or temporary, distance from the workplace, union affiliation, job-related training, and compensation provided by the company in case of industrial accident, etc.). Dummy variables include industrial dummy and professional dummy variables to control for differences in the wages of different industries and professions. We also included district dummy to evaluate regional income disparities. We have considered these variables for the present study after reviewing related literature. For instance, while Madheshwaran (2004) employed the same variables to evaluate the VSL for India, Viscusi and Aldy (2003) used them for the purpose of the Meta Analysis.

[8] The respondents had reported monthly wages which were annualized and then divided by 2000 hours to obtain hourly wages. The 2000 hours is a standard annual work time and many studies including Viscusi and Aldy (2003) and Madesh (2004) had used similar wage estimates in their respective studies

[9] However, using monthly wage or annual wages does not alter the results.

The most important but difficult part of the analysis was to obtain variables representing fatality and injury risks. We employed two approaches. We first used industry-level data calculated from the accident rate reported in the Labor Force Survey (LFS) and the Punjab Employees Social Security Institute (PESSI). This has an advantage in that they report actual risk. However, it carries a disadvantage in that it varies only across industries. With only nine industries in our worker dataset, it was not possible to cleanly identify the impact of the risk on wages. Second, we also used worker-level data collected in the survey on perceived risk. This has an advantage in that it varies across workers, factories, and industries. Therefore, it is possible to identify the impact of the risk on wages. It has a disadvantage in that it is not a measure of actual risk so that it may suffer from measurement errors.

5.1 Actual Risk Variables at the Industry Level

The data pertaining to fatal accidents of workers was compiled from the records of the Punjab Employees Social Security Institute (PESSI). Since the Institute does not regularly publish the incidents, we had to compile the record manually by looking into the registers which were maintained in their main and sub-offices across different parts of Lahore.[10] The Federal Bureau of Statistics and the Punjab Bureau of Statistics, on the other hand, do not publish details of sectoral fatal analysis.

These fatal and non-fatal risk measures exhibit industrial averages and are regarded as 2-digit[11] industrial risk measures, which means they do not represent job-specific risks. However, due to the non-availability of data, we had to employ these measures. The actual risk of deaths, culled from the registers of the Punjab Employees Social Security Institute (PESSI) and denoted as PESFAT, give the fatality rate per 10,000 workers (See Table 6).

With regard to actual injury rate at the industry level, we compiled several variables. We first calculated the actual risk of injury from the PESSI data. Secondly, we attempted the injury rate of manufacturing workers in Pakistan or in Punjab computed from the Labor Force Survey (LFS, 2006). We found that these variables also contain huge measurement errors. For these reasons, we do not include the actual injury rate at the industry level in our regression analysis.

5.2 Perceived Risk Variables at the Worker Level

In order to assess the job- and industry-specific risk measures, researchers such as Madheshwaran (2004) and Hamitt and Ibarraran (2006) have relied on a subjective measure of risk to account for workers' perception about job hazards. They have elicited the workers' job-related risk perception as a response to a dichotomous choice (yes/ no) question.

However, taking into consideration the limitations in the way of objectively assessing the risks discussed above the present study employs subjective risk for both deaths and injuries measured in three ways: 5-point Likert scale for fatality, 5-point Likert scale for injury, and 0-10 as the probability of receiving a fatal risk out of 10,000.

In the case of the Likert scale, it ranges from 1-5, where 1 represents minimal risk of life and injury in two separate questions and 5 represents a maximum risk of receiving fatal and non-fatal accidents.[12] The respondents were not only informed about the scales being used in those questions but were told to report on the perceived risk of death and injury in the present job in comparison with any other job they can do.[13] Tables 3 and 4 give information on responses to these questions.

Table 3 contains information about the perception of job-related fatality among blue-collar industrial workers in Lahore. A total of 678 workers were interviewed. The workers belonging to NIC[14] 1 and NIC 8 had the greatest representation while NIC 3 and NIC 9 had the lowest representation. Of those interviewed, approximately 81.5 percent of workers thought their risk of receiving job-related death as minimal (1 on the Likert scale) while 13 percent of the workers thought it was below average and approximately 2 percent considered the risk to be average

[10] We thank Mr. Safdar Raja and his team for help with the compilation of fatality data.
[11] 2-digits refers to the main industrial classifications. For example, 31 represents food, beverages and tobacco industries
[12] See questionnaire, where question no. 31, 32 and 33 have been used to construct subjective measures. These questions were formulated for the purposes of this study, as no previous known measures exist.
[13] See Q31 and Q32 in Appendix 1.
[14] National Industrial Codes=Industrial Classification defined by the Govt. of Pakistan. Also see Appendix 3 in this regard.

and above average. Only 1 percent perceived it to be either maximal or high risk as compared to any other job they could do. These results are not surprising as such accidents are not very common. In fact, the actual data (PESFAT) confirms this perception since the average risk of fatal accidents in 2006 was below four per 10,000 workers.

An inter-industry comparison of these answers, as recorded in Table 3, indicates that the highest number of workers who perceive their job-related fatalities to be minimal is to be found among workers of NIC 2, NIC 3, NIC 4, and NIC 9 (at 90 percent and above) while NIC 6 and NIC 7 had the lowest number (at approximately 64 percent). Only 4 percent of workers of industrial classification 7 considered their job-related fatal risk to be maximal while workers of NIC1, 2, 3, 4 and 9 perceived it to be 0 percent.

Table 4 shows that the perceived risk of job-related injury is higher (at 81.5 percent) than that for fatalities (at 30 percent). This is reasonable since there is a higher likelihood of workers being injured than of dying.

Beside the measures outlined above, we used another measure of perceived risk following the work of Hammitt and Ibarraran (2006). Table 5 explains the group-wise responses of the workers. The respondents were given a range of 0–10 as the probability of receiving a fatal risk out of 10,000. For example, 0/10,000 chances mean there is no chance of risk while 10/10,000 means there is a .001 chance of receiving a job-related fatal accident. In the survey, we asked the workers to assess their chance of facing a job-related risk of death out of ten thousand workers in the coming year. We used verbal analogies[15] regarding various 10,000 scenarios in order to help the respondents understand the issue under discussion. We resorted to this measure because stating risks in percentages can generate implausible results in a scenario where the probability of receiving job-related fatal risks is extremely low.

The study has therefore utilized four risk measures to assess the Value of Statistical Life and Injury: PESFAT, PRFNJ, PRFT1 and PRFT2. PESFAT, PRFT1 and PRFT2 are on fatality risk while PRFNJ is on injury risk.[16] PESFAT is actual risk measured at the industry level while PRFT1, PRFT2 and PRFNJ are perceived risk measured at the worker level. These risk variables are used in alternative equations in the next section to avoid multicollinearity owing to possible close proximity between the variables.

6. Methods

We estimate Hedonic wage equations and job risk equations using two different measures of risk as discussed above. The Hedonic wage equation with actual risks at work is estimated as:

$$\ln(W_{is}) = b_0 + b_1 Z_i + b_2 p_s + u_{is}, \qquad (3)$$

Where $\ln(W_{is})$ is the i^{th} worker's hourly wage rate in natural logarithm (subscript s corresponds to the 2 digit industrial sector), b_0 is a constant term, and Z is a vector of personal characteristic variables for the worker i. These include education measured as years of education, age and age square, and experience. It is also a vector of job characteristic variables for the worker i. The job characteristics considered for the present study comprises distance in minutes to the workplace from residence, union affiliation, training dummy, insurance dummy, compensation dummy, three profession dummies, Lahore district dummy variables, and a dummy for whether the job is permanent or temporary. p_s is the probability of death linked with worker i's job for sector s where the worker is employed, and u_{is} is the random error.

Since the risk variable p_s is available at the industry level only, the above specification may be subject to omitted variable bias. The wage level is usually different across sectors. To overcome this issue, one may use sector/industry dummies or estimate fixed effect models that control for observable/unobservable fixed characteristics of the sector. As p_s does not vary by sector, the fixed effect model wipes out its effect.

The coefficient b_2 captures the direct effects of p_s, which the study is attempting to infer and the indirect effects of other sector-level variables that are correlated with p_s such as the technology level, regulations, factory size distribution, governance type distribution, etc. To partially control for the omitted variable bias, it is possible to add

[15] See questionnaire for these analogies.

[16] Also see Table 6 for more explanations.

sectoral level variables such as type of technology, regulations, factory size, governance type, etc. However, while this may seem appealing, it results in the degrees-of-freedom (DOF) problem. Since there are only nine sectors in the dataset, we already have three coefficients to be estimated. We therefore estimate equation (3) knowing that our estimate for b_2 is likely to suffer from omitted variable bias. Whether it is an underestimation bias or overestimation bias is an empirical issue. These biases can be reduced however by using factory-level variables. Since wages were, in general, higher in larger factories or in corporate factories, we decided to include the size of the factory, or the corporate governance status of the factory for worker *i*, as legitimate explanatory variables. Such inclusion of additional variables can lessen the omitted variable bias problem for b_2. The study has therefore tried to include factory-level information to circumvent this issue.[17]

On the other hand, econometric specifications based on perceived risk variables allow us a much cleaner identification of the impact of risk on wages. We give the equation for such categories of risks below:

$$\ln(W_{is}) = b_0 + b_1 Z_i + b_2 p_i + b_3 q_i + a_s + e_{is}. \qquad (4)$$

where q_i stands for the injury risk variable. The difference between (3) and (4) is that the subscripts to the two risk variables are now *i*, not *s* (sector). Because of this, we can include as to control for the sector specific effects fixed effect Since p_i and q_i have variation within each sector, it is possible to identify the coefficients of interest b_2 and b_3 even if the whole set of industry dummies is included.

The dependent variable is hourly wage rate, as is evident from many other studies. However, the choice of the functional form is an unanswered question. Different researchers have used either linear or log-linear form. Following the Meta Analysis of Viscusi and Aldy (2003), we use the Box-Cox transformation and estimate the log-linear model.[18]

6.1 Computation of VSL

We computed the Value of Statistical Life and Value of Statistical Injury using the following standard equation:

VSL= *b^3*W¯*2000*10000, and

VSI= *b^3*W¯*2000*100 (5)

where, *b^3* is the coefficient of the fatality risk measured as the number of deaths per 10,000 workers in case of VSL, and, *b^3_* is the coefficient of injury risk measured as the number of injuries per 100 workers in the case of VSI, W¯ is the mean hourly wage rate which is multiplied by 2000 annual hours of work to annualize the Value and is multiplied with the scale of the variable which is per 10,000 workers for the fatality risk variables and per 100 workers for the non-fatal risk variable. However, since the dependent variable for this study is the log of the hourly wages, we will use the exp (*b^*) to compute the VSL and VSI in the above mentioned formula since other researchers such as Hamitt and Ibbararran (2006) have also computed the VSL using the same method.[19]

7. Results and Discussion

Descriptive statistics along with the definition of the variables which have been used for the present analysis are presented in Table 6. The average hourly wage rate in log form is 3.705 (anti-log= PKR 42[20]). The average education is six years of schooling and the average age is 27 years. The average experience in the present occupation is 5 years.

The 2-digit industry level fatality rate and the perceived fatality rate are almost similar with a slight variation of 1.17 and 1.36 per 10,000 per annum. The professed fatality and non-fatality statistics measured on the Likert scale

17 I wish to acknowledge the help of Prof. Takashi Kurosaki (Hitotsubashi University, Tokyo, Japan) who assisted me in developing the methodology for this study.

18 Evidently, many other researchers, for example Moore and Viscusi (1988a) and Madheshwaran (2004) have employed the same technique. Gunatilake (2003) has also suggested making use of the Box-Cox technique to select the functional form for such studies.

19 However, when the β`s are small, the two formulas yield the same results.

20 We calculated this using the prevailing exchange rate which at the time was USD 1= PKR 85.

reflect the mean risks as perceived by workers which can be classed as a below average level of risk (mean risk= 3). The industry level injury averages for both Pakistan as a whole and for Punjab alone are very close at 4.14 and 3.9 per 100 workers per year respectively

We present the estimation results of the alternative Hedonic wage models in Table 7. Columns 1 and 2 of the Table show the regression results based on the 2-digit industry level fatal and non-fatal risk variables whereas columns 3 and 4 show the regression estimates using the perceived risk measures.

The coefficient of fatal risk in all the three models using either industry-level actual risk data or individual-level perceived risk measure is positive and statistically significant. However, the result for PRFT2 is not significant. This is consistent with the compensating wage differentials theory and indicates that labor markets in Pakistan do pay a wage premium for higher risk. Moreover, the non-fatal risk coefficient is also insignificant.

Column (2) includes an additional explanatory variable at the factory level. We have added TOTMP, the total number of employees in the factory where the worker is employed. TOTMP has a positive coefficient, which is significant at the 10% level. This indicates that wages in larger factories tend to be higher than in smaller factories, which is consistent with our expectation.

The result in column (3) shows that the perceived risk of fatality (PRFT1) has a positive coefficient and is statistically significant at the 1% level while the perceived risk of injury (PRFNJ) has a positive but insignificant coefficient indicating that a higher fatality risk is associated with higher wages, which is identified in a much cleaner way than in the case of the industry level analysis. This is because our identification strategy clearly controls for all industry level factors and still finds that wages are higher when the perceived risk is higher. With regard to the injury risk, our result is weak since it is statistically insignificant although its coefficient is positive. Since PRFT1 is on a 5-point Likert scale, the interpretation of the results in column (3) shows that the log of wage will be higher by 0.14 if the worker's perception of fatality risk is increased by 1 point on a Likert scale (i.e., if the perception changes from "Below Average" to "Average", or from "Average" to "Above Average", and so on). While the result of the perceived fatality risk variable is statistically significant, the results of the worker-level covariates have not changed considerably as compared to results from previous models. The F-statistics shows that the overall model is also statistically significant.

We would like to estimate the Value of Statistical Life (VSL) based on the regression results of this model. Since the coefficient on PRFNJ is statistically insignificant, we do not attempt the estimation of the Value of Statistical Injury (VSI). We find that since PRFT1 is a 5-point Likert scale variable, we cannot estimate VSL without any further assumption.

We therefore assume some fixed numbers for a 1 point increase on a Likert scale using other sources of information on the distribution of fatality rates. Since, according to Table 6, the mean of PESFAT is 1.17, we can then assign 0 to "Minimal" on a 5-point Likert scale and 1.17 to "Average" on a 5-point Likert scale which means that the chances of death increases by 0.585 (in 10,000) to a 1 point increase on a Likert scale.[21] Our reasons for making such an assumption is that the actual risk of job-related deaths for three industrial groups out of the nine for the year 2006 was 0 in 10,000. In addition, Table 5 also reports that 304 out of the total 678 respondents perceived their job-specific risk of death to be 0 out of 10,000.

These assumptions make it possible to compute the VSL[22] which is estimated to be PKR 66.67 million with a 95 percent confidence interval of PKR 9.5 million to 95.23 million. The US dollar value of the point estimate is 775,193. Table 8 shows these values based on perceived risk.

The coefficients of the human capital variables are not sensitive to the choice of the other explanatory variables in the model. Both age and education show positive and significant relationships with the hourly wage in all the estimated regression models. However, the result of the work experience is insignificant in all the estimated regression models. The results of the professional dummy variables are also robust and show little sign of variations. The outcome of these two variables shows that a foreman on average earns 38 percent to 40 percent whereas supervisors earn 38 percent to 43 percent more than those in all other professional categories.

[21] I am indebted to Prof. Takashi Kurosaki for suggesting this.

[22] The coefficient of PRFT1*0.585*mean hourly wage*2000*10000.

The results for industrial dummy variables demonstrate that workers of textile, basic metallic and sports groups record higher earnings vis-à-vis the base category (that is, the food group). Evidently, within one of the specified models, the coefficient results demonstrate that workers of permanent status earn more on the average.

Table 8 gives the Value of Statistical Life based on point and interval estimation. The average values range from PKR 27.68 million to 66.67 million. The US dollar values range from 321,813 to 775,193. The Table does not show the values of statistical injuries because the perceived risk coefficient was not statistically significant.

Although these values are smaller in comparison with the VSL of many developed countries where it is in the range of USD 4 million to 9 million, our results are comparable with the estimates for many developing and developed countries, including Mexico, India, South Korea, and Hong Kong.[23] Table 9 displays the comparative statistics of the VSL and VSI for the developing countries.

In order to reinforce the validity of our estimates, we have also computed the Value of Statistical Life for Pakistan based on the Bowland and Beghin (2001) prediction equation which can be used to estimate the VSL for developing countries.

The equation is based on the Meta Analysis of the industrialized countries and takes into account the difference in risk, human capital and income between the developed and developing countries. The income elasticity estimated ranges from 1.52 to 2.269.[24] However, we have used the income elasticities estimated by different studies to compute the Value of Statistical Life for Pakistan. Table 10[25] presents the VSL based on the prediction equation. The equation provides a range of VSL from USD 0.17 million to 1.2 million. Nevertheless, Miller's estimated range of elasticities gives a close approximation of our reported results.

8. Conclusions and Policy Implications

The point estimates of the Value of Statistical Life in Pakistan based on the Hedonic Wage Models range from a minimum of PKR 27.67 million to 66.67 million. The US Dollar values of VSL lie between a minimum of 321,813 and a maximum of 775,193. The study could not provide the Value of Statistical Injury because the perceived injury variable used in this study was statistically insignificant. The variations in the results are due to the use of different risk measures, that is, actual and perceived risk measures in alternative regression models. Therefore, the study concludes that a compensating wage differential does exist in the formal private sector and the market does compensate workers for taking risks. These findings are consistent with labor market conditions and the hypothesis that workers are rational and that they consider risk when accepting jobs. These values can be used for cost-benefit analyses (CBA) of safety projects, for example, pollution control, or used by insurance companies for settling claims. Moreover, it is also pertinent to the on-going war on terrorism because policy makers could use it for the purpose of true impact assessment of war on terror in Pakistan.

However, as the first study to be attempted in this area, there are many limitations to the study. For one thing, risks have been treated as exogenous whereas they can be endogenous; moreover, the values so reported are not age-specific. Future research in this area can overcome these shortcomings.

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[23] See Viscusi and Aldy (2003).

[24] See Brajer and Rehmatian (2003).

[25] We are indebted to the Meta Analysis of Viscusi and Aldy (2003), USEPA, and World Development Indicators (WDI) in the development of this Table.

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Tables

Table 1: Sampling Frame

Details	No of Respondents	Max per factory
31 Food Group	125	10
32 Textile Group	83	7
33 Wood and Furniture	125	10
34 Paper and Publishing	83	7
35 Chemical Group	83	7
36 Non Metallic	125	10
37 Metal Group	125	10
38 Fabricated Metal	125	10
39 Other	125	10

Table 2: Targeted Sample Size Versus the Actual Numbers of Respondents

NIC	Type of Manufacturing	Targeted Respondents	Per Factory (max)	Actual Numbers
31	Food, beverages and tobacco	125	10	121
32	Textile, wool and hosiery, etc.	83	7	82
33	Wood or wood product or furniture	125	10	31
34	Paper, paper products, printing, publishing	83	7	74
35	Chemical petroleum, coal rubber and plastic products	83	7	93
36	Non-metallic products except petroleum and coal	125	10	41
37	Basic metal industries	125	10	91
38	Fabricated metal product, machinery and equipment	125	10	116
39	Other manufacturing industries and handicraft	125	10	30
	Total Respondents	**1,000**		**680**

Table 3: Perception of the Workers about Job-Related Fatalities by NIC (PRFT1)

NIC / Risk	1	2	3	4	5	6	7	8	9	Total
Minimal	94	74	27	66	80	26	60	98	28	553
Below Avg.	23	7	2	4	9	14	19	11	1	90
Average	4	0	1	1	2	0	5	2	1	16
Above Avg.	0	1	0	3	1	1	3	4	0	13
Maximal	0	0	0	0	1	0	4	1	0	6
Total	**121**	**82**	**30**	**74**	**93**	**41**	**91**	**116**	**30**	**678**

Table 4: Perception of the Workers about Job-Related Injuries by NIC (PRFNJ)

NIC / Risk Levels	1	2	3	4	5	6	7	8	9	Total
Minimal	23	52	5	29	25	8	6	47	12	207
Below Average	46	17	13	28	42	14	27	30	16	233
Average	39	5	3	7	15	7	21	21	0	118
Above Average	11	8	9	10	8	12	24	13	2	97
Maximal	2	0	0	0	3	0	13	5	0	23
Total	**121**	**82**	**30**	**74**	**93**	**41**	**91**	**116**	**30**	**678**

Table 5: Perception of the Workers about Job-Related Fatalities (PRFT2)

NIC / Risk Levels	1	2	3	4	5	6	7	8	9	Total
0	0	33	44	36	40	20	41	73	9	304
1	1	32	25	18	25	9	22	17	13	172
2	2	38	5	15	16	5	8	17	7	118
3	3	1	1	1	1	2	8	1	1	16
4	4	0	1	3	0	1	4	3	0	13
5	5	4	1	1	5	0	6	2	0	21
6	6	1	2	0	0	2	1	0	0	6
7	7	1	1	0	1	0	0	0	0	3
8	8	0	0	0	1	0	0	0	0	1
9	9	0	0	0	0	1	0	0	0	1
10	10	11	2	0	4	1	1	3	0	23
Total	**121**	**82**	**30**	**74**	**93**	**41**	**91**	**116**	**30**	**678**

Table 6: Variable Definitions and Descriptive Statistics

Variable	Variable Definition	Mean	Std. Dev.
Risk Variables			
PESFAT	Fatality rate compiled from the office of Punjab Employees Social Security Institute per 10,000 workers at the 2-digit industry level	1.17	1.27
PRFNJ	Professed/perceived injuries proportion measured on a 1-5 Likert scale (worker level variable)	2.26	1.14
PRFT1	Professed/perceived fatalities proportions measured on a 1-5 Likert scale (worker level variable)	1.27	0.68
PRFT2	Professed/perceived fatalities rate 0-10 per 10000 (worker level variable)	1.36	2.138
Worker-Level Variables			
PRMNT	If the worker's job is permanent=1, 0 otherwise	0.35	0.48
LHRWG	Hourly wage in PKR (in logarithm)	3.705	0.304
LFINS	If the worker life is insured=1, 0 otherwise	0.08	0.29
EDUCN	Years of schooling	6.037	4.129
AAAGE	Age of the respondent	27.38	7.983
FAMLZ	Family size	6.544	2.791
DEPEN	No of dependents	4.46	2.275
SPEDY	If the worker's job requires speedy work=1, 0 otherwise	0.73	0.44
EMPFM	Employed family members	2.11	1.201
RGRHR	Regular hours of work	8.697	1.612
EXPER	Experience in years	4.842	5.893
DSTNC	Distance from the workplace in minutes	31.36	20.78
UNION	Member= 1, 0 otherwise	0.0265	0.16
DCNMK	If the worker has to make decision=1, 0 otherwise	0.43	0.50
TRNNG	If the worker is provided any kind of training=1, 0 otherwise	0.84	0.36
COMPS	If the worker is provided compensation by the employers =1, 0 otherwise	0.52	0.51
WTHDM	Wealth dummy= value of the house in PKR	885126	1159938
NMSTK	If the worker job requires no mistake=1, 0 otherwise	0.15	0.37
JBNOS	If the worker job is very noisy=1, 0 otherwise	0.8	0.4
EXPOS	If the worker is exposed to smoke or dust=1, 0 otherwise	0.63	0.48
DSTRT	If the worker is from district Lahore= 1, 0 otherwise	0.71	0.45
SUPER	If the worker is a supervisor= 1, 0 otherwise	0.036	0.18
MACOP	If the worker is a machine operator= 1, 0 otherwise	0.23	0.42
FORMN	If the worker is a foreman= 1, 0 otherwise	0.04	0.2
MARRD	If the worker is married=1,0 otherwise	0.53	0.49
Factory Level Variables			
TOTMP	Total no of employees	501	1108
Industry Dummy Variables			
TXTDM	If the worker is from the Textile Group=1, 0 otherwise	0.12	0.32
BSCMT	If the worker is from Basic Metal Group=1, 0 otherwise	0.13	0.34
SPORT	If the worker is from Sport and Others Group=1, 0 otherwise	0.04	0.2
WOOD	If the worker is from Wood and Furniture Group=1, 0 otherwise	0.04	0.2
FOOD	If the worker is from the Food Group=1, 0 otherwise	0.17	0.38
PAPER	If the worker is from the Paper Group=1, 0 otherwise	0.10	0.31
CHEME	If the worker is from the Chemical Group=1, 0 otherwise	0.13	0.34
FABRI	If the worker is from the Fabricated Metal Group=1, 0 otherwise	0.17	0.37
NONMET	If the worker is from the Fabricated Metal Group=1, 0 otherwise	0.06	0.23

Table 7: Regression Results of the Alternative Hedonic Wage Equations (Dep var: log [wage rate])

VARIABLES	(Model 1)	(Mode 2)	(Mode 3)	(Mode 4)
PRFT2	——	——	——	0.002 (0.008)
PRFT1	——	——	0.14*** (0.050	
PRFNJ	——	——	0.051 (0.08)	0.006 (0.009)
PESFAT	0.034*** (0.01)	0.035*** (0.01)	——	——
EDUCN	0.014*** (0.00)	0.013*** (0.00)	0.01*** (0.002)	0.01*** (0.002)
AAAGE	0.007*** (0.00)	0.007*** (0.00)	0.008*** (0.001)	0.007*** (0.001)
EXPER	0.003 (0.00)	0.002 (0.00)	0.003 (0.002)	0.002 (0.002)
TRNNG	-0.007 (0.03)	-0.003 (0.03)	0.004 (0.02)	0.005 (0.02)
EXPOS	-0.02 (0.02)	-0.022 (0.02)	-0.01 (0.02)	-0.01 (0.02)
DSTRT	-0.02 (0.02)	-0.027 (0.02)	-0.04** (0.02)	-0.03** (0.02)
SUPER	0.4*** (0.1)	0.43*** (0.1))	0.38*** (0.07)	0.39*** (0.07)
MACOP	-0.01 (0.0)	-0.01 (0.00)	0.001 (0.03)	0.001 (0.03)
FORMN	0.39*** (0.08)	0.38*** (0.08)	0.4*** (0.07)	0.39*** (0.07)
UNION	0.1 (0.06)	0.1 (0.06)	0.09 (0.07)	0.07 (0.07)
PRMNT	0.07*** (0.02)	0.06*** (0.02)	0.06*** (0.02)	0.08** (0.02)
TOTMP	—	0.000168* (9.91e06)	1.09E-05 (9.99E-06)	1.09E-5 (9.9E-06)
TXTDM	—	—	0.11*** (0.04)	0.12*** (0.4)
BSCMT	—	—	0.17*** (0.05)	0.19*** (0.05)
SPORT	—	—	0.16** (0.07)	0.18** (0.07)
WOOD	—	—	0.03 (0.06)	0.02 (0.06)
CHEME	—	—	-0.04 (0.03)	-0.04 (0.03)
FABRI	—	—	-0.005 (0.03)	-0.005 (0.03)
PAPER	—	—	-0.0004 (00.4)	-0.0004 (0.04)
NONMET	—	—	-0.18*** (0.06)	-0.18*** (0.06)
Constant	3.13*** (0.15)	3.09*** (0.16)	2.9*** (0.16)	2.9*** (0.16)
F	12.9	12.9	10.35	9.83
R2	0.21	0.21	0.27	0.25
N	617	617	617	617

Note: Robust standard errors are shown within parentheses. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively.

Table 8: VSL Estimates Based on Point and Interval Estimations

Regression Model	VSL Based on Point Estimation (PKR)	Dollar Values of VSL Based on Point Estimation (USD)	VSL Based on Interval Estimation (PKR)
Model 1	27,676,000	321,813	13.02, 48.8 million
Model 2	28,490,000	331,279	13.02, 48.8 million
Model 3 under the Assumption	66,666,600	775193	9.5, 95.23 million

Table 9: Comparative Statistics of VSL and VSI of Developing Countries#

Study	Country	Average Income (USD 2,000)	Average Fatal Risk (per 10,000)	VSL (USD 2,000)	VSI (USD 2,000)
Hammitt and Ibarraran	Mexico	4,100	3.0	230,000-310,000	3000-10,000
Kim and Fishback (1999)	South Korea	8,100	4.9	800,000	
Liu et. al. (1997)	Taiwan	5,000-6,100	2.3-3.8	200,000-900,000	
Liu et. al.	Taiwan	18,500	5.1	700,000	50,000
Shanmugam (1997)	India	780	1.0	1,200,000-1,500,000	
Shanmugam (2000)	India	780	1.0	1,000,000-1,400,000	150,000-560,000
Shanmugam (2001)	India	780	1.0	4,100,000	350,000
Madesh (2004)	India	780	1.13	305,000-318,000	
Siebert and Wei	Hong Kong	11,700	1.4	1,700,000	

The table has been developed partly from the study of Hammitt and Ibarraran (2006)

Table 10: VSL for Pakistan Based on Prediction Equation Using Different Income Elasticities

Study	Income Elasticity (α)	US GNI per capita (2008)	Pakistan per capita (2008)	US VSL	VSLpk = VSLus (GNIpk/GNIus) (α)
Miller (2000)	0.85	$47930	$950	$7,400,000	$264107
Miller (2000)	0.96	$47930	$950	$7,400,000	$171578
Morzek and Taylor (2006)	0.46	$47930	$950	$7,400,000	$1218723
Morzek and Taylor (2006)	0.49	$47930	$950	$7,400,000	$1083474
Viscusi and Aldy (2006)	0.52	$47930	$950	$7,400,000	$963234
Viscusi and Aldy (2003)	0.61	$47930	$950	$7,400,000	$676819

APPENDIX

Annexure 1: Sampling Frame

Details	Manuf. of food and beverage, & tobacco	Manuf. of Textile Wearing Apparel and Leather ind.	Manuf. of Wood or Wood Product or Furniture	Manuf. of Paper, Paper Prod. Printing Publishing	Manuf of Chemical Petroleum, Coal Rubber and Plastic Prod.	Manuf. Non-Metallic Product Except Petroleum and Coal	Basic Metal Industries	Manuf. Fabricated Metal Product, machinery and equipment
No.of Injury Once (2)	20	62	26	3	3	31	1	26
Do	2	1	0	0	1	3	0	2
Respondent with No Injury (3)	362	3008	364	146	185	429	39	488
Total Respondents	384	3071	390	149	189	463	40	516
2+3=	22	63	26	3	4	34	1	28
2+3/5	0.057291667	0.02051449	0.066666667	0.020134228	0.021164021	0.073434125	0.025	0.054263566
7*100=	5.7	2.1	6.7	2.0	2.1	7.3	2.5	5.4

Note: Injury rates such as 5 and above 5 were considered as medium high and high risk categories, whereas below that number were considered as medium low and low risk categories. It was decided that a maximum of 125 respondents shall be interviewed from medium high and high risk categories and 83 respondents from medium low and low categories.

Annexure 2: Questionnaire

Project Title: The Value of Reduced Risk of Injury and Death in Pakistan Using Actual and Perceived Risk Estimates

Principal Investigator: M. Rafiq
Assistant Professor
Institute of Management Sciences, Peshawar
E-mail: sufi92@hotmail.com

Introductory Note for the Respondent

Dear Respondent,

This research project has been designed to find out the views of the blue collar industrial workers of Lahore about job safety issues. The results obtained can be utilized to propose appropriate policies for the concerned sector. We assure you that it is purely a research project and none of the information provided will be disclosed in any way. You are requested to cooperate with our team members by providing correct information. We thank you in anticipation of your cooperation.

Instructions: The respondent must be a male blue collar worker having at least one year of job-related experience in any Lahore-based job. This is required to ensure that the respondent is familiar with job-market conditions.

Section I: Household Demographic Information

Form no. _____ Date & Time: _____ Worker's Name:_____

Interviewer: _____ NIC: _____

Worker's Profile:

1. Nationality: _____ 2. District of Domicile: _____
3. Marital Status: _____
4. Literacy (reading and writing in any language): (Y / N)
5. Education Level in Years: _____
6. Age: _____
7. Monthly Income Shift-wise: i. _____ ii._____ iii. _____
8. Family Size: _____
9. Number of Dependent Family Members: _____
10. Total Number of Employed Family Members: _____
11. Monthly Income of the Employed Family Members: _____

Section II: Job Characteristics:

12. Title of the Job: ——————————

13. Title and Address of the Firm of the Respondents:

14. Whether the Present Job Is: (a) Full-time/Part-time (b) Permanent/Temporary

15. How Many Regular Hours Do You Work in This Job? ——————— hrs

16. How Often Are You Paid? (a) hourly (b) weekly (c) monthly

17. What Is Your Regular Pay During That Period? ——————————

18. In Addition to Your Regular Hours, Do You Also Work Overtime? (Y/N)

    If Yes,

    (a) How Many Hours: (Per day/Week) ——————

    (b) Payment (in PKR): (Per day/Week)

19. Weeks Worked Last Month ——————————

20. Are Your Work Hours Irregular? (Y / N)

21. Experience in Your Present Job: ——————————

22. How Many Minutes Does It Take to Commute, on average, from Your Residence to This Job?

23. Do You Think That Your Job Needs

    a. Speedy work: (Y / N)

    b. Decisions: (Y / N)

    c. No mistakes: (Y / N)

    d. Anything else: ——————

24. Are You a Union Member? (Y / N)

25. Does your employer provide you any kind of training? (Y / N)

26. What Kind of Training? (a) On-the-job Training (b) Off-the-job training (c) Both

27. Total Number of Employees of This Factory: ——————————

28. Leave Days with Full Pay: (Y / N)

Section III: Details about Working Conditions:

29. easons for Selecting Present Job?

    (a) Pay (b) Less risky (c) No choice (d) Other ————

30. Do You Feel That Your Job Is:

    (a) Very noisy (Y/N). If yes, then how often? ————————

    (b) Doe it expose you to gas, dust, or smoke, any thing else ————

    (c) How often is this exposure? (i) sometimes (ii) often (iii) always

31. Please tick the appropriate box below indicating your perception of receiving a job-related injury in your present job in comparison with any other job you can do?

Level	Response
1	Minimal
2	Below Average
3	Average
4	Above Average
5	Maximal

32. Please tick the appropriate box below indicating your perception of risk of fatalities in your present job in comparison to any other job you can do.

Level	Response
1	Minimal
2	Below Average
3	Average
4	Above Average
5	Maximal

33. If you remain at this job for the next 12 months, what do you think is your risk of dying in a job-related accident out of 10,000?

level	0	1	2	3	4	5	6	7	8	9	10

Instructions for Enumerators: Use the following analogies to explain the scenario to the respondents:

This can be compared with the number of hours in fourteen months (10,000 approx).

Or

Imagine 10,000 workers who work in a similar capacity. How many of them will receive a job-related fatal accident?

34. How many days do you expect to work at this job during the next four months?

35. During these four months, how many days of work do you expect to miss due to job-related injuries? ————

36. Is your life insured by any means? (Y/N)

37. If yes, how much is your company's share of the premium?

38. In addition, does your firm provide you any kind of compensation? (Y / N)

39. Do you remember any fatal or non-fatal accidents in your firm during the past 12 months?

40. If yes, then please provide the following details:

Nature of the accident	Number of persons
Fatal Non Fatal	

41. Did you face any job-related accident during the past twelve months? Yes/No

42. IF YES, then please provide the following information:

Nature of the Accidents	Reasons	Workdays Lost
1. 2. 3.		

43. Did you receive compensation from?

    (a) Firm (b) Social Security Scheme (c) Both

44. What other benefit do you get from your company/social security scheme?

Family Assets:

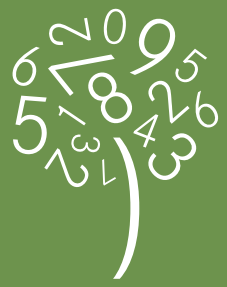
45. Details of Family Assets:

Type of Asset	Value in PKR	Income from assets (if any) per month/year
a. Owned house (y/n)		
b. Land		
c. Any other property		
d. Jewelry		
e. Prize Bonds		
f.		

46. Are you a tax payer? (Y / N)

47. If yes, what type of tax do you pay?

    (a) income tax (b) wealth tax (c) property tax (d) all of them (e) any other_____.



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