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“Is Survival a Luxury Good? Income Elasticity of the Value per Statistical Life”

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Is Survival a Luxury Good?
Income Elasticity of the Value per Statistical Life

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Abstract

The value of a change in mortality risk is conventionally described by the marginal rate of substitution between income and mortality risk—the value per statistical life (VSL). The income elasticity of VSL is important for estimating how the value of mortality risk varies with time (for evaluating programs with long-lived effects) and across populations with different income levels (for evaluating programs with international consequences). Previous estimates of income elasticity based on meta-analysis of wage-differential studies and cross-sectional comparisons in stated-preference studies suggest values between about one-half and one. We present new estimates based on a 16-year series of wage-differential estimates in Taiwan. Between 1982 and 1997, estimated VSL increased by a factor of five while household labor earnings increased by 60 percent, per capita GDP increased two-and-a-half fold, and the occupational fatality rate in manufacturing and service industries decreased by half. Comparing the growth of VSL with that of household income implies the income elasticity is between about two and five but this estimate may be biased by the endogeneity of VSL, which is affected by workers' job choices. Using a two-stage approach to control for endogeneity yields estimates of the income elasticity of VSL between two-thirds and one, consistent with estimates from other approaches.

1. Introduction

The value per statistical life (VSL) is defined as an individual's marginal rate of substitution between wealth or income and mortality risk in a specified time period. VSL is important in determining whether the value of a reduction in mortality risk due to environmental, health, or safety regulations exceeds its cost. Both intuition and standard models suggest the income elasticity of VSL is positive; as a result, it is conventional to assume that if incomes rise over time, VSL will also increase. These anticipated changes in VSL can be important for evaluating policies with benefits expected to persist well into the future, such as regulations directed toward climate change and storage of long-lived toxic or radioactive waste. The relationship between VSL and income is also critical for benefit-transfer applications, such as estimating the value of reducing air pollution in low-income countries using economic values estimated in high-income countries (Cropper et al. 2019). The income elasticity need not be constant; it can vary across income levels and between individuals. Empirical estimates, including ours, are of some average income elasticity for a defined population and income range.[1]

Conventional economic theory (Drèze 1962, Jones-Lee 1974, Weinstein et al. 1980) imposes few constraints on the income elasticity of VSL, except that it should be positive and exceed the coefficient of relative risk aversion with respect to wealth (Eeckhoudt and Hammitt 2001, Kaplow 2005). These constraints are of limited value, as estimates of relative risk aversion span a wide range, with minimum values around one and many estimates larger than five (Barseghyan et al. 2018). Moreover, Evans and Smith (2010) show that income elasticity need not exceed the coefficient of relative risk aversion if labor hours and income can be varied or there is sufficient complementarity between consumption and labor. Hammitt and Robinson (2011) argue that the income elasticity is likely to be larger than one, at least at low income levels, because the opportunity cost of spending on basic necessities becomes large as income falls to subsistence levels.

Empirical estimates have been obtained using several methods (Hammitt and Robinson 2011). The most direct is to examine how estimated VSL varies with respondents' income in stated-preference studies. This approach generally yields estimates that are statistically significantly positive but less than one, in many cases less than one-half (e.g.,

[1] Note that the income elasticity of VSL is the elasticity of the value of a marginal increase in survival probability, not the value of an increase in the quantity demanded at a fixed price. Luxury goods are usually defined as having an income elasticity of demand greater than one. See Flores and Carson (1997) for discussion of the relationship between the income elasticities of value and of demand.

between 0.1 and 0.4 in Corso et al. 2001, Alberini et al. 2004, and Hammitt and Haninger 2010, between 0.2 and 0.6 in a set of studies over several countries reported by Hoffman et al. 2017). Hedonic-wage studies usually do not estimate income elasticity because the dependent variable (the wage rate) is highly correlated with income. Meta-analyses of these studies generally yield estimates of approximately 0.5 to 1.0 (Viscusi and Aldy 2003, Viscusi and Masterman 2017a,b). Meta-analyses of stated-preference studies also yield estimates of one or smaller. For example, Lindhjem et al. (2011) estimate values of 0.7 to 0.9 (0.3 to 0.4 when they restrict their analysis to studies that satisfy more-stringent quality criteria). Masterman and Viscusi (2018) estimate values of 0.94 to 1.05 overall but find evidence that the elasticity decreases with income; they estimate it is about 1.0 for lower-income countries and 0.55 for higher-income. A few studies suggest income elasticities substantially larger than one; e.g., in a hedonic-wage study using quantile regression, Kniesner et al. (2010) estimate an income elasticity of about 1.4, decreasing from about 2.2 in the lowest income decile to about 1.2 in the highest decile.

We introduce a novel approach to estimating the income elasticity of VSL: we estimate VSL using repeated cross-sectional estimates of a standard wage-hedonic model then estimate income elasticity taking account of the endogeneity of VSL due to workers' job choices. We use annual data on occupational-fatality risk and wages to estimate VSL over time in a rapidly developing economy, Taiwan during the 1980s and 1990s. Comparing the growth in estimated VSL with the growth in household income implies an income elasticity of two or more. This estimate may be biased, however, because a worker's VSL is affected by his job choice and is endogenous. To address this possibility, we use a two-stage approach: First, we estimate the hedonic-wage function for each of the 16 years for which we have data and use the estimates to calculate VSL for each worker and year. Second, we estimate a model to describe these predicted individual VSLs as a function of the workers' household incomes and socioeconomic characteristics (Bartik 1987, Palmquist 1984). The estimated effect of income on VSL in this second stage is a measure of its income elasticity. Using this two-stage approach, our estimates of the income elasticity are between about two-thirds and one, consistent with much of the prior literature.

In the first stage, we develop alternative estimates of VSL. First, we estimate standard cross-sectional hedonic-wage functions for each year for which we have data. Second, as a sensitivity analysis we replace the realized risks in each year by risks predicted from prior years' realized risks using an adaptive-expectations approach and estimate the hedonic-wage equations. Using predicted risk accounts for possible biases that result from the maintained assumption that workers accurately forecast future risk of the jobs among which they choose. Third, we pool our cross-sectional data over time and estimate a reduced-form model of how the hedonic-wage function and average VSL shift over time.

Over the period we study, average household labor income grew 60 percent, GDP per capita grew by a factor of about two and a half, and estimated VSL grew by a factor of five. Attributing the change in VSL solely to the change in income implies an elasticity of two to five. This estimate of income elasticity may be biased, however. An individual worker's VSL is endogenous, because it reflects his choice of job risk and wage determined by optimizing over the set of available jobs for which he is qualified. Using a two-stage approach to control for this endogeneity yields estimates of the income elasticity between 0.65 and 0.91, consistent with estimates from much of the previous literature.

Only two prior studies have estimated VSL for a population over time.[2] Both found that VSL increased more rapidly than income, suggesting an elasticity greater than one. Costa and Kahn (2004) estimated VSL using hedonic-wage regressions for US workers each decade from 1940 to 1980; comparing estimated VSL with per capita GNP implies an income elasticity of 1.5 to 2.0. This result is vulnerable to the endogeneity problem identified here. Hammitt et al. (2019) conducted stated-preference studies using similar methods in Chengdu, China in 2005 and 2016; comparing estimated VSL with income growth over the period implies an elasticity of 3.0.

Except for direct estimates derived from between-respondent comparisons in stated-preference studies, all the methods used to estimate income elasticity are vulnerable to the problem of ecological inference: differences between group averages may reveal little about differences between individuals (Robinson 1950, Freedman 2015). By predicting workers' job choices and hence VSL, our approach may provide estimates of income elasticity that are more closely linked to individual than to group differences.

The remainder of the paper is organized as follows. The data are described in Section 2. Section 3 presents the hedonic-wage equations and their estimates. Section 4 estimates the income elasticity of VSL by examining the relationship between estimated VSL and household earnings. Conclusions are in Section 5.

[2] In related work, Aldy and Viscusi (2008) find that age-specific VSL is larger for later birth cohorts, which they attribute to secular increases in lifetime income.

2. Data

Our data cover the years 1982-1997. Data on worker income and personal characteristics are from the annual Taiwan Labor Force Survey conducted by the Taiwan Directorate-General of Budget, Accounting and Statistics. Each sample is drawn independently (individuals cannot be linked between years) using a two-stage stratified-random-sampling method. In the first stage, 515 administrative districts are randomly selected from strata defined by urbanization, industrial structure, and educational attainment. In the second stage, 19,600 households are selected from within these districts and information is collected on the approximately 60,000 household members aged 15 years and older. The data include individual demographic and employment characteristics. For compatibility with our risk data, we include only individuals who are employed full time in the manufacturing, transportation, and service sectors, yielding a sample size of 10,457 to 13,161 workers per year.

Our risk data consist of annual industry-fatality rates (deaths per 10,000 workers). The data were provided by the Taiwan Labor Insurance Bureau. The Bureau administers a compulsory insurance program under the Taiwan Labor Insurance Act, which requires that all industrial workers between the ages of 15 and 60 be insured. Fatality rates are constructed for each of 26 two-digit industries. Rates are defined as the total number of work-related death claims divided by the total number of insured employees, which ranges between 4.8 million and 6.2 million over the period. Although risk measures that estimate fatality rate by industry and occupation are preferred (Viscusi 2004), they are not available for Taiwan. Effects of any bias arising from greater measurement error or confounding of persistent inter-industry wage differences with the risk measure (Leigh 1995) should vary little over time and have minimal effect on our estimates of how VSL changes with economic growth.

The means and standard deviations for selected variables used in the hedonic-wage models are reported in Table 1. Reflecting the rapid economic growth of Taiwan over this period, the nominal hourly wage more than tripled, from about NT$50 in 1982 to more than NT$150 in 1997 (the 1991 exchange rate was NT$25.75 = US$1). In contrast, the consumer price index increased by only 40 percent, which implies the real wage more than doubled (from about 60 to 130 1991 NT$). The variable labeled “Income” is the total annual labor earnings of all household members. As shown in Figure 1, real income increased by a factor of 1.6 over the period. The rate of increase is slower than that of wages because the number of employed household members decreased over the period (the average worker’s labor earnings increased from 33 percent to 44 percent of household labor earnings); in addition, monthly hours worked decreased slightly. Real GDP per capita increased somewhat more rapidly, by a factor of 2.7 (Figure 1, Table 4).

The demographic variables reveal a substantial maturation of the workforce over the period. The average age increased from 29.7 to 34.6 years and the fraction of workers who are married increased from 46 to 57 percent. Mean experience in the current job increased from about 50 to 75 months. The average worker's education also increased, from about 8.9 to 10.9 years. This increase was stimulated by a nine-year compulsory educational program established in 1968. Reflecting the success of the program, education increased most rapidly for workers aged 20-30 years, from 7.6 years in 1982 to 12.2 years in 1997.

Occupational fatality risk declined substantially over the period. Table 2 lists the industries we study and their average mortality risk levels at the beginning and end of the period (four-year averages). Risk declined in all industries, by widely varying amounts. The largest proportional reduction (76 percent) occurred in the miscellaneous manufacturing category and the smallest reduction (10 percent) occurred in beverages and tobaccos. There is no apparent relationship between the proportional risk reduction and the risk level at the beginning of the period.

The sample-average mortality rate (weighted by industry employment) is reported in Table 1. As shown in Figure 2, the industry-average risk is somewhat larger than the sample-average risk, reflecting the disproportionate allocation of workers to safer industries. Both the sample-average and the industry-average risk declined by almost half over the period. Although the occupational-fatality risk early in the period was well above the US level of about 1 per 10,000 (Viscusi and Aldy 2003), the risk at the end of the period is only modestly above that level. The decline of fatality risk in our sample may be due to multiple factors including labor-safety regulation and increasing employment of foreign workers.[3] Foreign workers are not included in the labor-insurance data. If such workers disproportionately substituted for Taiwanese workers in the more-hazardous jobs within an industry, the risk measured by deaths recorded in the insurance data would decline even if there were no change in industry-average risk. This would not bias the estimated hedonic-wage functions, however, as the worker-characteristic data include only Taiwanese workers.

[3] In October 1989, the Taiwan government initiated large engineering projects to promote development and allowed the employment of foreign construction workers. By the end of 1991, there were 2,999 foreign workers in Taiwan. Soon afterward, the government allowed the manufacturing and care-giving industries to adopt foreign workers. By the end of April 2003, their number reached 304,556.

3. Estimated Value per Statistical Life

We estimate VSL using three approaches. We begin by estimating standard hedonic-wage equations independently for each of the 16 years for which we have data. These equations describe the wage rate as a function of occupational risk, job and worker characteristics and describe the jobs from which a worker selects. Second, as a sensitivity analysis, we account for worker uncertainty about industry risk. At the time a worker begins a job, or decides to continue a job, the risks he would face in each alternative job are uncertain. The conventional approach estimates the risk in a period by the realized fatality rate, which implicitly assumes that the worker accurately forecasts the future risk. As an alternative, we assume that workers forecast the risk in each industry using an adaptive-expectations approach in which future risk is extrapolated from realized risk in previous years. Third, we pool our data over time and estimate the hedonic-wage equation as a function of worker characteristics and time, using alternatively the realized and forecast measures of industry risk.

3.1 Standard Hedonic Regression

For each of the 16 years, we estimate a standard semi-logarithmic hedonic-wage function defined as:

$$log(WAGE_i) = \alpha + \beta\ RISK_i + \gamma^1\ Z_i^1 + \varepsilon_i^1 \qquad (1)$$

where *WAGE* is an individual's nominal hourly wage rate, *RISK* is the industry-specific mortality rate he faces, and Z^1 is a vector of individual characteristics including gender, age, marital status, education, work experience in the current job, quadratic terms for education and work experience, and six indicators for occupational category (professionals, senior managers, clerical supervisors and office administrators, clerks and salespersons, service workers, craft and related operators, drivers and mobile operators).

Parameter estimates are reported in Table 3. Two sets of t-statistics are reported. The first (in parentheses) is calculated from the conventional standard errors, assuming the error term is independently and identically distributed across workers. The second [in brackets] is calculated using Huber (1967) robust standard errors clustered by industry to capture heteroskedasticity. The hedonic-wage function fits reasonably well, with adjusted R^2 values of nearly 0.5 for each year. The coefficient on *RISK*, which is of primary interest, is positive and significantly different from zero in all cases with t-statistics between 5.49 and 14.6 using the conventional standard errors (between 1.72 and 7.34 using the robust standard errors). The risk coefficients range from 0.012 to 0.064, which implies wages are roughly 1 to 7 percent higher for each 1/10,000 risk increment. The estimated risk coefficients increase over time. Coefficients on the other variables are generally significantly different from zero and stable across years. Controlling for other factors, men are paid about one-third more than women and married workers are paid about 10 percent more than unmarried workers.[4] The wage rate increases at an increasing rate with education and increases at a decreasing rate with experience in the current job. The effect of age is positive, small in absolute value, and significantly different from zero in all years.

The corresponding average VSLs for each year (1991 US$1,000) are reported in column (1) of Table 4 and plotted in Figure 3. VSL is calculated as the estimated derivative of annual earnings with respect to the increase in industry fatality risk at the sample mean wage rate and working hours per month. It is converted to 1991 NT$ using the Taiwan Consumer Price Index and then to US$ at the 1991 exchange rate of NT$25.75 = US$1. Estimated VSL increases sharply over most of the period, from less than US$1 million in 1982 to about US$6 million in 1994. Between 1994 and 1997 it fluctuates between about US$5 million and US$7 million.

3.2 Estimates Using Predicted Risk

At the time a worker decides whether to begin a new job, or continue his current job, the fatality risks are uncertain. The standard approach implicitly assumes that workers accurately forecast the risks from which they choose. As an alternative, we consider the case where workers forecast the risks for the next year using an adaptive-expectations approach. In addition to being more realistic about what workers know about risk at the time they make job choices, this approach has the advantage of combining realized fatality rates over multiple years, which diminishes variability and may produce a more accurate measure of the expected risk.

Under this approach, workers are assumed to forecast the risk in industry *i* and year *t* using observed risks over the preceding two years (Viscusi and O'Connor 1984),

$$RISK_{i,t} = \delta_0 + \delta_1\, RISK_{i,t-1} + \delta_2\, (RISK_{i,t-1} - RISK_{i,t-2}) + \nu_{i,t}. \quad (2)$$

Equation (2) is estimated alternatively using OLS and industry fixed effects. As shown in Table 5, the parameter estimates for the two specifications are similar. The adjusted R^2 values are 0.77 and the estimated coefficients are significantly different from zero, with estimates of δ_1 greater than zero and estimates of δ_2 less than zero. Equation (2) can be expressed as

$$RISK_{i,t} = \delta_0 + (\delta_1 + \delta_2)\, RISK_{i,t-1} - \delta_2\, RISK_{i,t-2} + \nu_{i,t}. \quad (2')$$

[4] Pilossoph and Wee (2021) attribute the marital wage premium to increases in a worker's reservation wage and acceleration of job promotion.

Inserting the estimated coefficients in this second form shows that predicted risk is an increasing function of risk in each of the previous two periods, with slightly greater weight on the more recent period.

The hedonic-wage function (1) is re-estimated substituting predicted values of $RISK_{i,t}$ for the realized values. The results are quite similar to those shown in Table 3. The corresponding estimates of VSL are reported in columns (2) and (3) of Table 4 and plotted in Figure 3. Like the estimates obtained using the realized risk, these estimates increase from values less than US$1 million at the beginning of the period to values of about US$6 million (or more) by the end of the period. The insensitivity of estimated VSL to substituting predicted risk for realized risk suggests that results are not sensitive to workers' uncertainty about industry risks in the upcoming period.

3.3 Estimates Using Pooled Data

As an alternative to the independent annual estimates, we pool the data across years and estimate the hedonic-wage function as a function of time. We estimate

$$log(WAGE_{it}) = \alpha_0 + \alpha_1 T_t + \alpha_2 T_t^2 + \alpha_3 RISK_{it} + \alpha_4 (RISK_{it} \cdot T_t) + \alpha_5 (RISK_{it} \cdot T_t^2) + \gamma^3 Z_{it}^3 + \varepsilon_{it}^3. \quad (3)$$

The variable T is defined as (year – 1990) and is a proxy for economic growth. Z^3 is a vector of worker characteristics including gender, age, education, experience, and marital status. The estimated values of α_4 and α_5 provide information about the change in VSL with time and economic growth. Positive estimates of α_4 and α_5 suggest that VSL increases over time at an increasing rate. The estimated values of α_1 and α_2 provide information about how wages change over time.

Results are shown in Table 6 using realized and predicted risk (using alternatively the OLS and fixed-effect specifications reported in Table 5). The results suggest that wages have increased with time (estimates of α_1 are significantly greater than zero) but the rate of increase has slowed (estimates of α_2 are significantly less than zero). The estimates of the coefficient α_4 on the interaction between T and $RISK$ are positive and highly significant, confirming earlier results that show VSL increasing over the period. The estimates of α_5 are significantly greater than zero, suggesting that VSL has increased at an increasing rate. The estimated coefficients of worker characteristics are similar to those for the independent estimates (Table 3).

Estimates of VSL from the pooled model are reported in columns (4) – (6) of Table 4 and plotted in Figure 3. These are similar to the estimates obtained using the independent annual hedonic-wage functions, except the values are higher in the earlier years and increase more smoothly over the period, because pooling smooths much of the interannual variation.

4. Income Elasticity of VSL

We adopt two approaches to estimating the income elasticity of VSL. First, we compare the growth of average VSL over the period with the growth of average income. Specifically, we regress the logarithm of real VSL in each year on the logarithm of, alternatively, average real household income and real GDP per capita.

Second, we employ a two-stage procedure to account for endogeneity of VSL. The endogeneity arises because a worker's job choice affects his VSL. As illustrated in Figure 4, the wage-hedonic approach assumes that a worker chooses among alternative jobs for which he is qualified, based on his work experience, education, and other factors. These differ in occupational risk, wage, and other factors. The hedonic-wage function describes the set of jobs available to a worker. It is estimated by regressing the wage each worker receives on his occupational fatality risk, controlling for worker characteristics. When plotted as wage versus occupational survival probability (one minus occupational fatality risk) as in Figure 4, the locus of available jobs must be downward sloping. The hedonic-wage function depends on the market interaction of workers and employers and is exogenous to an individual worker. Each worker is assumed to choose the job he prefers most of those available to him, which implies his indifference curve is tangent to the hedonic-wage function at the job he holds, and hence his VSL is equal to the local slope of the hedonic-wage function.[5] Under the standard theoretical model, VSL increases with income and with total mortality risk (the 'dead-anyway effect'; Pratt and Zeckhauser 1996). Hence the indifference curves are convex, as illustrated in Figure 4 (Eeckhoudt and Hammitt 2001).

As described above, our estimates imply that the hedonic-wage function shifted outward and became steeper over time, i.e., wages and VSL both increased (estimates of α_1 and α_4 in equation (3) are positive). This pattern is illustrated by the hedonic-wage functions for years t_0 and t_1 in Figure 4. A worker chooses a job in each period, e.g., the job at point A in year t_0 and the job at point B in the later year t_1. The shift from A to B may reflect either a change of job or a change in wage and risk for the same job. The worker's revealed VSL in each year depends on his job choice. Over the sample period, wages increased and risks decreased, as illustrated in the shift from point A to point B. Neglecting the endogeneity of

[5] If the set of available jobs is discrete, his VSL is bounded by the slopes of the line segments between the optimal job and the (undominated) neighboring jobs that present higher and lower risks, respectively.

job risk would be equivalent to comparing average VSL (the average slope of the hedonic-wage function), rather than the revealed VSL of each worker (the local slope at the job he chooses), as they shift over time.

To account for this potential endogeneity, we use a two-stage procedure.[6] For each year and each worker, in the first stage we predict the job the worker will take from his available set (indexed by its risk) and derive the worker's predicted VSL (the local slope of the hedonic-wage function). In the second stage, we pool across workers and years and regress workers' predicted VSLs in each year on their household incomes and other characteristics. The estimated relationship between VSL and household income is a measure of the income elasticity of VSL.

Specifically, in the first stage we estimate

$$RISK_{it} = \gamma^4 Z_{it}^4 + \varepsilon_{it}^4 \quad (4)$$

where $RISK_{it}$ is a measure of worker i's risk in year t, γ^4 is a vector of coefficients, and Z^4_{it} is a vector of worker characteristics including gender, age, education, household size and income, age and education squared, interactions of gender with age and education, and an intercept. We use the predicted values from equation (4), $\widehat{RISK_{it}}$, together with worker characteristics to predict each worker's VSL in each year using the corresponding hedonic-wage regression (Table 3). In the second stage, we estimate income elasticity by estimating

$$log\left(\widehat{VSL_{it}}\right) = \theta\, log(y_{it}) + \pi\, \widehat{RISK_{it}} + \gamma^5 Z_{it}^5 + \varepsilon_{it}^5 \quad (5)$$

where, for worker i in year t, $\widehat{VSL_{it}}$ is the worker's predicted VSL, y_{it} is his household income, and $\widehat{RISK_{it}}$ is his predicted risk. Z^5_{it} is a vector of worker characteristics including age, education, age and education squared, household size, and an intercept.

There are two important econometric issues in estimating the second stage: identification and endogeneity (Bartik 1987, Palmquist 1984). Identification requires distinguishing a worker's demand for safety (i.e., his VSL) from the hedonic-wage function. We identify workers' demands using data from separate markets, differentiated by year. The assumption is that in choosing his job for each year, the worker must select his preferred wage and risk combination from the available set, which is characterized by that year's hedonic-wage function. We identify preferences for safety assuming that workers' utility functions do not change over time, while the hedonic-wage locus shifts because of changes in technology (Ekeland et al. 2002).

[6] Other papers that have used a similar two-stage approach to investigate how VSL varies with individuals' characteristics include Viscusi and Moore (1989) and Moore and Viscusi (1990), who examined how VSL depends on life expectancy, and Aldy and Viscusi (2008), who examined how it depends on age and birth cohort.

For the second stage, the VSLs from multiple years are pooled and demand functions for safety (i.e., the marginal value of safety, which equals VSL) are estimated. The endogeneity problem arises because the worker's VSL and risk are determined simultaneously by his job choice. The OLS estimate of demand for safety is inconsistent. Hence we estimate the second stage by instrumental variables (IV), using gender, age, marital status, household size, household income, age squared, education squared, and interactions of gender with age and with education as instruments. For comparison, we also estimate the second stage using OLS. Young (2021) warns that IV results are sensitive to heterogenous errors and influential (high-leverage) observations and reports that these problems plague a comprehensive sample of papers published in prominent journals.

Results using the first approach (regressing the logarithm of average VSL in each year on the logarithm of average household income or GDP per capita) are presented in Tables 7A and 7B. Results are presented using as dependent variable the logarithm of each of the three estimates of annual average VSL using realized risk and predicted risk (columns (1) – (3) of Table 4). As shown in Table 7A, regressing log VSL on log average household income yields estimated income elasticities between 4.0 and 4.8. Controlling for annual average risk decreases the estimated income elasticity to values between 2.0 and 3.7. Using real GDP per capita as the income measure (Table 7B) yields smaller estimates of 2.4 to 3.0 (not controlling for average risk) and 1.3 to 1.7 (controlling for average risk). All of the estimates that do not control for average risk are significantly different from one; of those controlling for average risk, only the estimate using realized risk and household income (Table 7A, column (4)) is significantly different from one.

In Tables 7A and 7B, the estimated coefficient on average risk is negative (although those in column (4) using realized risk are not statistically significant), which is inconsistent with the assumption that these regressions characterize workers' indifference curves. A negative coefficient on risk is often found in meta-analyses of hedonic-wage studies that control for both average income and average risk (e.g., Liu et al. 1997, Viscusi and Aldy 2003). It can be explained as a selection effect, in which workers with lower VSLs sort to jobs with higher risk. This suggests that estimates of income elasticity that do not control for workers' job choices are biased.

Results using the two-stage approach are presented in Table 8. Estimating equation (5) using IV yields estimates of income elasticity between 0.75 and 0.91. All three estimates are statistically significantly smaller than one. The estimated coefficients on risk are positive and statistically significant, consistent with the theoretical expectation. The estimated coefficients of age and age squared are significantly positive and negative respectively. This suggests that VSL increases then decreases with age, with a peak at age 48 or 49, which is roughly consistent with other estimates (Aldy and Viscusi 2008, Aldy 2019). OLS estimates of equation (5) yield modestly smaller estimates of the income elasticity, between 0.65 and 0.73. These are also statistically significantly smaller than one. In contrast, the estimated coefficient of risk is significantly less than zero, which is incompatible with the interpretation of these estimates as representing workers' indifference curves.

The estimates of income elasticity using the two-stage approach are much smaller than the estimates based on comparing hedonic-wage functions across time reported in Table 7A (between 2.0 and 4.8). This suggests the earlier estimates are biased because of the failure to recognize that VSL is endogenous. Estimating the second stage using either IV or OLS produces qualitatively similar results, an income elasticity somewhat smaller than one, but larger than 0.75 (using IV) or larger than 0.65 (using OLS).

5. Conclusions

Using a unique data set including annual wage and occupational fatality risk data over a 16-year period in Taiwan, we have examined how VSL increases with economic growth. This period experienced rapid economic growth combined with increases in workplace safety: real wages more than doubled while occupational risk declined by half. The estimated rate of substitution between income and risk (VSL) increased by a factor of five or more. Comparing the increase in VSL with the increase in average household income over time implies the income elasticity is between two and five. However, this estimate is biased because it fails to account for the endogeneity of VSL that results from workers' job choices. It is also vulnerable to the problem of ecological regression: differences in average VSL may reveal little about differences in individuals' VSL. We control for these limitations using a two-stage approach to first predict VSL for each worker and year, then regress these predictions on household income and other worker characteristics. Using this approach, the estimated income elasticity of VSL is between 0.65 and 0.91, regardless of whether the second stage is estimated using IV or OLS. This value is consistent with the values found in most previous studies, which have generally found values between about one-half and one.

Our estimates of the income elasticity of VSL are based on intertemporal comparisons within a population. With only two exceptions (Costa and Kahn 2004, Hammitt et al. 2019) previous estimates are based on cross-sectional comparisons between or within populations. Standard theory does not distinguish between intertemporal and cross-sectional income elasticities, but there are factors that may lead to some divergence. One possibility is that, at least in the early stages of economic development, workers may not recognize that one of the goods they can purchase with their increased income is occupational safety. To the extent that workers perceive safety conditions in industry as immutable, they may spend their incremental incomes more on consumer goods than on occupational safety. This effect would tend to suppress the intertemporal income elasticity. Alternatively, if economic development is characterized by disproportionate growth in new, safer industries that are attractive to workers primarily because they are growing rapidly and offer better career prospects rather than because they are safer (e.g., microelectronic manufacturing), firms in older, more hazardous industries (e.g., steel production) may need to increase wages to retain workers. This effect would tend to bias the estimated income elasticity upward, since the additional compensation paid in hazardous industries is, by hypothesis, in part compensation for job attributes such as limited opportunities for advancement (or limited job security in declining industries). The maturation of the workforce over the period we study could have shifted the hedonic-wage function toward higher VSL over time, also biasing upward our estimated income elasticity. Despite the rapid increase of VSL in Taiwan during this period of economic growth, our analysis suggests the income elasticity is no larger than one.

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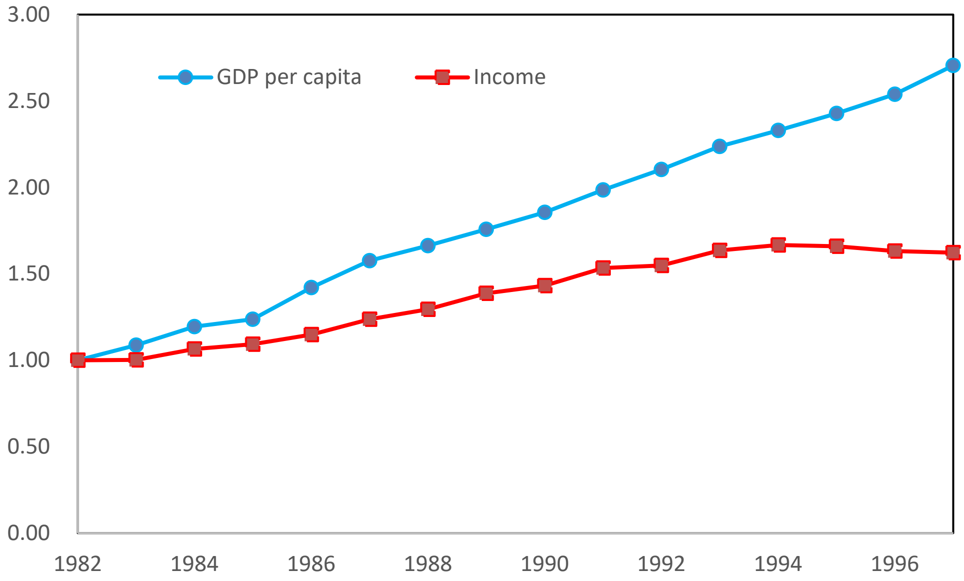

Figure 1. Growth of real household labor income and real GDP per capita (normalized to value in 1982)

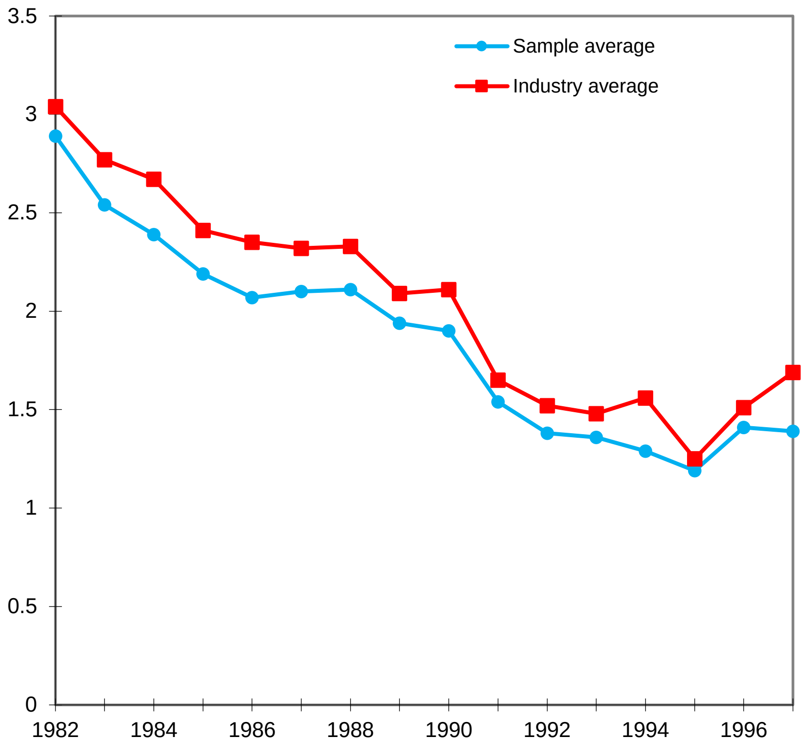

Figure 2. Manufacturing-sector occupational fatality risk (risk = annual fatalities per 10,000 workers)

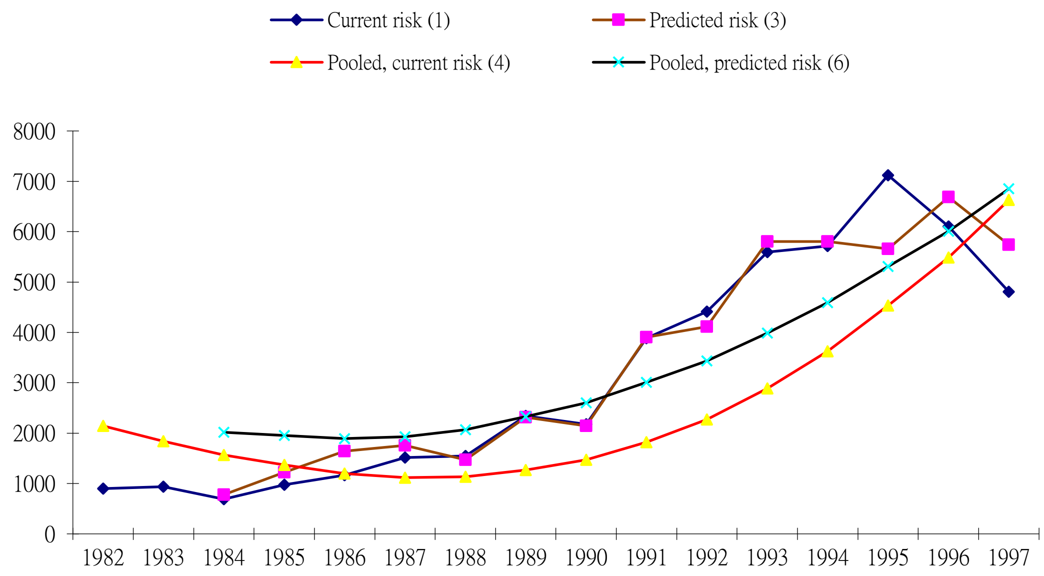

Figure 3. Trends in value per statistical life
(1991 US$1,000)
Note: Numbers in parentheses correspond to columns in Table 4.

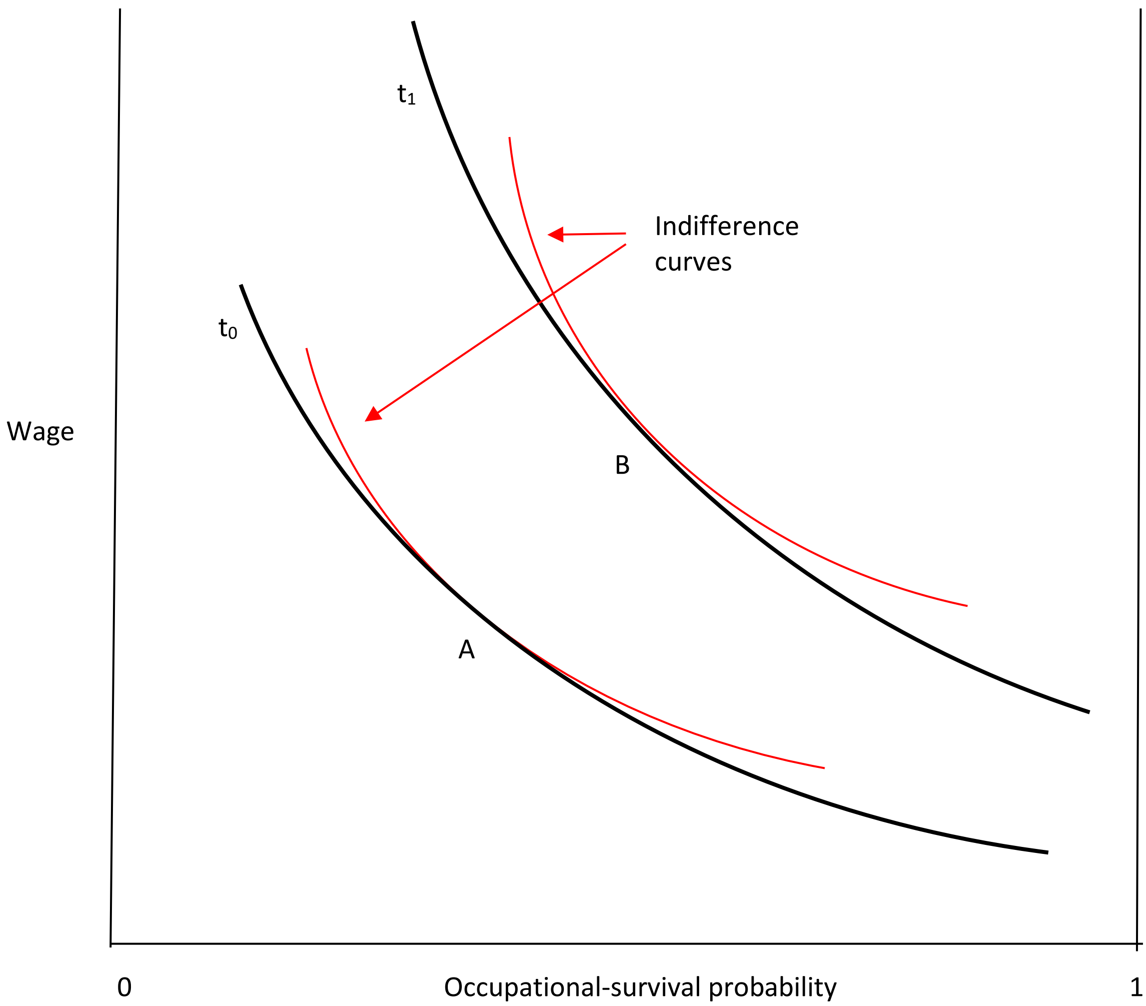

Figure 4.Hedonic regression functions and indifference curves for years t_0 and t_1

Table 1. Sample statistics

Year	Wage	Income	Risk	Male	Age	Married	Education	Experience	Hours	N
1982	49.52	29.31	2.89	0.59	29.73	0.46	8.94	49.78	196.56	10,457
	(22.53)	(19.35)	(1.44)	(0.49)	(11.43)	(0.49)	(3.51)	(61.88)	(27.78)	
	[57.86]	[34.25]								
1983	52.78	29.78	2.54	0.58	30.24	0.49	9.09	50.12	195.17	10,622
	(26.74)	(19.00)	(1.52)	(0.49)	(11.53)	(0.49)	(3.58)	(63.01)	(27.18)	
	[60.84]	[34.33]								
1984	53.92	31.65	2.39	0.57	30.56	0.50	9.16	48.66	197.10	11,790
	(24.71)	(21.32)	(1.46)	(0.49)	(11.39)	(0.49)	(3.60)	(60.74)	(27.63)	
	[62.17]	[36.49]								
1985	57.26	32.39	2.19	0.57	30.76	0.51	9.20	48.99	196.02	11,768
	(28.35)	(20.80)	(1.18)	(0.49)	(11.19)	(0.49)	(3.58)	(61.10)	(27.13)	
	[66.14]	[37.42]								
1986	59.67	34.30	2.07	0.56	30.92	0.52	9.26	50.07	196.51	12,082
	(28.45)	(22.40)	(1.80)	(0.49)	(11.09)	(0.49)	(3.54)	(62.62)	(28.62)	
	[68.44]	[39.35]								
1987	63.28	37.13	2.10	0.56	31.17	0.52	9.53	50.02	198.44	13,161
	(31.09)	(25.23)	(1.37)	(0.49)	(10.91)	(0.49)	(3.59)	(60.68)	(28.90)	
	[72.20]	[42.37]								
1988	70.20	39.37	2.11	0.57	31.67	0.52	9.70	52.28	197.39	12,971
	(31.90)	(26.60)	(1.29)	(0.49)	(10.88)	(0.49)	(3.51)	(61.06)	(26.15)	
	[79.08]	[44.35]								
1989	82.59	44.03	1.94	0.57	32.18	0.53	9.85	54.51	195.72	12,656
	(37.44)	(25.66)	(1.06)	(0.49)	(10.80)	(0.49)	(3.50)	(61.93)	(25.45)	
	[89.11]	[47.50]								
1990	93.85	47.31	1.90	0.57	32.39	0.54	9.95	54.23	192.33	11,774
	(44.73)	(25.99)	(1.08)	(0.49)	(10.70)	(0.49)	(3.44)	(61.57)	(24.09)	
	[97.25]	[49.03]								
1991	104.71	52.52	1.54	0.57	32.63	0.55	10.04	53.44	192.88	11,558
	(44.92)	(29.29)	(0.87)	(0.49)	(10.65)	(0.49)	(3.40)	(61.36)	(23.24)	
	[104.71]	[52.52]								
1992	115.51	55.40	1.38	0.58	33.20	0.54	10.20	56.60	192.44	11,289
	(48.72)	(32.72)	(0.71)	(0.49)	(10.68)	(0.49)	(3.38)	(62.04)	(24.27)	
	[110.56]	[53.03]								
1993	124.89	60.25	1.36	0.57	33.52	0.56	10.25	57.54	192.33	11,345
	(54.22)	(34.13)	(0.82)	(0.49)	(10.69)	(0.49)	(3.40)	(62.83)	(24.17)	
	[116.13]	[56.03]								
1994	134.24	63.91	1.29	0.57	33.75	0.57	10.29	60.08	192.59	11,208
	(58.01)	(33.55)	(0.74)	(0.49)	(10.64)	(0.49)	(3.39)	(65.87)	(25.66)	
	[119.92]	[57.10]								
1995	143.78	65.95	1.19	0.57	33.96	0.56	10.54	61.71	191.79	10,906
	(60.79)	(35.02)	(0.67)	(0.49)	(10.63)	(0.49)	(3.38)	(66.60)	(22.06)	
	[123.88]	[56.82]								
1996	150.37	66.83	1.41	0.56	34.29	0.56	10.78	64.06	190.51	10,496
	(65.57)	(36.38)	(0.79)	(0.49)	(10.52)	(0.49)	(3.39)	(70.03)	(23.62)	
	[125.70]	[55.87]								
1997	153.51	67.08	1.39	0.57	34.55	0.57	10.89	74.69	190.56	10,883
	(67.71)	(37.64)	(0.85)	(0.49)	(10.57)	(0.49)	(3.35)	(71.80)	(23.97)	
	[127.19]	[55.85]								

Notes: Standard deviations are in parentheses. Variable definitions: Wage: nominal hourly wage rate (NT$), real hourly wage rate in brackets (1991 NT$); Income: nominal monthly household labor income (NT$1,000), real monthly household labor income in brackets (1991 NT$1,000); Risk: annual mortality rate per 10,000 workers; Male: male=1, female=0; Age: age in years; Married: married=1, other=0; Education: years of schooling; Experience: months of work experience at current job; Hours: working hours per month; N: number of observations.

Table 2. Risk by industry

Industry	Average (1982-1985)	Average (1994-1997)	Decrease (percent)
Primary Metal	6.93	2.64	62
Transportation Service[a]	5.32	2.97	44
Warehousing Service[a]	5.32	2.97	44
Lumber and Furniture	3.94	1.72	56
Nonmetallic Mineral	3.79	3.35	12
Paper and Printing	3.62	1.34	63
Transportation	3.54	1.85	48
Beverages and Tobaccos	3.18	2.87	10
Food	3.04	0.97	68
Machinery	2.62	1.59	39
Chemicals[b]	2.48	1.47	41
Chemical Products[b]	2.48	1.47	41
Petroleum and Coal[b]	2.48	1.47	41
Rubber[b]	2.48	1.47	41
Plastic[b]	2.48	1.47	41
Textiles	2.35	1.24	47
Metal Products	2.24	1.57	30
Miscellaneous	1.86	0.45	76
Leather	1.50	0.82	45
Electrical and Electronic	1.42	0.80	43
Wholesale Service[b]	1.41	0.93	34
Retail service	1.41	0.93	34
Foreign Trade Service[b]	1.41	0.93	34
Restaurant and Travel Service[b]	1.41	0.93	34
Precision Instruments	1.36	0.55	60
Apparel	0.73	0.28	61
Average industry	2.72	1.50	45
Average worker	2.50	1.32	47

Notes: Risk = annual fatalities per 10,000 workers. Risk data available only for aggregates of industries identified by a, b, c.

Table 3. Selected parameter estimates of hedonic-wage models, 1982-1997

	Independent Variables									
Year	Risk	Male	Age	Married	Edu	Edu^2	Exper	Exper^2	Adj. R^2	F-value
1982	0.016	0.274	0.002	0.111	-0.004	0.002	0.003	$-0.51\cdot10^{-5}$	0.49	726.23
	(7.44)	(40.65)	(4.07)	(14.85)	(-1.25)	(9.00)	(23.67)	(-13.82)		
	[2.00]	[14.65]	[3.12]	[9.24]	[-0.94]	[5.52]	[8.66]	[-5.96]		
1983	0.017	0.281	0.001	0.128	0.001	0.001	0.003	$-0.54\cdot10^{-5}$	0.49	757.99
	(7.56)	(40.56)	(3.42)	(16.58)	(0.41)	(7.66)	(24.24)	(-14.71)		
	[3.57]	[15.71]	[2.14]	[7.11]	[0.44]	[6.53]	[11.54]	[-7.11]		
1984	0.012	0.272	0.001	0.112	-0.003	0.002	0.003	$-0.61\cdot10^{-5}$	0.47	751.67
	(5.49)	(42.94)	(2.31)	(16.10)	(-0.89)	(9.19)	(27.45)	(-17.03)		
	[2.57]	[18.14]	[1.01]	[6.20]	[-0.75]	[5.09]	[11.11]	[-7.97]		
1985	0.016	0.274	0.002	0.108	0.002	0.003	0.003	$-0.62\cdot10^{-5}$	0.47	764.11
	(6.20)	(43.87)	(4.48)	(15.69)	(0.92)	(7.57)	(27.76)	(-17.93)		
	[1.72]	[16.37]	[2.13]	[6.94]	[0.72]	[4.42]	[14.40]	[-8.80]		
1986	0.018	0.299	0.002	0.116	0.004	0.001	0.003	$-0.55\cdot10^{-5}$	0.49	843.78
	(10.46)	(47.67)	(4.07)	(16.99)	(1.35)	(8.48)	(27.96)	(-17.04)		
	[7.34]	[14.37]	[2.20]	[6.35]	[1.19]	[4.87]	[9.88]	[-7.58]		
1987	0.022	0.303	0.001	0.097	0.001	0.001	0.003	$-0.56\cdot10^{-5}$	0.48	869.82
	(9.85)	(49.81)	(3.79)	(14.45)	(0.45)	(8.16)	(29.29)	(-17.22)		
	[3.70]	[19.58]	[1.33]	[5.24]	[0.35]	[4.59]	[11.59]	[-7.99]		
1988	0.021	0.314	0.002	0.103	0.004	0.001	0.003	$-0.48\cdot10^{-5}$	0.49	900.82
	(9.13)	(53.79)	(4.82)	(15.90)	(1.32)	(7.91)	(25.32)	(-14.29)		
	[4.39]	[16.31]	[1.38]	[8.99]	[1.70]	[9.55]	[14.08]	[-6.91]		
1989	0.029	0.339	0.001	0.086	-0.001	0.001	0.002	$-0.34\cdot10^{-5}$	0.49	867.59
	(10.08)	(56.34)	(3.25)	(13.17)	(-0.36)	(9.11)	(23.91)	(-13.04)		
	[3.16]	[17.65]	[1.07]	[7.12]	[-0.31]	[7.44]	[13.31]	[-7.91]		
1990	0.025	0.321	0.001	0.095	$-0.3\cdot10^{-3}$	0.001	0.002	$-0.45\cdot10^{-5}$	0.47	768.19
	(8.67)	(51.45)	(2.50)	(14.04)	(-0.09)	(7.73)	(22.21)	(-12.59)		
	[4.89]	[14.56]	[0.79]	[7.20]	[-0.05]	[4.97]	[12.00]	[-7.00]		
1991	0.041	0.321	0.001	0.078	0.001	0.001	0.002	$-0.36\cdot10^{-5}$	0.47	761.86
	(11.66)	(52.14)	(3.19)	(11.62)	(0.41)	(7.19)	(20.81)	(-13.89)		
	[5.27]	[14.73]	[1.64]	[3.92]	[0.28]	[3.95]	[12.11]	[-5.75]		
1992	0.044	0.305	0.001	0.077	-0.001	0.001	0.003	$-0.49\cdot10^{-5}$	0.48	737.98
	(10.32)	(49.44)	(4.14)	(11.41)	(-0.27)	(7.79)	(23.06)	(-13.53)		
	[3.50]	[12.31]	[1.32]	[6.23]	[-0.17]	[4.82]	[8.17]	[-4.61]		
1993	0.053	0.336	0.001	0.078	0.011	0.001	0.002	$-0.48\cdot10^{-5}$	0.48	776.24
	(14.42)	(51.89)	(2.15)	(11.52)	(3.01)	(5.25)	(23.25)	(-12.36)		
	[4.67]	[10.92]	[0.73]	[7.42]	[2.26]	[4.103]	[14.847]	[-7.184]		
1994	0.053	0.339	0.001	0.069	0.006	0.001	0.002	$-0.36\cdot10^{-5}$	0.48	727.16
	(13.21)	(52.97)	(4.15)	(10.24)	(1.49)	(5.50)	(21.54)	(-10.21)		
	[3.64]	[11.75]	[1.85]	[4.94]	[1.81]	[5.94]	[8.13]	[-2.90]		
1995	0.064	0.310	0.002	0.074	0.005	0.001	0.002	$-0.39\cdot10^{-5}$	0.49	749.41
	(14.59)	(49.60)	(5.34)	(11.24)	(1.59)	(6.24)	(21.19)	(-11.03)		
	[5.14]	[14.59]	[2.66]	[6.45]	[1.09]	[3.86]	[7.85]	[-4.01]		
1996	0.054	0.300	0.003	0.073	0.007	0.001	0.002	$-0.36\cdot10^{-5}$	0.48	702.72
	(14.27)	(45.00)	(7.21)	(10.69)	(1.83)	(6.19)	(20.09)	(-10.05)		
	[3.65]	[12.82]	[4.74]	[8.78]	[1.10]	[3.88]	[13.60]	[-6.44]		
1997	0.043	0.290	0.003	0.061	0.008	0.001	0.002	$-0.29\cdot10^{-5}$	0.47	687.97
	(12.63)	(46.40)	(8.25)	(9.36)	(2.22)	(5.45)	(18.97)	(-9.46)		
	[4.86]	[13.99]	[3.99]	[6.15]	[1.97]	[3.94]	[7.86]	[-3.75]		

Notes: t-statistics in parentheses. Clustered t-statistics in brackets. Regressions include indicators for six occupation categories.

Table 4. VSL from alternative models (1991 US$1,000)

		Annual estimates			Pooled data		
		Realized risk	Predicted risk		Realized risk	Predicted risk	
Year	Real GDP/capita		OLS	Fixed effects		OLS	Fixed effects
		(1)	(2)	(3)	(4)	(5)	(6)
1982	4.79	899			2,142		
1983	5.21	937			1,838		
1984	5.72	689	630	778	1,564	2,123	2,019
1985	5.93	973	1,103	1,220	1,366	1,942	1,953
1986	6.81	1,167	1,602	1,639	1,196	1,793	1,892
1987	7.56	1,513	1,682	1,755	1,117	1,765	1,926
1988	7.97	1,549	1,413	1,468	1,136	1,877	2,068
1989	8.43	2,339	2,375	2,313	1,269	2,148	2,331
1990	8.89	2,173	2,244	2,147	1,470	2,492	2,604
1991	9.52	3,885	4,197	3,905	1,822	3,033	3,007
1992	10.08	4,415	4,459	4,115	2,274	3,680	3,437
1993	10.72	5,597	6,797	5,804	2,890	4,529	3,986
1994	11.16	5,714	7,092	5,805	3,627	5,509	4,588
1995	11.64	7,121	6,745	5,657	4,535	6,698	5,310
1996	12.17	6,100	8,539	6,686	5,486	7,904	6,005
1997	12.97	4,806	7,107	5,742	6,628	9,350	6,850

Notes: Values in column (1) predicted using annual models reported in Table 3. Values in columns (2) – (3) predicted using annual models that substitute predicted risk, using predictions from models reported in Table 5. Values in columns (4) – (6) predicted using columns (4) – (6) of Table 6.

Table 5. Parameter estimates of the predicted risk model

Variable	OLS	Industry fixed effects
$Risk_{t-1}$	0.8554	0.6546
	(34.664)	(14.621)
$Risk_{t-1}$ - $Risk_{t-2}$	-0.4093	-0.3191
	(-9.246)	(-6.754)
Intercept	0.1678	
	(2.793)	
Adj. R^2	0.77	0.77
N	364	364

Note: t statistics in parentheses.

Model: $Risk_{j,t} = \delta_0 + \delta_1 Risk_{j,t-1} + \delta_2 (Risk_{j,t-1} – Risk_{j,t-2}) + \nu_{j,t}$

Table 6. Selected parameter estimates of hedonic-wage model using pooled data (1982-1997)

	Realized risk	Predicted risk	
		OLS	Fixed effects
	(1)	(2)	(3)
T	0.0511	0.0547	0.0555
	(158.67)	(126.88)	(139.21)
T^2	-0.0026	-0.0038	-0.0034
	(-36.63)	(-35.78)	(-33.78)
Risk	0.0171	0.0289	0.0302
	(18.08)	(25.35)	(27.84)
Risk·T	0.0018	0.0028	0.0015
	(10.70)	(12.50)	(7.93)
Risk·T^2	0.0006	0.0007	0.0004
	(18.67)	(13.03)	(8.17)
Male	0.3076	0.3090	0.3082
	(193.75)	(184.66)	(184.02)
Age	0.0016	0.0016	0.0016
	(16.87)	(15.66)	(15.65)
Married	0.0929	0.0899	0.0898
	(53.72)	(49.47)	(49.41)
Edu	0.0038	0.0043	0.0043
	(4.54)	(4.77)	(4.80)
Edu^2	0.0012	0.0012	0.0012
	(28.52)	(26.40)	(26.33)
Exper	0.0026	0.0026	0.0026
	(96.46)	(90.34)	(90.18)
$Exper^2$	$-0.46 \cdot 10^{-5}$	$-0.45 \cdot 10^{-5}$	$-0.45 \cdot 10^{-5}$
	(-54.49)	(-50.70)	(-50.69)
Intercept	3.9065	3.8815	3.8783
	(578.41)	(534.02)	(536.42)
Adjusted R^2	0.63	0.62	0.62
σ	0.3056	0.3032	0.3031
N	184,968	163,889	163,889

Note: t-statistics in parentheses.

Table 7A. Estimated relationship between average VSL and household income

	(1)	(2)	(3)	(4)	(5)	(6)
Risk measure	Realized	Predicted OLS	Predicted FE	Realized	Predicted OLS	Predicted FE
Log(household income)	3.9934 (16.53)	4.7903 (11.20)	4.0217 (10.94)	3.6864 (4.01)	2.4849 (1.93)	1.9880 (1.81)
Mean risk				-0.1200 (-0.35)	-0.9744 (-1.87)	-0.8596 (-1.94)
Intercept	-4.5297 (-6.09)	-6.9351 (-5.20)	-4.5999 (-4.02)	-3.3644 (-0.98)	1.9295 (0.40)	3.2200 (0.77)
Adjusted R^2	0.9478	0.9054	0.9013	0.9442	0.9217	0.9198
σ	0.1788	0.2507	0.2154	0.1847	0.2280	0.1942
N	16	14	14	16	14	14
p-value	0.000	0.000	0.000	0.012	0.273	0.388

Note: t-statistics in parentheses. Dependent variable is log of average VSL from column of Table 4 for indicated risk measure. p-value is for test of hypothesis that coefficient of log(household income) = 1.

Table 7B. Estimated relationship between average VSL and GDP per capita

	(1)	(2)	(3)	(4)	(5)	(6)
Risk measure	Realized	Predicted OLS	Predicted FE	Realized	Predicted OLS	Predicted FE
Log(GDP per capita)	2.3662 (11.99)	2.9889 (11.79)	2.4983 (10.92)	1.5048 (2.24)	1.6532 (2.75)	1.2586 (2.35)
Mean risk				-0.5588 (-1.34)	-0.9278 (-2.38)	-0.8611 (-2.48)
Intercept	2.7114 (6.41)	1.4172 (2.53)	2.4367 (4.82)	5.5757 (2.56)	5.9562 (3.03)	6.6493 (3.80)
Adjusted R^2	0.9049	0.9139	0.9010	0.9100	0.9379	0.9308
σ	0.2412	0.2392	0.2157	0.2346	0.2031	0.1804
N	16	14	14	16	14	14
p-value	0.000	0.000	0.000	0.466	0.300	0.639

Note: t-statistics in parentheses. Dependent variable is log of average VSL from column of Table 4 for indicated risk measure. p-value is for test of hypothesis that coefficient of log(household income) = 1.

Table 8. Estimated relationship between predicted VSL and household income

	(1)	(2)	(3)	(4)	(5)	(6)
	IV	IV	IV	OLS	OLS	OLS
Risk measure	Realized	Predicted OLS	Predicted FE	Realized	Predicted OLS	Predicted FE
Log(household	0.909	0.867	0.745	0.727	0.715	0.647
income)	(186.19)	(160.19)	(160.25)	(237.18)	(197.72)	(203.99)
Risk	0.411	0.503	0.514	-0.104	-0.136	-0.054]
	(61.68)	(55.77)	(67.87)	(-86.25)	(-82.31)	(-38.22)
Age	0.068	0.066	0.058	0.088	0.087	0.080
	(60.18)	(50.98)	(49.77)	(111.33)	(94.67)	(98.88)
Age^2	$-0.70 \cdot 10^{-3}$	$-0.67 \cdot 10^{-3}$	$-0.60 \cdot 10^{-3}$	$-0.86 \cdot 10^{-3}$	$-0.84 \cdot 10^{-3}$	$-0.78 \cdot 10^{-3}$
	(-47.34)	(-39.65)	(-40.00)	(-83.13)	(-69.79)	(-73.72)
Edu	0.112	0.115	0.096	0.112	0.116	0.105
	(45.97)	(41.04)	(37.95)	(64.59)	(57.51)	(59.10)
Edu^2	$-0.26 \cdot 10^{-2}$	$-0.26 \cdot 10^{-2}$	$-0.19 \cdot 10^{-2}$	$-0.31 \cdot 10^{-2}$	$-0.30 \cdot 10^{-2}$	$-0.25 \cdot 10^{-2}$
	(-21.11)	(-18.43)	(-14.81)	(-33.12)	(-29.30)	(-28.49)
Household size	-0.190	-0.177	-0.153	-0.149	-0.144	-0.131
	(-129.41)	(-107.90)	(-105.93)	(-152.47)	(-126.22)	(-130.30)
Intercept	-0.898	-0.461	0.968	1.416	1.717	2.397
	(-16.59)	(-7.55)	(18.93)	(43.58)	(44.42)	(70.81)
F-value	10,603	7,683	7,950	21,033	14,805	14,720
σ	0.903	0.960	0.862	0.641	0.694	0.611
Adj. R^2	0.443	0.384	0.414	0.443	0.387	0.386
N	184968	163889	163889	184968	163889	163889
p-value	0.000	0.000	0.000	0.000	0.000	0.000

Notes: t-statistics in parentheses. Dependent variable is log of individual worker's VSL predicted from columns (1) – (3) of Table 4 using indicated risk measure. Instrumental variables are: Male, Age, Married, Edu, Log(household income), Household size, Age^2, Edu^2, Male·Age, and Male·Edu. p-value is for test of hypothesis that coefficient of log(household income) = 1.