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Thomas J. Kniesner

Syracuse University
USA
tkniesne@maxwell.syr.edu

IZA
Germany

John D. Leeth

Bentley University
USA
jleeth@bentley.edu

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Boston – Delft

Foundations and Trends® in Microeconomics

Published, sold and distributed by:
now Publishers Inc.
PO Box 1024
Hanover, MA 02339
USA
Tel. +1-781-985-4510
www.nowpublishers.com
sales@nowpublishers.com

Outside North America:
now Publishers Inc.
PO Box 179
2600 AD Delft
The Netherlands
Tel. +31-6-51115274

The preferred citation for this publication is T. J. Kniesner and J. D. Leeth, Hedonic Wage Equilibrium: Theory, Evidence and Policy, Foundations and Trends® in Microeconomics, vol 5, no 4, pp 229–299, 2009

ISBN: 978-1-60198-370-1

Foundations and Trends® in Microeconomics
Volume 5 Issue 4, 2009

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Foundations and Trends® in Microeconomics, 2009, Volume 5, 8 issues. ISSN paper version 1547-9846. ISSN online version 1547-9854. Also available as a combined paper and online subscription.

Foundations and Trends® in
Microeconomics
Vol. 5, No. 4 (2009) 229–299

DOI: 10.1561/0700000005

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Hedonic Wage Equilibrium: Theory, Evidence and Policy

Thomas J. Kniesner[1,2] and John D. Leeth[3]

[1] *Syracuse University, USA tkniesne@maxwell.syr.edu*
[2] *IZA, Germany*
[3] *Bentley University, USA jleeth@bentley.edu*

Abstract

We examine theoretically and empirically the properties of the equilibrium wage function and its implications for policy. Our emphasis is on how the researcher approaches economic and policy questions when there is labor market heterogeneity leading to a set of wages. We focus on the application where hedonic models have been most successful at clarifying policy relevant outcomes and policy effects that of the wage premia for fatal injury risk.

Estimates of the overall hedonic locus we discuss imply the so-called value of a statistical life (VSL) that is useful as the benefit value in a cost-effectiveness calculation of government programs to enhance personal safety. Additional econometric results described are the multiple dimensions of heterogeneity in VSL, including by age and consumption plans, the latent trait that affects wages and job safety setting choice, and family income.

Simulations of hedonic market outcomes are also valuable research tools. To demonstrate the additional usefulness of giving detail to

the underlying structure we not only develop the issue of welfare comparisons theoretically, but also illustrate how numerical simulations of the underlying structure can also be informative. Using a reasonable set of primitives we see that job safety regulations are much more limited in their potential for improving workplace safety efficiently compared to mandatory injury insurance with experience rated premiums. The simulations reveal how regulations incent some workers to take more dangerous jobs, while workers' compensation insurance does not (or less so).

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1

Labor-Market Equilibrium with Differented Workplaces

In the standard labor market model all workers are identical, all firms are identical, and a single wage equalizes the quantities of labor supplied and demanded. If the wage is too low then the excess demand for workers drives the wage up, while if the wage is too high the excess supply of workers drives the wage down. When workplaces differ in terms of non-wage job attributes the process describing labor market equilibrium is more complicated. Instead of a single wage, a wage function equilibrates the quantity of labor supplied to the quantity demanded at or near possible values of the attribute (Rosen, 1974). Here we examine theoretically and empirically the properties of the equilibrium wage function. Our focus is on the set of research and policy questions one can examine with enriched representation of labor market equilibrium, that is a set of wages caused by firm and worker heterogeneity.

Economists label the equilibrium relationship between wages and job attributes a hedonic equilibrium wage function. The logic behind the label is that wages reflect not only the overall conditions in the labor market but also the relative attractiveness (pleasure) of one job versus another. The underlying force generating the hedonic wage function is the sorting of workers and firms among the various levels of the job characteristic. To simplify our discussion suppose that all employers offer identical hours of work, and workers accept employment in only one firm. Further, we focus on a single job characteristic, z, which can be measured continuously and is a job disamenity, such as danger, heat, noise, stress, or poor fringe benefits.

In the remainder of Section 1 we lay out the complete economic structure of the hedonic labor market equilibrium model emphasizing the additional complexity and economic richness created by firms who differ in the production technologies and workers who differ in their attitudes toward risk. The remainder of Section 1 considers the possibility of multiple hedonic equilibrium loci for highly distinctive groups of workers such as smokers and nonsmokers and the hedonic locus for desirable workplace attributes.

Having established the basics of labor market outcomes under heterogeneity in Section 1, we proceed in Section 2 to describe the precision one can bring to policy evaluations with the hedonic equilibrium locus versus that with knowledge of the underlying fundamentals, such as an individual's indifference curve revealing the worker' willingness to pay for a better working environment. The reader interested mainly in learning the fundamentals of hedonic equilibrium can focus on Sections 1 and 2 only.

As a complement to Section 2, Section 3 describes the special econometric issues involved with estimating the hedonic locus and the underlying structure resulting from worker and firm heterogeneity and the implicit prices of workplace characteristics that are the fundamental ingredients to a hedonic equilibrium econometric model. The reader who is knowledgeable in the theoretical dimension of hedonic equilibrium, but who wants to learn the econometric nuances of the model, can focus on Section 3.

Section 4 presents recent empirical results for the hedonic wage equilibrium locus and their implications for policy that use the value of a statistical life (VSL), which is the implicit value workers as a group place on one life. Section 4 is a standalone presentation that may be the primary interest of readers knowledgeable in how to estimate hedonic equilibrium regression models but want to learn some useful recent econometric results. In particular, Section 4 begins with questions of whether there is a simple way to get distributional issues into the model via a person's relative position in the wage distribution and whether relative position is an empirically more important issue than the worker's age. The effect of aging on the worker's implicit pay for accepting a fatal injury risk will depend on consumption plans and we provide estimates of the importance of planned consumption in equilibrium wage outcomes. Both relative position and consumption are forms of worker measured heterogeneity and we supplement the heterogeneity issue in Section 4 with results for latent worker heterogeneity. Our econometric evidence is that accounting for latent worker heterogeneity that may be correlated with job safety risk is the single most important dimension of an econometric model of hedonic wage equilibrium. Accounting for latent heterogeneity greatly narrows the range of VSL estimates and clarifies the cost-effectiveness of life-saving policies. The issue presented in Section 4 is a formal regression model of differences in the effect of fatal injury on the wage by expected wage level. Using quantile regression with latent individual heterogeneity included discovers wealth effects in the value of a statistical life that are policy relevant and also makes the econometric results now consistent with economic theory, which has not formerly been the case.

Econometric estimates are not the only way to give empirical content to the hedonic model. In Section 5 we present the empirical alternative of numerical simulation, which may be the focal section for readers well versed in the theory and econometrics but wish to expand their knowledge base to include the technique of computable hedonic equilibrium. Specifically, in Section 5 we numerically simulate the complete hedonic model developed in Section 1. By parameterizing the underlying structure of the model we are able to examine large and complex changes in workplace safety policy that would be poorly estimated by an econometric model due to extrapolation bias and latent parameters. Our results show the relative dominance of workers' compensation insurance over occupational safety and health regulations in improving workplace safety.

Section 6 concludes.

1.1 Firms

Programs to improve workplace conditions or fringe benefits (lower z) are costly. An employer must anticipate corresponding economic benefits, such as greater output, lower pay for workers, smaller insurance premiums, or lower fines for violating government standards to be willing to bear their additional costs.[1] The economic problem confronting the employer is to choose the combination of capital, labor, and workplace environment that maximizes profit subject to $z \geq 0$. To reduce the complexity of the discussion we assume a standard device exists that monotonically decreases the workplace disamenity. We refer to the generic device, which represents all the firm's efforts to improve the work environment, as work environment equipment. Revenue is a function of capital, labor, and work environment equipment. Input cost includes the wage bill plus the cost of capital. Also included are the cost of work environment equipment, the cost of workers' insurance (health, workers compensation, and disability), and possible fines for violating government workplace standards, which are avenues for government policy that we will ultimately explore.

Algebraically, profit is:

$$\Pi = R(n, k, E(z); \mu) - W(z)n - p_k k - p_e E(z) - P_i(z)n - V(z), \tag{1.1}$$

where $\Pi \equiv$ profit,
$R(\cdot) \equiv$ the revenue function,
$n \equiv$ the number of workers,
$k \equiv$ the quantity of capital,
$e \equiv$ the quantity of work environment equipment, $e = E(z)$; $E(\cdot)$ is the work environment function and $\partial E/\partial z \equiv E' < 0$,

[1] Programs geared to reducing workplace disamenities may increase or decrease production. Reducing disamenities such as heat and noise could improve worker productivity and expand output. In the case of workplace injuries, Viscusi (1979) argues that greater safety raises output by diminishing the disruptive effects of accidents and by increasing the stability of the workforce. Alternatively, slowing the pace of the assembly line or installing cumbersome machine guards can interfere with the work process and decrease output. For purposes of the theoretical derivation of hedonic equilibrium we assume that reductions in workplace disamenities raise output.

$\mu \equiv$ a parameter representing the efficiency of work environment equipment in the production of output ($\partial^2 R/\partial e \partial \mu > 0$),

$W(z) \equiv$ the market wage function, $\partial W/\partial z \equiv W' > 0$,

$p_k \equiv$ the per-unit price of capital,

$p_e \equiv$ the per-unit price of work environment equipment,

$p_i \equiv$ the per-worker price of health, disability, and workers compensation insurance, $p_i = P_i(z)$; $P_i(\cdot)$ is the insurance pricing function with $\partial P_i/\partial z \equiv P' > 0$, and

$V(z) \equiv$ the expected fine for violating workplace standards, $\partial V/\partial z \equiv V' > 0$.

Labor, capital, and work environment equipment each increase revenue at decreasing rates, and all cross derivatives among labor, capital, and work environment equipment are positive. Note that $W(z)$ need not be an equilibrium wage function as yet; workers and firms need only observe and make their decisions based on the relationship between wages and the job disamenity.

Managers influence profit through their decisions on hiring labor, purchasing capital, and purchasing work environment-improving equipment (reducing workplace disamenities). All three decisions must be made jointly to maximize profit; decreasing disamenities increases the productivity of labor and capital, while increasing labor and capital increases the net benefits from improving the work environment. By differentiating Equation (1.1) with respect to n, k, and z, setting each result equal to zero and rearranging terms, we can show the firm's optimal usage of each input occurs when:

$$\frac{\partial R}{\partial n} = W(z) + P_i(z), \tag{1.2}$$

$$\frac{\partial R}{\partial k} = p_k, \quad \text{and} \tag{1.3}$$

$$\frac{\partial R}{\partial E}E' - W'n - P'n - V' = p_e E'. \tag{1.4}$$

Firms increase their use of labor and capital until the expected marginal revenue product of each input equals its expected marginal cost. In addition, firms reduce workplace disamenities until the marginal benefit — greater output, lower wages, lower insurance costs, and smaller government fines — equals the marginal cost of purchasing more work environment equipment. Because the output effect of work environment equipment varies among workplaces the marginal benefits of reducing workplace disamenities differ among firms, in turn causing the optimum level of the disamenity to vary. Firms where work environment-improving measures are highly productive reduce disamenities more than firms where improving the work environment is less productive.

The situation facing the firm can be viewed graphically. A firm's offer wage function (isoprofit curve) shows the tradeoff between wages and workplace disamenities at a constant level of expected profit with capital and labor used in optimal quantities. To keep the same level of profit, wages must fall as work disamenities decrease to compensate for the added cost of purchasing work environment equipment so that offer wage functions slope upward. Firms with greater costs of producing a pleasant workplace require a greater wage reduction to lower disamenities than firms with smaller costs of producing a pleasant work environment, all else equal. The firm with the higher marginal cost of producing a better workplace will have a more steeply sloped offer wage function at a given wage and work disamenity than a firm with a lower marginal cost. Finally, profits rise as wages fall implying the lower the offer wage function the higher the profit.

Figure 1.1 shows the market wage function and offer wage functions for two companies. As can be seen, Company A maximizes profit by offering workers job attributes equal to z^A, the level where the offer wage function is just tangent to the hedonic wage function. Because its costs of providing an amenity such as a pleasant or safe work environment are greater, Company B maximizes profit by offering a less agreeable job, z^{B}, but paying higher wages than Company A to compensate workers for the less pleasant working conditions. With a sufficiently large number of diverse firms each point on the hedonic wage function represents a point of tangency for some company or companies. The hedonic wage function represents an upper envelope of a family of offer wage curves that differ because of the variation in the technical ability of firms to produce pleasant work environments. It slopes

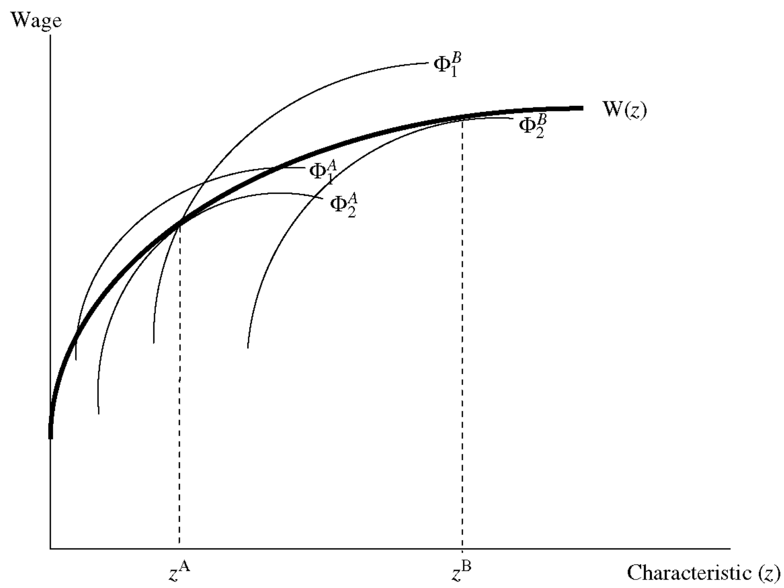

Fig. 1.1 Firm equilibrium.

upward because firms are willing to pay higher wages to avoid bearing the added expenses of providing better working conditions.

1.2 Workers

The problem confronting a worker is to find the level of consumption and workplace disamenity that maximizes utility subject to the overall budget constraint. In the situation we are considering the mathematical representation of utility is:

$$u = U(c, z; \alpha), \tag{1.5}$$

where $u \equiv$ the utility index,
$U(\cdot) \equiv$ the worker's utility function with $\partial U/\partial c > 0$ and $\partial U/\partial z < 0$,
$c \equiv$ consumption,
$z \equiv$ the workplace attribute, and
$\alpha \equiv$ a parameter determining workers' preferences regarding z.

In this representation $U(\cdot)$ represents a standard utility function with the workplace attribute, z, differing from normal consumption items, c, only in the sense that z is directly provided by employers and c is purchased by workers in an open market. Many hedonic wage studies and much of our later analysis examine workplace risk as the job characteristic. When examining a stochastic job attribute such as the likelihood of a workplace injury or fatality it is natural to use a Von Neumann–Morgenstern expected utility function to represent preferences. The analysis we develop is quite general and can easily be modified to examine stochastic workplace attributes using a Von Neumann–Morgenstern approach (see, for instance, Kniesner and Leeth, 1995b; Viscusi and Hersch, 2001; Viscusi and Aldy, 2003).

Remember $W(\pi)$ in Equation (1.5) represents the market wage function, observable to workers and firms, and y is non-labor income, so that consumption is $c = W(z) + y$. By substituting the expression for c into Equation (1.5), differentiating with respect to z, setting the result equal to 0, and then rearranging we can show that a worker's optimal level of z is when:

$$\frac{\partial U}{\partial c} W' = -\frac{\partial U}{\partial z}. \tag{1.6}$$

The story here is the standard one where a worker weighs the marginal benefit of a higher level of a workplace disamenity against the marginal cost. The left-hand side of Equation (1.6) represents the marginal benefit, which is the added pay from a more disagreeable job, and the right-hand side of Equation (1.6) represents the marginal cost, which is the direct loss of utility from the job disamenity. Because preferences differ among workers the perceived marginal gain and cost differ among them too, in turn causing the optimal level of z to vary. Interpersonal differences or heterogeneity is a fundamental dimension of labor market hedonics. Workers with a strong distaste for z sort into jobs with low workplace disamenities, and workers with only a mild distaste for z sort into jobs with high workplace disamenities.

Similar to the situation for firms, workers' decisions regarding the disamenity can also be clarified graphically. A worker's acceptance wage function (indifference curve) illustrates the tradeoff between wages and

z at a constant level of utility. To maintain a specific level of well-being wages must rise to compensate for bearing a higher amount of a bad job characteristic, so acceptance wage functions slope upward. Additionally, workers more averse to the disamenity require greater wage compensation for a given increase in z than workers less averse to the disamenity, all else equal, so the worker with the steeper acceptance wage function at a given (W, z) is the more averse to the job attribute. Lastly, workers prefer higher wages to lower wages at any level of the attribute, so the higher the acceptance wage function the higher the utility. The choice of the optimal level of z can be viewed similarly to the choice of the optimal purchase of commodities with the market wage function replacing the standard income constraint.

Figure 1.2 portrays acceptance wage functions for two workers in relation to a market wage function. We see Worker C maximizing utility by selecting a job offering attributes equal to z^{C}. The highest level of utility the worker can achieve occurs where the acceptance wage function is just tangent to the market wage curve. Although z^{C} maximizes

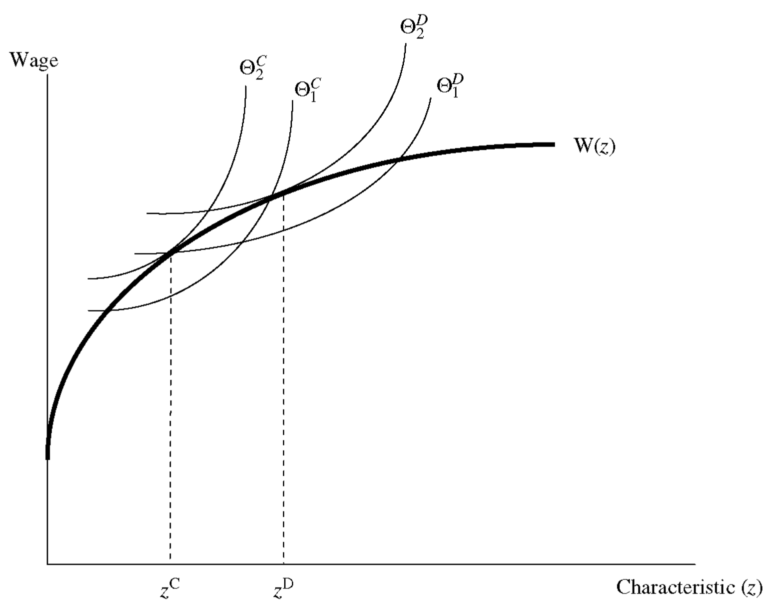

Fig. 1.2 Worker equilibrium.

Worker C's utility, it does not maximize Worker D's utility; Worker D requires a smaller increase in wages to accept a slight rise in workplace disamenities, utility held constant. Worker D maximizes utility by choosing a slightly more disagreeable job, characterized by z^{D}, and earning a higher wage. With a sufficiently large number of diverse workers, each point on the hedonic wage function is a point of tangency for some group of workers. In technical language, the wage function represents the lower envelope of a family of acceptance wage curves, which differ because workers vary in their attitudes regarding z.

1.3 Labor Market Equilibrium

Firms supply a given type of workplace based on the market wage function and their ability to produce the attribute. Workers sort into a given job type (z) based on the market (hedonic) wage function and their preferences regarding the job attribute. The hedonic wage function equilibrates the supply and demand for labor along the entire job attribute spectrum. A shortage of workers in high-z establishments, for instance, will drive up wages, thereby enticing some workers away from more pleasant employment. At the same time, the wage hike will encourage some firms to expand their expenditures on workplace improvements to reduce labor costs. With workers moving toward greater z, and firms moving toward less z, wages must rise in relatively more desirable workplaces. An excess demand for labor at any point along the job attribute spectrum alters the delicate balancing of labor supply and demand everywhere. Wages adjust until the supply of labor equals the demand for labor along the entire spectrum.

The slope of the acceptance wage function measures the wage a worker is willing to sacrifice to reduce job disamenities by a small amount and, therefore, provides a dollar figure of worker's willingness to pay for job attributes implicitly. At the same time, the slope of the isoprofit curve measures the reduction in wages required by a firm to compensate for the higher costs of improving the work environment. As can be seen in Figure 1.3, the hedonic wage function maps out a set of tangencies between workers' acceptance wage functions and firms' isoprofit curves or offer wage functions.

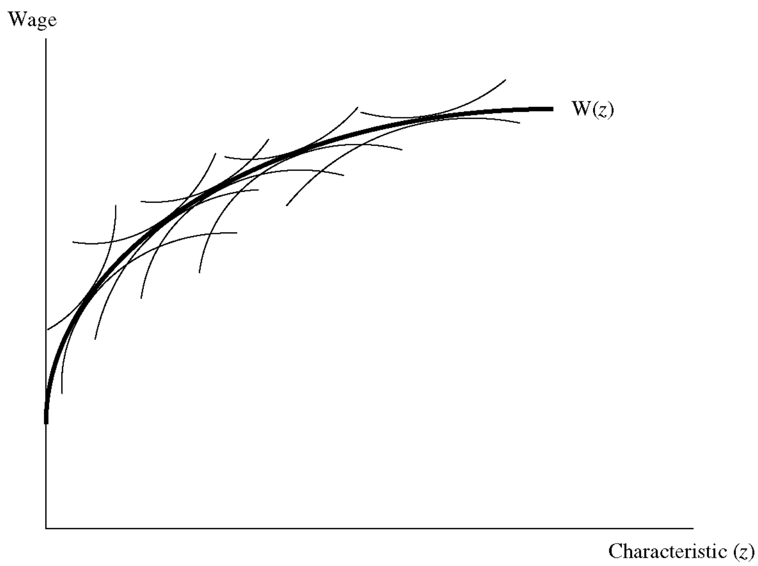

Fig. 1.3 Hedonic labor market equilibrium.

Although firms could reduce z below the various levels shown in Figure 1.3, thereby improving the work environment, the benefits would be less than the costs. The small wage reduction would not compensate for the added expenses. Workers could likewise improve their work environment by accepting employment at a firm offering a lower z. They choose not to because the wage sacrifice exceeds the value they place on a more pleasant environment. This is not to say workers dislike a nice work setting. They simply like *both* a pleasant workplace and income, so they willingly make tradeoffs between amenities and income. In equilibrium, the monetary sacrifice workers are willing to make for additional amenities just equals firms' costs of providing additional amenities.

The hedonic wage function balances the supply and demand for labor along the entire job attribute spectrum. The equilibrium wage function here must satisfy the following condition (Rosen, 1974):

$$L(\alpha)\left|\frac{d\alpha}{dz}\right|dz = N(\mu)F(\mu)\left|\frac{d\mu}{dz}\right|dz, \tag{1.7}$$

where $L(\cdot) \equiv$ the density function of workers with respect to α, with $\alpha_{\min} \leq \alpha \leq \alpha_{\max}$,

$N(\cdot) \equiv$ the demand for labor by an individual firm, and
$F(\cdot) \equiv$ the density function of firms with respect to μ, with $\mu_{\min} \leq \mu \leq \mu_{\max}$.

The differentials $d\alpha/dz$ and $d\mu/dz$ depict the sorting of workers and firms into levels of z, which is the mapping of acceptance and offer wage functions along the market wage function in Figure 1.3. The left-hand side of Equation (1.7) represents the number of workers supplying labor to firms with a given level of safety while the right-hand side of Equation (1.7) represents the demand for workers. Because labor supplied and demanded must be identical in equilibrium we can use Equation (1.7) to describe the equilibrium sorting of workers by job attribute. By totally differentiating the first-order conditions for the maximization of profit with respect to μ (treating it as an endogenous variable) we can develop an expression for the equilibrium sorting of firm characteristics by job attribute (see Equations (1.2)–(1.4)). We can then determine the increase in wages necessary for workers to accept a given job attribute (dw/dz) using the first-order conditions for utility maximization (see Equation (1.6)). A system of three simultaneous first-order differential equations completely describing hedonic equilibrium in the labor market is:

$$\frac{d\alpha}{dz} = A'(z, \alpha, \mu, w, M'), \tag{1.8}$$

$$\frac{d\mu}{dz} = M'(z, \alpha, \mu, w, A', W'), \quad \text{and} \tag{1.9}$$

$$\frac{dw}{dz} = W'(z, \alpha, w). \tag{1.10}$$

In hedonic equilibrium the first-order conditions for utility and profit maximization are satisfied, and the labor market is in equilibrium at all levels of job attributes. The three differential Equations (1.8), (1.9), and (1.10) determine the relationship between worker characteristics and z, between firm characteristics and z, and the hedonic wage function. Boundary conditions determine the minimum μ and the maximum z observed in the labor market as well as establish equilibrium at the two endpoints of the attribute spectrum.

1.4 Segmented Labor Markets

Not everyone in the labor market may face the same hedonic wage function. The hedonic wage function can differ across groups because of discrimination or because of observable differences in productivity. In a notable study, Viscusi and Hersch (2001) examine the wage–workplace risk functions facing smokers and nonsmokers. Smoking is dangerous, so one would expect the greater risk tolerance of smokers (flatter acceptance wage functions) would cause them to locate further to the right along the hedonic wage locus. In Figure 1.4 smokers would locate at job risk π_2 and nonsmokers at job risk π_1. If smokers and nonsmokers face the same hedonic wage function then smokers who bear more workplace risk earn a higher premium for risk than nonsmokers.

If smokers earn a smaller risk premium for bearing more risk than nonsmokers then they must face a lower, flatter hedonic wage function than nonsmokers such as the one labeled smokers in Figure 1.4. Examining the size of risk premiums for different groups provides a strong test of a segmented labor market. As shown in Figure 1.4 the risk premium for nonsmokers, $w^n(\pi_1) - w^n(0)$, where $w^n(0)$ is the wage rate with zero job risk, exceeds the risk premium of smokers, $w^s(\pi_2) - w^s(0)$. Such a segmented labor market can occur if employers are able to identify groups of workers who are less efficient at producing the job characteristic in question. Besides more workplace injuries, smokers have more accidents at home than nonsmokers, implying a lower ability to produce safety, which makes it desirable for employers to offer them a smaller wage gain for accepting more risk. Viscusi and Hersch find that smokers earn a smaller risk premium than nonsmokers although their risk of injury is higher, demonstrating that they face a hedonic wage function that is lower and flatter than the one facing nonsmokers, such as in Figure 1.4.

Other studies also find evidence of segmented labor markets. Blacks face a lower, flatter hedonic wage function for workplace fatalities than whites (Viscusi, 2003) and Mexican immigrants to the United States face a lower, flatter hedonic wage function for workplace fatalities than U.S. natives (Viscusi and Hersch, 2010).

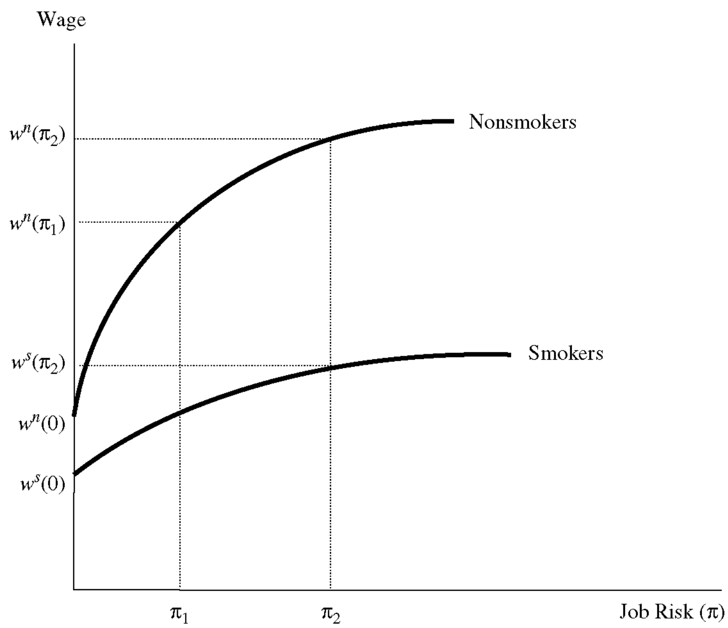

Fig. 1.4 Hedonic wage functions for smokers and nonsmokers.

1.5 Desirable Job Attributes

Our discussion to now has described the situation where workers face a disagreeable job characteristic such as poor fringe benefits; an increased danger of an injury or illness; an extremely noisy, hot, dusty, or otherwise unpleasant workplace; more frequent spells of unemployment; or overly rigid work hours. If worker utility falls with higher levels of the attribute in question and costs rise when firms attempt to eliminate the attribute, then the hedonic wage function will be upward sloping as in Figure 1.3. On the other hand, if workers get utility from the attribute ($\partial U/\partial z > 0$), and costs rise as firms provide the attribute, as would be the case with fringe benefits, then the hedonic wage function would slope downward. Defining z as a positive job attribute does not alter the underlying thought process of hedonic equilibrium, although it does alter the final conclusion concerning the sign of the relationship between wages and the attribute. However, any negative job attribute can be redefined as a positive attribute and vice versa;

instead of workplace safety, workplace danger; instead of pleasant working conditions, unpleasant working conditions; and instead of flexible work hours, inflexible work hours. In some cases it is more natural to think of the job attribute as a negative condition of employment and in other cases as a positive condition of employment. When the attribute is framed as a positive condition, a job amenity, wages fall as the amount of the attribute rises. Workers sacrifice wage income for the desirable job characteristic, and the lower wage costs compensate firms for the higher costs of providing the job characteristic.

References

Abowd, J. and D. Card (1989), 'On the covariance structure of earnings and hours changes'. *Econometrica* **57**, 411–445.

Aldy, J. E. and W. K. Viscusi (2008), 'Adjusting the value of a statistical life for age and cohort effects'. *Review of Economics and Statistics* **90**, 573–581.

Arellano, M. and S. Bond (1991), 'Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations'. *Review of Economic Studies* **58**, 277–297.

Ashenfelter, O. (2006), 'Measuring the value of a statistical life: Problems and prospects'. *Economic Journal* **116**, C10–C23.

Ashenfelter, O. and M. Greenstone (2004), 'Estimating the value of a statistical life: The importance of omitted variables and publication bias'. *American Economic Association Papers and Proceedings* **94**, 454–460.

Black, D. A. and T. J. Kniesner (2003), 'On the measurement of job risk in hedonic wage models'. *Journal of Risk and Uncertainty* **27**, 205–220.

Borjas, G. (2010), *Labor Economics,* Fifth Edition. New York, NY: McGraw-Hill/Irwin.

Breyer, S. (1993), *Breaking the Vicious Circle: Toward Effective Risk Regulation*. Cambridge, MA: Harvard University Press.

Brown, J. N. and H. S. Rosen (1982), 'On the estimation of structural hedonic price models'. *Econometrica* **50**, 765–768.

Chetty, R. (2006), 'A new method of estimating risk aversion'. *The American Economic Review* **96**, 1821–1834.

Dorsey, S. and N. Walzer (1983), 'Workers' compensation, job hazards, and wages'. *Industrial and Labor Relations Review* **36**, 642–654.

Eeckhoudt, L. R. and J. K. Hammitt (2001), 'Background risks and the value of a statistical life'. *Journal of Risk and Uncertainty* **23**, 261–279.

Ehrenberg, R. G. and R. S. Smith (2009), *Modern, Labor Economics, Theory and Public Policy,* Tenth Edition. Boston, MA: Pearson Education, Inc.

Ekeland, I., J. J. Heckman, and L. Nesheim (2004), 'Identification and estimation of hedonic models'. *Journal of Political Economy* **112**, S60–S109.

Epple, D. (1987), 'Hedonic prices and implicit markets: Estimating supply and demand functions for differentiated products'. *Journal of Political Economy* **95**, 59–80.

Evans, M. F. and V. K. Smith (2010), 'Measuring how risk tradeoffs adjust with income'. *Journal of Risk and Uncertainty* **40**, 33–55.

Frank, R. H. and C. R. Sunstein (2001), 'Cost-Benefit analysis and relative position'. *University of Chicago Law Review* **68**, 323–374.

Graham, J. D. (2008), 'Saving lives through administrative law and economics'. *University of Pennsylvania Law Review* **157**, 395–540.

Greene, W. H. (2008), *Econometric Analysis*. Upper Saddle River, NJ: Prentice Hall, fifth edition.

Griliches, Z. and J. A. Hausman (1986), 'Errors in variables in panel data'. *Journal of Econometrics* **31**, 93–118.

Hahn, J., J. Hausman, and G. Kuersteiner (2007), 'Long-difference instrumental variables estimation for dynamic panel models with fixed effects'. *Journal of Econometrics* **140**, 574–617.

Harris, J. E. (1979), 'Pricing rules for hospitals'. *The Bell Journal of Economics* **10**, 224–243.

Hwang, H., W. R. Reed, and C. Hubbard (1992), 'Compensating wage differentials and unobserved productivity'. *Journal of Political Economy* **100**, 835–858.

Johansson, P. O. (2002a), 'On the definition and age-dependency of the value of a statistical life'. *Journal of Risk and Uncertainty* **25**, 251–263.

Johansson, P. O. (2002b), 'The value of a statistical life: Theoretical and empirical evidence'. *Applied Health Economics and Health Policy* **1**, 33–41.

Johnson, W. and H. S. Wai (1980), 'Entitlement to disability benefits from more than one public program'. Syracuse University Health Studies Program, Discussion Paper, March.

Kahn, S. and K. Lang (1988), 'Efficient estimation of structural hedonic systems'. *International Economic Review* **29**, 157–166.

Kaplow, L. (2005), 'The value of a statistical life and the coefficient of relative risk aversion'. *Journal of Risk and Uncertainty* **31**, 23–34.

Kniesner, T. J. and J. D. Leeth (1988), 'Simulating hedonic labor market models: Computational issues and policy applications'. *International Economic Review* **29**, 755–789.

Kniesner, T. J. and J. D. Leeth (1989a), 'Can we make OSHA and workers' compensation insurance interact more effectively in promoting workplace safety: A numerical simulation analysis of hedonic labor market equilibrium'. *Research in Labor Economics* **10**, 1–51.

Kniesner, T. J. and J. D. Leeth (1989b), 'Separating the reporting effects from the injury rate effects of workers' compensation insurance: A hedonic simulation'. *Industrial and Labor Relations Review* **42**, 280–293.

Kniesner, T. J. and J. D. Leeth (1995a), 'Numerical simulation as a complement to econometric research on workplace safety'. *Journal of Risk and Uncertainty* **12**, 99–125.

Kniesner, T. J. and J. D. Leeth (1995b), *Simulating Workplace Safety Policy*. Norwell, MA: Kluwer Academic Publishers.

Kniesner, T. J. and W. K. Viscusi (2003), 'Why relative economic position does not matter: A cost-benefit analysis'. *Yale Journal on Regulation* **20**, 1–24.

Kniesner, T. J. and W. K. Viscusi (2005), 'Value of a statistical life: Relative position vs. relative age'. *American Economic Review: Papers and Proceedings of the American Economic Association* **95**, 142–146.

Kniesner, T. J., W. K. Viscusi, C. Woock, and J. P. Ziliak (2010a), 'The value of a statistical life: Evidence from panel data'. Working Paper, Syracuse University, Center for Policy Research, Number 122.

Kniesner, T. J., W. K. Viscusi, and J. P. Ziliak (2006), 'Life-cycle consumption and the age-adjusted value of life'. *Contributions to Economic Analysis and Policy* **5**. http://www.bepress.com/bejeap/contributions/vol5/iss1/art4.

Kniesner, T. J., W. K. Viscusi, and J. P. Ziliak (2010b), 'Policy relevant heterogeneity in the value of statistical life: New evidence from panel data quantile regressions'. *Journal of Risk and Uncertainty* **40**, 15–31.

Kniesner, T. J. and J. P. Ziliak (2002), 'Tax reform and automatic stabilization'. *The American Economic Review* **92**, 590–612.

Koenker, R. (2004), 'Quantile regression for longitudinal data'. *Journal of Multivariate Analysis* **91**, 74–89.

Lamarche, C. (2010), 'Robust penalized quantile regression estimation for panel data'. *Journal of Econometrics* **157**, 396–408.

Leeth, J. D. and J. Ruser (2003), 'Compensating wage differentials for fatal and nonfatal injury risk by gender and race'. *Journal of Risk and Uncertainty* **27**, 257–277.

Leigh, J. P. and R. N. Folsom (1984), 'Estimates of the value of accident avoidance at the job depend on the concavity of the equalizing differences curve'. *Quarterly Review of Economics and Business* **24**, 55–66.

Lillard, L. and Y. Weiss (1979), 'Components of variation in panel earnings data: American scientists'. *Econometrica* **47**, 437–454.

MaCurdy, T. (2007), 'A practitioner's approach to estimating intertemporal relationships using longitudinal data: Lessons from applications in wage dynamics'. In: J. Heckman and E. Leamer (eds.): *Handbook of Econometrics*, vol. 6A. Amsterdam: Elsevier B.V., pp. 4057–4167.

Moffitt, R. A. (2001), 'Policy interventions, low-level equilibria, and social interactions'. In: S. H. Durlauf and H. P. Young (eds.): *Social Dynamics*. Washington, DC: Brookings Institution Press, pp. 45–82.

Moore, M. and W. K. Viscusi (1990), *Compensation Mechanisms for Job Risks*. Princeton, NJ: Princeton University Press.

Olson, C. A. (1981), 'An analysis of wage differentials received by workers on dangerous jobs'. *The Journal of Human Resources* **16**, 167–185.

Rosen, S. (1974), 'Hedonic prices and implicit markets: Product differentiation in pure competition'. *Journal of Political Economy* **82**, 34–55.

Ruser, J. and R. Butler (forthcoming), 'The economics of occupational safety and health'. *Foundations and Trends in Microeconomics* (http://www.nowpublishers.com/mic).

Ruser, J. W. and R. S. Smith (1991), 'Reestimating OSHA's effects — Have the data changed?'. *Journal of Human Resources* **26**, 212–235.

Shepard, D. S. and R. J. Zeckhauser (1984), 'Survival versus consumption'. *Management Science* **30**, 423–439.

Shogren, J. F. and T. Stamland (2002), 'Skill and the value of life'. *Journal of Political Economy* **110**, 1168–1173.

Shoven, J. B. and J. Whalley (1992), *Applying General Equilibrium*. New York: Cambridge University Press.

Sojourner, A. (2010), 'Partial identification of willingness-to-pay using shape restrictions with an application to the value of a statistical life'. Industrial Relations Center, University of Minnesota (Twin Cities Campus), Working Paper 0110.

Solon, G. (1986), 'Bias in longitudinal estimation of wage gaps'. National Bureau of Economic Research, Technical Working Paper 58.

Solon, G. (1989), 'The value of panel data in economic research'. In: D. Kasprzyk, G. Duncan, G. Kolton, and M. P. Singh (eds.): *Panel Surveys*. New York: John Wiley and Sons, pp. 486–496.

Spengler, H. and S. Schaffner (2006), 'Using job changes to evaluate the bias of the value of a statistical life'. Unpublished paper, Darmstadt University of Technology, March.

Sunstein, C. R. (2004), 'Are poor people worth less than rich people? Disaggregating the value of statistical lives'. AEI-Brookings Joint

Center for Regulatory Studies (Washington, DC), Working Paper No. 04-05, January.

U.S. Department of Transportation, Office of the Assistant Secretary for Transportation Policy (2005). Revised Departmental Guidance: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses. Washington, DC.

U.S. Office of Management and Budget (2003). OMB CIRCULAR A-4, Regulatory Analysis (Rep. No. A-4). Washington, DC.

Viscusi, W. K. (1979), *Employment Hazards: An Investigation of Market Performance*. Cambridge: Harvard University Press.

Viscusi, W. K. (1981), 'Occupational safety and health regulation: Its impact and policy alternatives'. In: J. P. Crecine (ed.): *Research in Public Policy Analysis and Management*, vol. 2. Greenwich, CT: JAI Press, pp. 281–299.

Viscusi, W. K. (1993), 'The value of risks to life and health'. *Journal of Economic Literature* **31**, 1912–1946.

Viscusi, W. K. (2003), 'Racial differences in labor market values of a statistical life'. *Journal of Risk and Uncertainty* **27**, 239–256.

Viscusi, W. K. (2004), 'The value of life: estimates with risks by occupation and industry'. *Economic Inquiry* **42**, 29–48.

Viscusi, W. K. (2009), 'The devaluation of life'. *Regulation and Governance* **3**, 103–127.

Viscusi, W. K. and J. Aldy (2003), 'The value of a statistical life: A critical review of market estimates throughout the world'. *Journal of Risk and Uncertainty* **27**, 5–76.

Viscusi, W. K. and W. Evans (1990), 'Utility functions that depend on health status: Estimates and economic implications'. *American Economic Review* **80**, 353–374.

Viscusi, W. K. and J. Hersch (2001), 'Cigarette smokers as job risk takers'. *Review of Economics and Statistics* **83**, 269–280.

Viscusi, W. K. and J. Hersch (2010), 'Immigrant status and the value of statistical life'. *Journal of Human Resources* **45**, 749–771.

Weiss, Y. and L. A. Lillard (1978), 'Experience, vintage, and time effects in the growth of earnings: American scientists, 1960–1970'. *Journal of Political Economy* **86**, 427–447.

Woittiez, I. and A. Kapteyn (1998), 'Social interactions and habit formation in a model of female labour supply'. *Journal of Public Economics* **70**, 185–205.

Wooldridge, J. M. (2002), *Econometric Analysis of Cross-Section and Panel Data*. Cambridge, MA: The MIT Press.

Ziliak, J. P. (1998), 'Does the choice of consumption measure matter? An application to the permanent-income hypothesis'. *Journal of Monetary Economics* **41**, 201–216.