The Rising Price of Non-Market Goods

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Non-market goods such as unpaid household labor, leisure, health and longevity, and the environment are important components of the standard of living. They represent a large fraction of all activities. Prime-aged men and women spend 17 percent of their day in leisure activities, and 5 and 13 percent of their time, respectively, in unpaid housework compared to 23 and 13 percent of their time, respectively, in paid work.[1] The quantity of non-market goods is rising over time. In the United States life expectancy at birth is now 77 years, having risen by 29 years since 1900. In Los Angeles County between 1980 and 1998, average annual daily exceedences of the national smog standard declined by 60 days from 71 to 11. Falling big city murder rates merit national news headlines.

Studies of living standards have focused on the tremendous change in the quantity of non-market goods, but have assumed that the value of non-market goods, except for unpaid labor, has remained constant. This assumption underlies most health studies (e.g. William T. Nordhaus 2002; Kevin M. Murphy and Robert H. Topel 2002; and David M. Cutler and Elizabeth Richardson 1997). Nordhaus (2002) valued declines in mortality since 1900 using a constant value of life. Even the Boskin CPI Commission (Michael J. Boskin et al. 1998) discussed trends in the quantity of non-market goods (i.e pollution and crime progress) without mentioning incorporating such goods' implicit prices into a broader CPI measure.

But, there is no reason to think that implicit prices or the willingness to pay for non-market goods has remained constant. Rising real and shadow wages have made both leisure and unpaid household labor more expensive. Rising incomes have also made such normal goods as safety, health, a temperate climate and the environment more valuable.

We document the price dynamics of non-market goods by estimating repeat cross-sectional hedonic regressions. We focus on two important and measurable non-market goods – job fatality risk and climate. In both cases we find that both price and quantity have been rising. This evidence is consistent with rising valuation.

We use our estimates of job risk compensating differentials to construct new evidence on long-run trends in value of life. Accounting for price changes affects how we view the retrospective and prospective benefits of medical innovations. A rising value of life implies that marginal improvements in safety and in longevity are becoming more valuable. We report evidence that the price of living in a temperate winter and summer climate has significantly increased over time.

I. Changes in the Value of Life

On theoretical grounds we would expect that the value of life has increased. The value of life can be expressed as the marginal rate of substitution between wealth and the probability of survival. Unless people pay to increase risk, as wealth increases so does the value of life (Sherwin Rosen 1988). For a working person, as the wage increases so does the value of life. Changes in survival probabilities from disease or changes in retirement life styles will also affect the value of life. If expected utility at older ages rises because of increases in survival probabilities, improvements in health at older ages, or the rise of retirement as a time to enjoy the good life, then the young will need more compensation to take a risky gamble. Theory, however, cannot tell us the expected magnitude of increases in the value of life.

We estimate value of life from measured labor market compensating differentials for risk taking using the 1940-1980 censuses and fatality data from the Bureau of Labor Statistics. These years provide us with consistent data series, and more importantly, shed light on a period that experienced unprecedented declines in fatality rates.[2] We present the first nationwide value of life estimates for the United States at more than one point in time. Most researchers measuring the value of life have generally focused on the 1970s onwards (see W. Kip Viscusi (1993) for a review).

The results that we present for each year are from a simple hedonic wage regression of the form,

$$wage_{ij} = bX_{ij} + gf_j + u_{ij} \qquad (1)$$

where i indexes the individual, j indexes the industry, the dependent variable is the hourly wage, f is the industry fatality risk, and the vector X consists of age, dummies indicating race, foreign birth, marital status, education, blue collar status, and residence in a metropolitan area, and state fixed effects. We estimated these regressions for full-time male workers ages 18-30 with some high school education (see Dora L. Costa and Matthew E. Kahn (2002) for these regression estimates and additional specifications and stratifications). We restricted the sample to men because we do not have fatality rates for women by industry. We restricted to younger ages because the young are more likely to be in the riskier jobs within an industry.

Cross-sectional hedonic wage regressions will recover the value of life provided that labor markets are perfectly competitive, workers are informed about actual industry risk levels, observables control for differences in productivity, and all workers have the same preferences over money and risk. In practice, our cross-sectional estimates of the life of value will be biased because of differential tastes for risk, unobserved job skills, and unobserved ability to self-protect against risk. Because we observe those with the lowest value of life in risky jobs, we will underestimate willingness to pay for safety. If workers are heterogeneous in their abilities and if the econometrician only partially observes productivity and if not all compensation is taken in the form of wages, then we will underestimate the value of life in any given year (Hae-Shin Hwang, Robert W. Reed, and Carlton Hubbard 1992). [3] As discussed in Costa and Kahn (2002), our estimated change in the value of life between 1940 and 1980 is likely to be a lower bound estimate of changes in the value of life. Our estimates of implicit prices rising at the same time as quantities of safety are increasing is consistent with the hypothesis that willingness to pay for a reduction in job fatality risk has grown over the years.[4]

Our estimates of equation (1) show that between 1940 and 1980 value of life rose more than five-fold (see Table 1). Our value of life estimate for 1980 of 7.4 million in 2002 dollars is within the range of 3.6 to 8.3 million in 2002 dollars found by Viscusi (1993) using data for the 1980s. We regress our estimates of value of life on per-capita GNP and obtain an income elasticity of 1.7. We then predict the value of life in 1900, 1920 and 2000 (see Table 1) and find that the value of life rose more than 28-fold over the entire twentieth century.[5]

The rising value of life suggests that evaluations of the benefits of mortality reductions or health improvements over the entire twentieth century underestimate the value of current improvements in health or mortality relative to the dramatic improvements of the past. Table 2 illustrates. The largest age-adjusted mortality declines occurred prior to 1960. Using the 1980 value of life, we would conclude that the biggest gains were prior to 1960 when the biggest change in quantities occurred.[6] If we assumed that the income elasticity of value of life was equal to one and used the ratio of 1980 value of life to 1980 GNP to calculate value of life, we would conclude that the value of mortality declines in 1980-2000 was slightly less than that in 1940-1960. But, if we allow for our estimated changes in price, the largest gain occurred after 1960 when mortality increases were relatively marginal. Under all three scenarios, per capita national health care expenditures are rising faster than the value of mortality declines, but when we do not accurately allow for changes in the value of life, our health care sector seems much less productive.

Our findings also have implications for prospective evaluations. Government agencies such as the Environmental Protection Agency treat the value of life as a constant for cost-benefit analysis. But, for investments where the benefits accrue for several decades using current value of life estimates will underestimate the economic gains.

II. Changes in the Value of Climate

Climate is a spatially-tied non-market good. The supply of land with a temperate climate does not change over time. Climate is consistently measured across cities and over time. This minimizes the measurement issues that inhibit measuring long-run trends in the quantity and implicit pricing of local school quality, crime, or pollution.

Building on the quality of life literature, we estimate how the hedonic implicit price of climate has evolved from 1970 to 1999, using data from 1970, 1980, 1990, and 1999 for home prices and for wages in 1970, 1980, and 1990.[7] For every year our regressions are of the form,

$$house_{ij} = bX_i + gZ_j + u_{ij}$$

$$wage_{ij} = fV_{ij} + dZ_j + e_{ij}$$

where i indexes the housing unit or the individual, j indicates the metropolitan area, the dependent variables are the level of home prices multiplied by 7.5% (to impute an annual rental price for owners) and the level of the hourly wage, X is a vector of housing characteristics, V is a vector of worker characteristics, Z is a vector of climate controls (annual average January and July temperature, and annual average rainfall by metropolitan area, obtained from the National Oceanic Administration ftp://ftp.ncdc.noaa.gov/pub/data/ccd-data/), and u and e are error terms.[8] The results that we present are from a median censored regression (James Powell 1984) in which standard errors are clustered by metropolitan area.[9] The wage regression results are based on a sample of full time working men age 20-60.

Our climate price dynamics results are presented in Tables 3 and 4. Across all years warmer January temperatures significantly increase housing prices and warmer July temperature and higher rainfall lower them. Between 1970 and 1990 the “price'' of owning a home in a place with warm January temperatures, cool July temperatures, and less rainfall rose.[10] Unlike the home price regressions, the capitalization of climate into men’s wages has not changed much between 1970 and 1990. In both decades, an extra degree of July temperature reduces hourly wages by 10 cents. Given the rise in two earner “power couples” over the last 30 years, such couples are paying a higher climate price for southern locations (that feature high July temperatures) than retired couples.

Between 1970 and 1999, the average person increased his exposure to January and July temperature by 2.6 and 0.7 degrees respectively. Given the change in prices between 1970 and 1990, the average person has not substantially increased his climate expenditure. But, this average masks a large price increase for migrants to warm winter, temperate summer climates (such as those offered in most of California). In 1970, a person would have to pay an extra $1,288 (1990 dollars) in higher annual imputed rent to purchase San Francisco's climate over Chicago's climate. In 1990, this price differential increased by $6,259 (1990 dollars) to $7,547.

III. Conclusion

A National Academy of Sciences panel is currently investigating the incorporation of non-market goods into satellite accounts to the National Income and Product Accounts. Hedonic approaches are being widely used by statistical agencies for quality adjustments to market goods. These approaches, as well as discrete choice models, can also be fruitfully applied to measuring price and valuation dynamics of non-market goods.

We have estimated repeat hedonic regressions and found that the implicit price of job safety and climate has increased over time. A higher value of life implies that the value of mortality declines and therefore of medical innovations and of safety improvements has increased, even though mortality gains have been relatively small. Our repeat hedonic climate estimates show that the cost of purchasing temperate climate is rising over time. We conjecture that the price of other non-market goods has increased as well. A higher value of life implies that the cost of crime has risen. Rising climate valuation may increase the demand for complements such as clean air.

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Table 1: The Value of Life in 2002 Dollars. 1900-2000

Year	Value of Life	
1900	$427,000	(predicted)
1920	895,000	(predicted)
1940	1,377,000	
1950	2,426,000	
1960	2,884,000	
1970	5,176,000	
1980	7,393,000	
2000	12,053,000	(predicted)

Note: Values of life for 1940-1980 are from Costa and Kahn (2002) and are estimated from hedonic wage regressions. Values of life for 1900, 1920, and 2000 are predicted from a regression of the log of value of life on per capita GNP.

Table 2: The Value of Mortality Declines by Period in 2002 Dollars, 1900-2000

	1900-1920	1920-1940	1940-1960	1960-1980	1980-2000
Age-adjusted mortality decline per year per million persons	3,709	3,621	4,458	3,001	1,671
Value of annual mortality declines, per person:					
Using 1980 value of life	$27,421	26,770	32,958	22,186	12,346
Using 1980 value of life and income elasticity equal to one	$6,647	$8,905	$14,916	$18,303	$14,872
Using average value of life in each period	$2,452	4,113	9,500	15,422	16,247
Increase in annual per capita national health care expenditures		$141	511	1,447	2,526

Sources: Age-adjusted death rates are standardized using year 2000 standard population and are from series Hist 293, CDC/NCHS. Value of life estimates are from Table 1 in this paper. When we assumed an income elasticity equal to one we used the ratio of 1980 value of life to 1980 GNP to estimate value of life in each year. Each life was valued at the dollar value, without regard to age at death. Per capita national health care expenditures are from Series B 221-235 (U.S. Bureau of the Census 1975: 73) and from U.S. Centers for Medicare and Medicaid Services, Health Accounts. Per capita expenditures are only available beginning in 1929. The annual increase between 1920 and 1929 was interpolated based upon 1929-1940 trends.

Table 3: Trends in Climate Pricing Based on Repeat Hedonic House Price Regressions

	1970	1980	1990	1999
July temperature	-108.850	-195.560	-407.990	-309.305
	(16.119)	(27.480)	(64.918)	(62.579)
January temperature	8.132	71.529	136.690	67.129
	(7.644)	(14.588)	(23.994)	(20.291)
Annual rainfall	-9.451	-60.149	-58.859	-43.596
	(8.279)	(8.658)	(18.005)	(22.672)
Pseudo R^2	0.25	0.244	0.185	0.177
Observations	43,173	42,019	49,506	14,212

Note: Results are from a censored median regression (Powell 1984). The dependent variable is the level of annualized home prices in 1990 dollars. Standard errors clustered on the metropolitan area are in parentheses. The samples, from the censuses in 1970-1990 and the American Housing Survey in 1999, were restricted to owners. Additional covariates include the age of the unit, the number of rooms, and a dummy variable indicating whether the unit is a single detached home.

Table 4: Trends in Climate Pricing Based on Repeat Hedonic Hourly Wage Regressions

	1970	1980	1990
July temperature	-0.104	-0.087	-0.106
	(0.019)	(0.020)	(0.022)
January temperature	-0.019	-0.029	-0.009
	(0.011)	(0.013)	(0.008)
Annual rainfall	-0.018	-0.015	-0.007
	(0.012)	(0.009)	(0.008)
Pseudo R^2	0.115	0.105	0.130
Observations	50,000	50,000	50,000

Note: Results are from a censored median regression (Powell 1984). The dependent variable is the level of men's hourly wages in 1990 dollars. 50,000 observations were randomly drawn from each census. The samples were restricted to full-time working men ages 25-60. The top and bottom one percent of wages were trimmed. Standard errors clustered on the metropolitan area are in parentheses. Additional covariates include age, age squared, and dummy variables indicating educational level (less than high school, high school, and college) and non-white.

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[1] Estimated from Americans' Use of Time, 1985. The sample was restricted to ages 25 to 54.

[2] We do not use the 1990 census to estimate the value of life because we could not obtain comparable fatality rates.

[3] Jason F. Shogren and Tommy Stamland (2002) argue that once one accounts for both risk preference and the personal ability to reduce risk of death or injury, then value of life estimates are biased upwards.

[4] We recognize that discrete choice methods, such as those presented in Steven Berry, James Levinsohn and Ariel Pakes (1995), could be used to directly estimate whether marginal valuations for safety and climate have increased over time. A discrete choice study of industry choice would face at least two challenges. Because there are 48 states (which differ with respect to their workers compensation insurance schedules) and over 100 industries, the dimensionality of this problem would be cumbersome. In addition, a discrete choice model of industry choice would face the extra challenge of instrumenting for wages. The industry wage will be an explanatory variable in such a discrete choice model. It is likely to be correlated with unobserved industry attributes captured in the error term. In a hedonic model, industry wage is a dependent variable and OLS will yield consistent implicit price estimates if the industry risk level is uncorrelated with the error term (see equation 1).

[5] Our predicted value of life estimate of 0.9 million 2002 dollars in 1920 is within Price Fishback's (1992) estimated range of 0.3-0.11 million for coal mining in the United States.

[6] We are following the strategy used by Nordhaus (2002) who, like most researchers, used a value of life derived from 1970s and 1980s data on compensating wage differentials for job risk. He found that the biggest growth in living standards occurred in the first half of the twentieth century, when most of the mortality improvements took place.

[7] See Jennifer Roback (1982), Glenn C. Blomquist, Mark C. Berger, and John P. Hoehn (1988), Joseph Gyourko and Joseph Tracy (1991), and Michael I. Cragg and Matthew E. Kahn (1999).

[8] In these hedonic results we simply include the climate variables as measures of metropolitan area non-market goods. We are assuming that other non-market goods such as crime and pollution are uncorrelated with climate. We have chosen to estimate parsimonious hedonic models because of the difficulty of collecting pollution and crime data by city/year. In addition, it is important to note that the public use Census data simply indicates what metropolitan area a person lives and for a subset of MSAs indicates whether the household lives in the center city or suburbs. Studies such as Roback (1982) that have included additional non-market goods such as crime and pollution into hedonic wage and home price regressions face a measurement error challenge. Within metropolitan area variation in community level crime may be much larger than cross-metropolitan area variation in average crime. Within a metropolitan area, the population Tiebout sorts into communities. Thus, the average crime level in a MSA is a noisy proxy for the crime level of the community the household actually chooses. Unlike crime or air pollution, within metropolitan area variation in climate exposure is likely to be quite small.

[9] Census home price data are top coded and the top codes differ across census years. Concerned that our Census housing specifications have relatively few structural characteristics, we have

used the 1999 American Housing Survey to examine whether our climate price estimates are robust to controlling for additional structure attributes. We find that our results are quite robust to changing specifications.

[10] The 1999 AHS results suggest that climate prices fell between 1990 and 1999. We present these results to show that climate capitalization is reflected in independent data sets. Here we focus on the 1970 to 1990 trend based on IPUMS census data because we have consistent data for these years.