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Analysis of Rural Quality of Life and Health: A Spatial Approach

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This article examines the relationship between quality of life, health, and several socioeconomic variables. It draws on survey data from a random sample of more than 2,000 residents in 21 counties in West Virginia and spatial data generated by geocoding survey respondents' addresses and hospital locations. The empirical results are consistent with the theoretical predictions and indicate, for instance, that quality-of-life satisfaction increases with income and education but decreases with unemployment. Also, the results support the notion that inferences drawn regarding substantive issues often change when spatial dependence is taken into account.

Keywords: *quality of life; health; rural development; spatial dependence*

In recent years, the notion of quality of life (QOL) has attracted much attention (Clark & Oswald, 1994; Deller, Tsung-Hsiu, Marcouiller, & English, 2001; Dissart & Deller, 2000; Easterly, 1999; Hall & Jones, 1997, 1998; Heubusch, 1998; Reichert & Rudzitis, 1992). As a concept, QOL can mean different things to different people, encompassing such notions as "well-being," centered on the individual, to "good place," centered on the location (Dissart & Deller, 2000). Recent QOL studies have evaluated the term within local jurisdictions and among nations (Gerdtham & Johannesson, 1997; Mencken, 1998; Sousa-Poza & Sousa-Poza, 2000). Despite the burgeoning literature, however, there is little unanimity on the subject. To encapsulate its full meaning, it is not sufficient to consider only the process of, provision of, and access to a better environment and better facilities. Rather, QOL should also include a consumer-oriented perspective that is concerned with the manner of delivery of goods, services, or facilities; with the quality of the environment; and with the experience that arises from consuming goods and services. Considered from this perspective, QOL has a number of implications for planning.

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This article examines the relationship between QOL satisfaction and rural health across West Virginia counties. In pursuing this objective, the article contributes to the literature on QOL in two respects. On the theoretical side, it links QOL to rural health. On the empirical side, it introduces a measure of geographic space by testing for spatial dependence in QOL and health variables. Typically, the analysis is built on the notion that QOL of rural people and places depends on many

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things—availability of well-paying jobs; access to critical services, such as health care, education, and communication; strong communities; and a healthy natural environment. Although urban people and places are equally dependent on these things, the smaller size of rural communities poses challenges not usually present in urban areas.

In rural West Virginia, the relations and interactions of these challenges are complex in character, constantly changing, and often not well understood. Small-scale, low-density settlement patterns make it more difficult and costly for communities and businesses to provide critical services. The decline in jobs and incomes in the coal mining industry, on which many rural West Virginia communities depended, has forced rural people to find new ways to make a living. Although a few geographic areas in the state, especially the eastern panhandle counties, are currently enjoying relatively strong economic growth, most counties, especially rural mining counties in central and southern sections, are experiencing only slow economic growth at best. Thus, we attempt to examine the direct and indirect effects of several variables believed to influence individuals' satisfaction or dissatisfaction with life in rural West Virginia.

The remainder of this article is organized into five sections. First, we begin with a discussion of the theoretical approach motivated by Gerdtham and Johannesson (1997). Next, we present the ordered probit estimation approach, followed by measures and specification of the spatial approach. The last sections present a description of the data, a discussion of the empirical results, and our conclusions.

THEORETICAL APPROACH

Economic theory emphasizes the process by which individuals rationally allocate resources to meet their needs, thereby "producing" utility. Utility is derived according to

$$U_i = U_i(h_i, x_i, s_i), \tag{1}$$

where U_i represents utility or life satisfaction of individual i ($i = 1, \ldots, I$), h_i is the health status of individual i, $\boldsymbol{x}_i$ is a vector of private goods consumed, and $\mathbf{s}_i$ is a vector of socioeconomic variables that affect utility (Gerdtham & Johannesson, 1997). Utility is maximized subject to the following budget constraint:

$$Y_i = P_{xi} x_i + P_{mi} m_i, \tag{2}$$

where Y_i is the exogenously given income of individual i, P_{xi} is a vector of private goods prices faced by individual i, and P_{mi} is a vector of health goods prices faced by individual i.

The health variable (h_i) is produced according to the following health production function:

$$h_i = f(m_i, h_{0i}, s_i), \tag{3}$$

where m_i is a vector of health goods, such as medical care, and h_{0i} is the initial (given) health status. Following several steps of derivation, the following indirect utility or life satisfaction function (V_i) is obtained:

$$V_i = V_i[h_i(Y_i, P_{xi}, P_{mi}, h_{0i}, S_i)\ Y_i, P_{xi}, S_i]. \tag{4}$$

The exogenous variables (Y_i, P_{xi}, S_i) in Equation 4 may influence QOL either directly or indirectly through the intervening health variable. The first approach is to model the intervening health variable explicitly in the following equation system:

$$V_i = \beta_1 + \beta_2 Y_i + \beta_3 P_{xi} + \beta_4 h_i + \beta_5 S_i + \varepsilon_1 \tag{5}$$

$$h_i = \beta_6 + \beta_7 Y_i + \beta_8 P_{xi} + \beta_9 P_{mi} + \beta_{10} h_{0i} + \beta_{11} S_i + \varepsilon_2. \tag{6}$$

Alternatively, Equation 6 can be substituted for h_i in Equation 5 and the following reduced-form equation estimated:

$$V_i = \beta_{12} + \beta_{13}Y_i + \beta_{14}P_{xi} + \beta_{15}P_{mi} + \beta_{16}h_{0i} + \beta_{17}S_i + \varepsilon_3. \tag{7}$$

In these equations, β_1 through β_{17} represent coefficients to be estimated, and ε_1 through ε_3 are error terms assumed to have a zero mean and constant variance. It is also assumed that $\text{cov}(\varepsilon_1, \varepsilon_2) = 0$. The full structural approach of Equations 5 and 6 distinguishes between the indirect effects of the exogenous variables working through health and the direct effects of the exogenous variables after controlling for health. That is, the model identifies the process underlying the effects of the exogenous variables. The second approach, Equation 6, captures only the total (direct and indirect) effects of the exogenous variables in a reduced-form equation. In this article, both approaches are used to evaluate the direct and indirect effects of the variables.

EMPIRICAL SPECIFICATION

For relationships involving ordinal dependent variables, the appropriate estimation techniques are probit or logit models (Hanushek & Jackson, 1977). These techniques take the ceiling and floor effects into account and avoid the use of subjectively chosen scores assigned to the categories. An ordered probit model is used here because the dependent variables are ordered responses.

We assume linear dependence between the latent variable V_i^* and the variables X_i, β, and ε_i, respectively. Thus,

$$V_i^* = \beta X_i + \varepsilon_i,\ \varepsilon_i \sim N(0, \sigma^2). \tag{8}$$

The variable V_i^* defines a variable v_i related to the aforementioned categories in the following way:

$$V_i = \begin{cases} 0 \text{ if } V_i^* \leq \theta_0 \\ 1 \text{ if } \theta_0 < V_i^* \leq \theta_1 \\ 2 \text{ if } \theta_1 < V_i^* \end{cases} \tag{9}$$

where $\theta_i = 0, 1$ are unobservable thresholds. Denoting the cumulative density function of the standard normal distribution as $\Phi(\bullet)$, it follows that the probabilities of an individual for each category are given by

$$\text{Prob}[V_i = 0] = \Phi[\mu_0 - \alpha X] \tag{10}$$

$$\text{Prob}[V_i = 1] = \Phi[\mu_1 - \alpha X] - \Phi[\mu_0 - \alpha X] \tag{11}$$

$$\text{Prob}[V_i = 2] = 1 - \Phi[\mu_1 - \alpha X], \tag{12}$$

with $\alpha = \beta / \sigma$ and $\theta_j / \sigma = 0,1$. Note that only the ratios β / σ and θ_j / σ are estimable (Dustman, 1996).

To correct for specification error, a multiplicative heteroscedasticity-ordered probit model is used to estimate structural Equations 5 and 6 and the reduced-form Equation 7. Equations 5 and 6 are recursive (triangular) systems with a diagonal Σ matrix. That is, there is a unidirectional dependency between health and utility, and the disturbances across equations are assumed contemporaneously. The equations in the utility health system are thus estimated separately using the ordered probit model (Gerdtham & Johannesson, 1997; Greene, 1993, 1995).

SPATIAL APPROACH

Previous research (Killian & Tolbert, 1993; Mencken, 1998) shows that there is considerable work-related commuting across county borders. This supports the argument that the expansion and contraction of economic activity is impervious to politically constructed geographical borders (Anselin, 1988; Land & Deane, 1992). For instance, Mencken (1997) reported higher satisfaction levels of well-being in the southern Appalachian counties at the end of the 1980s. When he reanalyzed the data and corrected for spatial dependence,[1] some of his results changed (Mencken, 1998).

There is currently no formal method for estimating ordered probit or logit models with more than two choice outcomes for the case of spatially dependent data. Therefore, to address the issue of spatial dependence as it pertains to QOL survey data, we geocode the survey respondents' addresses and obtain the *x* and *y* coordinates. Using these coordinates, we calculate the distance from each observation (survey respondent) to all others and then extract the closest 10 nearest neighbors. The nearest neighbors are used to construct an *n* by *n* row standardized (i.e., row sums are unity) spatial weight matrix *W*. The matrix is then multiplied[2] times some of the explanatory variables to produce additional spatial explanatory variables used to test the spatial dependence hypothesis that inferences drawn regarding substantive issues often change when spatial dependence is taken into account.

Similarly, the issue of whether proximity to a hospital improves one's health, hence adding to QOL satisfaction, is examined using spatial data generated by geocoding hospital locations in each county. Economic theory suggests that some measure of utility exists, u^*, representing the net benefit (on QOL) of residing near a hospital, which is an unobservable variable. Let $W = 1$ if individual *i* resides close to a hospital and 0 otherwise, and let π be the probability that the individual needs hospital access due to illness. Then, the probability P_{HA}(close to a hospital when access is needed) $= \pi$ and $\text{var}[P_{HA}] = \pi(1 - \pi)$. Thus, individual utility or satisfaction is (presumably) lower the farther from the hospital the individual lives and the higher the subjective risk, π. Accordingly, we design a distance buffer around the hospitals, and households that fall within a 2-mile buffer zone are assigned an adjacency value of 1; all other households are assigned a value of 0, hence constructing the hospital variable used in the analysis.

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DATA

The data used are obtained from a QOL mail survey conducted in 2000.[3] The survey was sent to a random sample of 2,000 residents in 21 counties located in the southern and eastern panhandle regions in West Virginia (see Figure 1). The areas are representative samples of the poor and rich counties in the state. The two regions differ somewhat by their proximity to big metropolitan areas. The eastern panhandle region is close to Washington, D.C., but the southern region is relatively isolated.

The survey respondents were selected randomly using telephone numbers and were asked to respond to a categorical question: "Is your daily life a source of personal satisfaction?" The responses are rated on a 3-point scale (see Table 1). Following the same approach, the health variable is represented by a categorical question: "How would you describe your health status?" This type of categorical health measure (see Table 1) has been shown to capture important information about the individual's health (Connelly, Philbrick, Smith, Kaiser & Wymer, 1989) and to be an important predictor of mortality (Idler & Kasl, 1991; Kaplan & Camacho, 1983; Wannamethee & Shaper, 1991).

Last, we generated spatial data through geographical information systems—address geocoding[4]—whereas secondary data are drawn from the Bureau of Business and Economic Research (2000), the Regional Economic Information System (1999), and the Bureau of Economic Analysis (1999, 2000).

Figure 1: Map of West Virginia Showing the Two Regions Sampled

EMPIRICAL RESULTS

The empirical results suggest that the models explain a substantive amount of the variations in the dependent variables. The goodness-of-fit value (pseudo R^2) is 0.299 and 0.318 in the QOL and health structural equations, respectively, and 0.295 for the reduced-form QOL equation. It is imperative to note, however, that the pseudo R^2 as a measure of goodness of fit deserves only limited attention because it was chosen to maximize the joint density of the observed dependent variables rather than maximizing a criterion based on a prediction of y, as with R^2 in ordinary least squares regression analysis. To further examine the goodness of fit of the estimated ordered probit equations, frequencies of actual and predicted outcomes are reported in Table 2.

The results in Table 2 suggest that the two models perform similarly, with the structural equation correctly predicting 66% (683) of the outcomes and the reduced equation predicting 67% (684) of the 1,028 observations. The structural form equation predicts that 429 (observed = 383) of the total 1,028 respondents fall in the higher satisfaction category; the reduced-form equation predicts 477.

To control for heteroscedasticity in the data, the variance of the error terms is assumed to take the following form: $\text{Var}[\varepsilon_i] = [\exp(\gamma' z_i)]^2$. The variables included in Z_i are income and government expenditure. The estimates of the variance functions based on the specification suggest that income and government expenditure explain a significant portion of the variation in the disturbance across observations. The estimated effects of each independent variable on the dependent variable are discussed and summarized in Tables 3 and 4. To facilitate the interpretation of the results, the

TABLE 1
Summary of Variables

Dependent variables	
Categorical quality of life satisfaction assessment of personal satisfaction:	
0 = daily life is never a source of personal satisfaction	
1 = daily life is sometimes a source of personal satisfaction	
2 = daily life is a source of personal satisfaction most of the time	
Categorical Health Index assessment of own health on a 3-point scale:	
0 = poor health	
1 = fair health	
2 = good health	
Independent variables	
Male	1 = male
Race	1 = White
Age1	1 = age 18 to 34 years
Age2	1 = age 35 to 44 years
Age3	1 = age 45 to 64 years
Age4	1 = older than 64 years
Unemployment	1 = unemployed
Civil status	1 = not married or cohabiting
Health problems	1 = parents or siblings had any health problems
Education1	1 = did not graduate high school
Education2	1 = graduated high school
Education3	1 = attended college
Income1	1 = the gross annual income is in the first quartile of the income distribution (i.e., less than $20,000)
Income2	1 = the gross annual income is in the second quartile of the income distribution (i.e., $20,000 to $25,353)
Income3	1 = the gross annual income is in the third quartile of the income distribution (i.e., $25,354 to $34,075)
Income4	1 = the gross annual income is in the fourth quartile of the income distribution (i.e., greater than $34,076)
Religion	1 = religion is said to be a source of strength and comfort
Amenities	1 = there is a hospital or college in the county of residence
Health0	1 = the health status is rated as bad health in the categorical health question
Health1	1 = the health status is rated as fair in the categorical health question
Health2	1 = the health status is rated as good in the categorical health question
Local government	1 = the performance of the county government is rated as fair or good
Region	1 = the individual lives in a county in southern West Virginia
Government education expenditure	1 = government expenditure on education was above state's average in 1998
Duration	1 = lived in the county for more than 10 years
Neighborhood	1 = satisfied with the neighborhood as a place to live
Environment	1 = concerned with the quality of the environment in the county
Population	1 = county population was less than 20,000 in 1998
Hospital	1 =household falls within the designed distance buffer

predicted probabilities of being in the highest QOL satisfaction category for each level of the explanatory variable are reported in Table 5 at the mean level of all explanatory variables.

When we look at the effects of the demographic variables, age, civil status, and gender appear to influence both health and QOL satisfaction. First, the coefficient on the older population variable (AGE4) is negative and statistically significant in both equations. This implies that all things being equal, older individuals are more likely to be dissatisfied with life and to be in poor health than are individuals in the youngest age group (18 to 34 years). The observed impact of age on health is, of course, expected, but the negative effect of age on QOL satisfaction is not equally obvious. The explanation is probably to be found in the observation that the health status of individuals in the higher age group (AGE4) largely influences QOL satisfaction. When health status is assumed

TABLE 2
Frequencies of Actual and Predicted Outcomes for Ordered Probit Model

Structural Form Quality-of-Life Equation					*Reduced-Form Quality-of-Life Equation*				
	Predicted					*Predicted*			
Actual	0	1	2	Total	Actual	0	1	2	Total
0	346	4	1	351	0	349	1	1	351
1	7	98	189	294	1	31	61	202	294
2	23	121	239	383	2	66	43	274	383
Total	376	223	429	1,028	Total	446	105	477	1,028
Model prediction[a]				66%					67%

a. The predicted percentages are calculated as (predicted / total sample) × 100.

TABLE 3
Ordered Probit Maximum Likelihood Estimation: Structural Form Equation[a]

	Quality-of-Life Equation			*Health Equation*		
Variables	*Coefficient*	*T-Ratio*	*Spatial Effect*	*Coefficient*	*T-Ratio*	*Spatial Effect*
Constant	1.984***	4.509	1.3415**	2.016***	3.775	2.7423**
Male	–0.530	–1.515	—	–0.281*	–1.645	—
Civil status	–0.572*	–1.703	—	–1.233*	–1.833	—
Unemployment	–0.280***	–4.043	—	–0.285***	–2.892	—
Religion	1.345*	1.765	—	0.715**	1.890	—
Age2	0.058	1.245	—	0.457e – 01	0.928	—
Age3	0.124*	1.761	—	–0.185e – 02	–0.658	—
Age4	–0.587*	–1.722	—	–1.089***	–2.550	—
Education2	0.217**	2.250	—	0.198**	2.301	—
Education3	1.171*	1.668	—	0.49e – 02*	1.658	—
Race	1.496**	2.102	—	0.026	0.149	—
Income2	0.284**	2.056	—	1.643**	2.095	—
Income3	0.175**	2.429	—	0.186***	2.533	—
Income4	0.750***	6.408	—	0.226**	1.932	—
Health1	0.197***	–2.947	—	—	—	—
Health2	0.269***	3.824	—	—	—	—
Health problems	—	—	—	–0.211***	–2.970	—
Duration	–0.027	–1.170	0.0032*	—	—	0.666*
Local government	0.301	1.309	0.764*	0.142	1.157	0.9153*
Environment	–0.003	–1.399	0.116	–0.516*	–1.746	0.0534**
Region	0.033	0.359	—	–0.265*	–1.633	—
Neighborhood	1.334*	1.715	0.104*	0.538*	1.602	0.8579**
Amenities	1.171	1.638	0.075*	0.608e–04**	2.053	0.0077
Population	0.069	0.739	—	1.345*	1.757	—
Hospital	–0.046	–0.598	—	–0.396***	–2.357	—
Government education expenditure	0.016	0.279	—	0.181e–01	0.991	—
μ_1	1.011***	19.459	1.1555***	1.294***	14.335	1.4419***
Interactions completed	21			22		
Sample size	1,028			1,028		
Log – L	–954.8			–961		
Model χ^2	26.02			12.50		
Pseudo R^2	0.299			0.318		

a. Dependent variables = quality-of-life satisfaction and health indexes.
*p < .10. **p < .05. ***p < .01.

TABLE 4
Ordered Probit Maximum Likelihood Estimation: Reduced-Form Equation[a]

Variables	*Coefficient*	*T-Ratio*	*Spatial Effect*	*T-Ratio*
Constant	2.730***	3.823	2.823***	3.1314
Male	–0.276***	–3.149	—	—
Civil status	–2.167**	–2.165	—	—
Unemployment	–2.099***	–3.580	—	—
Religion	0.619**	1.924	—	—
Age2	–0.307	–1.341	—	—
Age3	–0.0001**	–1.895	—	—
Age4	0.003	1.383	—	—
Education2	0.334***	3.162	—	—
Education3	1.786***	10.537	—	—
Race	7.959e –006	0.345	—	—
Income2	0.308***	3.291	—	—
Income3	0.267***	3.176	—	—
Income4	0.005***	2.435	—	—
Health problems	–0.769***	–6.640	—	—
Duration	0.062	1.318	0.7578*	1.6015
Local government	0.124	1.504	0.9826**	2.3909
Environment	–0.658**	–2.024	0.7401	1.1584
Region	–0.124*	–1.616	—	—
Neighborhood	0.578*	1.698	0.056**	3.0894
Amenities	1.349*	1.775	0.2055	1.3835
Population	0.058	0.905	—	—
Hospital	–0.587*	–1.746	—	—
Government education expenditure	1.132	1.612	—	—
μ_1	4.762***	5.259	2.4491***	3.7140
Interactions completed	23			
Sample size	1,028			
Log-L	–954			
Model χ^2	13.7640			
Pseudo R^2	0.295			

a. Dependent variable = quality-of-life satisfaction index.
**p* < .10. ***p* < .05. ****p* < .01.

constant, the sign of the AGE4 coefficient becomes positive (see Table 4), implying that when health status is controlled, individuals in the highest age group are more likely to be satisfied with life compared with individuals in the youngest age group. The effect of AGE2 (35 to 44 years) and AGE3 (45 to 64 years) is positive, but only AGE3 is significant in the QOL equation. Overall, the results suggest a U-shaped relationship between age and QOL satisfaction when controlling for health status.

Second, the results of the civil status variable suggest that being single has a negative effect on both health and QOL satisfaction. These results conform to the findings of Gove, Hughes, and Style (1983), who found a strong causal relationship between being married and being satisfied with QOL. The total effect in the reduced-form equation is also negative and statistically significant, perhaps because of the direct and indirect effects manifested in the structural form equations. The predicted probability of being satisfied most of the time is 0.47 for people who are single and 0.62 for people who are married or cohabiting. Notably, the effect on satisfaction of being single is greater compared with the difference in satisfaction between the highest and the lowest income quartile ($p < .05$) and the difference in satisfaction between men and women ($p < .01$). However, the effect does not differ significantly from the difference in satisfaction between the highest and the lowest education category.

TABLE 5
Predicted Probabilities[a]

Variables	*Direct Effects*	*Total Effects*
Male	0.51230	0.55211
Female	0.54872	0.60145
Single	0.47199	0.01882
Married	0.62010	0.73251
Employed	0.52343	0.58647
Unemployed	0.43550	0.49124
Religion = 0	0.53650	0.55111
Religion = 1	0.46219	0.48540
Age1	0.59178	0.55821
Age2	0.57284	0.63417
Age3	0.55390	0.96011
Age4	0.60309	0.63010
Education1	0.57221	0.55415
Education2	0.51300	0.62832
Education3	0.61071	0.67180
White	0.57960	0.57260
Non-White	0.45607	0.49113
Income1	0.52084	0.53199
Income2	0.58016	0.57879
Income3	0.61884	0.58871
Income4	0.59874	0.61343
Health problems = 0	0.38112	0.36512
Health problems = 1	0.61414	0.52823
Health0	0.50000	0.38365
Health1	0.51192	0.44145
Health2	0.59587	0.62234
Duration = 0	0.55121	0.52211
Duration = 1	0.55079	0.54140
Local government services = 0	0.38100	0.39430
Local government services = 1	0.54675	0.59390
Environment = 0	0.38767	0.32861
Environment = 1	0.56501	0.48741
Southern region	0.54199	0.39784
Eastern panhandle region	0.55590	0.41541
Neighborhood = 0	0.44133	0.46933
Neighborhood = 1	0.52084	0.53315
Amenities = 0	0.04836	0.50515
Amenities = 1	0.50107	0.55786
Hospital = 0	0.52054	0.57242
Hospital = 1	0.38827	0.46114
Population = 0	0.29647	0.37884
Population = 1	0.18942	0.48588
Government education expenditure = 0	0.05313	0.25971
Government education expenditure = 1	0.41317	0.49329

a. Predicted probabilities of daily life being a source of personal satisfaction most of the time. The predicted probabilities are calculated as $F(\hat{\beta}' X) = \hat{F}$ (Greene, 1993).

Third, male gender and White race have a negative and a positive effect, respectively, on both QOL and health equations, although only White race is statistically significant in the structural equation. In the reduced-form equation, both variables maintain their signs but show a reverse in significance. The predicted probability of being satisfied most of the time is 0.55 for men and 0.60 for women, whereas it is 0.57 for being White and 0.49 for being non-White. On the other hand, the race-health results are somewhat surprising. Based on the general U.S. statistics, race (particularly being Black) is negatively correlated with health. However, our findings show a positive relationship, although it is not significant. The possible explanation might lie in the fact that the population of West Virginia is overwhelmingly White such that the effect of being Black is not readily captured.

To better understand the data, we control for the effect of size—the size of the county where respondents reside (i.e., the central place hierarchy)—by including county population. The coefficients on the variable are positive in all equations, but they are not statistically significant. Such findings speak to the low-density settlement patterns in West Virginia that make it more difficult and costly for rural communities and businesses to provide critical services that would enhance health and QOL satisfaction.

The findings for the region variable show weak evidence to suggest that individuals living in the southern region are more likely to be satisfied with life than are those living in the eastern panhandle. Although the coefficient for this variable is positive in the structural QOL equation, it is not statistically significant. The coefficient for this variable is negative and statistically significant in both the health and reduced-form QOL equations. The predicted probability of being satisfied most of the time is 0.39 for living in the southern region and 0.41 for living in the eastern panhandle. To the contrary, neighborhood appears to play a significant role in enhancing both QOL satisfaction and health status. In the structural form equation, the coefficient for the neighborhood variable is positive and statistically significant. In the reduced-form equation, the neighborhood variable maintains both a positive sign and the significance.

When we look at individuals' purchasing power, the estimated coefficients of the income variables are positive and statistically significant in all equations. As predicted by economic theory, the results suggest that individuals with higher incomes are more likely to be satisfied with life and have better health, other things being equal. The predicted probability of being satisfied most of the time increases from 0.53 in the lowest income quartile to 0.61 in the highest income quartile, taking into account the total effect of income. If only the direct effect of income on satisfaction is considered, the difference in the predicted probability for a respondent being satisfied most of the time is only 2% between the lowest and the highest income quartiles. This indicates that a large part of the effect of income on QOL satisfaction occurs through the intervening health variable (Bezruchka, 2001)—probably through expenditures such as medical insurance and drug costs (Nixon, 1997).

Turning to human capital, we find the results for the education variable are positive as hypothesized and highly significant in both the structural and reduced-form equations. These results are compatible with theory and with societal expectations that higher education attainment is associated with improved socioeconomic status, higher wage rates, and better health, all of which lead to better living standards. The predicted probability of being satisfied most of the time increases from 0.55 with less than a high school education to 0.67 for a university education based on the total effect in the reduced-form equation. If only the direct effect on QOL satisfaction is considered, the probability of being satisfied most of the time increases from 0.57 for less than a high school education to 0.61 for a college education. The difference in satisfaction between having a university education and having less than a high school education is greater than the difference in satisfaction between men and women, but it is not significantly different from the difference in satisfaction between the highest and the lowest income quartiles.

Unemployment has a negative and statistically significant correlation with health and QOL satisfaction. Similar to income and education, unemployment affects health and QOL satisfaction simultaneously. These results are expected because labor is the primary source of income for the majority of households. Labor is determined by the unemployment rates, number of hours worked, labor participation rate, and other factors. Thus, unemployment results in lower levels of QOL and health care. It must be noted, however, that an argument could be made for reverse causation; that is, work status (and unemployment) could be the result of health problems in some cases. Notably, however, the effect of unemployment on satisfaction is not significantly different from the effect of gender or the effect of being single. The effect is also not significantly different from the difference in satisfaction between individuals in the highest and lowest income quartiles.

Health has a significant and positive effect on QOL satisfaction

Health has a significant and positive effect on QOL satisfaction. Both health dummy variables are significant, and the effect of good health is significantly higher than is the effect of fair health. The predicted probability of being satisfied most of the time is 0.38 with poor health status and 0.62 with good health. In the reduced-form equation, the results suggest that improving a person's health status from fair to good, for instance, would increase the probability of being satisfied with life most of the time by 0.18. Similarly, the proxy variable for inherited health status, illness in the family (health problems), is significant and negatively related to health status in the structural form equation. In the reduced-form equation, initial inherited health has the hypothesized negative relationship on QOL satisfaction, but it is not statistically significant. The predicted probability of being satisfied most of the time in the reduced-form equation is 0.36 if parents or siblings had any health problems and 0.53 if they did not.

The results also show religion to have a positive impact in the structural equation, but the coefficients are significant only in the health equation. In the reduced-form equation, the total effect of religion on QOL satisfaction is positive and significant. These results are not new for religion has been long recognized as a powerful factor in promoting good health among individuals (Yinger, 1957) and the whole society (Durkheim, 1976). This presumption has endured in the theoretical literature at least in part because, as Ellison (1991) and Idler (1987) have suggested, religion appears to provide a variety of inducements to personal and community well-being, such as enhanced social integration and support. Idler (1987) added that involvement in religion might also constrain high-risk behaviors, such as smoking, drinking, and engaging in sexual activity outside a stable relationship.

However, not all studies have supported these hypotheses about the religion-health link. A few studies have shown no relationship between the two, especially when controlling for such factors as social class and previous health status. Some scholars (Singer, 1979) have even argued that religiosity may have deleterious effects on overall health. Alternatively, individuals in poor health may be drawn to religion in seek of comfort and healing, which raises the question of causality. Thus, the overall contribution of religion to well-being remains a source of controversy.

Duration (i.e., years of residence) is included to examine the effect that living in the county more than 10 years might have on satisfaction. The estimated results do not have the hypothesized positive effect in the structural equation and are not statistically significant. In the reduced-form equation, the variable has the hypothesized positive sign, although it is not statistically significant. The influence of the intervening health variable is a possible explanation for the positive sign in the reduced-form equation. To the contrary, neighborhood appears to play a significant role in enhancing both QOL satisfaction and health.

Our analysis of the policy variables suggests that government expenditure on education and local government services has a positive effect on health and QOL satisfaction but is not significant. The education expenditure results imply, for instance, that other things being equal, government spending on schools and training would increase people's satisfaction. As for the local government services, the predicted probability of being satisfied most of the time in the reduced-form equation is 0.59 with good local government services and 0.39 with poor services.

As hypothesized, the amenity variable shows a positive and significant effect in both structural equations. In the reduced-form equation, the intervening positive effect through the health equation increases the total effect of amenities on QOL satisfaction. The predicted probability of being satisfied most of the time is 0.55 in counties with higher amenity packages, such as medical facilities, higher institutions of learning, or nearer proximity to metropolitan areas, and 0.51 in counties without such amenities. In the literature, amenities are closely related to the environment, but our results for the environmental variable are contrary to the hypothesized positive sign.

Last, we tested whether spatial effects are truly important. The tests are based on standard *t* tests on the coefficients associated with spatial variables. We started by examining whether proximity to a hospital influences health and satisfaction with life. As one would expect, the results show the effect of nearness to a hospital to be more pronounced in the health equation than in the QOL equation. In the health equation, individuals residing beyond a 2-mile radius from a hospital were more likely to report poor health than were those residing within the radius.

All the coefficients on the spatial variables are significant with the exception of coefficients on the environment and amenity variables. As a general interpretation, the spatial coefficients represent the average of the 10 nearest survey respondents' opinions regarding each of the specified spatial variables. Although spatial effects are weaker on the environment and amenity variables, spatial dependence tests show that inferences drawn regarding substantive issues such as those considered here often change when spatial dependence is taken into account. Thus, for spatially dependent data, ignoring spatial dependence may lead to biased and inconsistent estimates and inferences.

SUMMARY AND CONCLUSIONS

It is interesting to briefly relate our results to two recent studies (Clark & Oswald, 1994; Gerdtham & Johannesson, 1997) that used a similar methodology. Our findings conform to the results in these two studies in several areas. First, the two studies found that being unemployed and being single have strong negative effects on QOL satisfaction or happiness. Second, they also found a U-shaped relationship between age and QOL satisfaction, with contentment being lowest for individuals in their mid-30s (Clark & Oswald, 1994) and in the 45-to-64 age group in our study and in Gerdtham and Johannesson (1997).

There are, however, some important differences in the results. For instance, using Swedish data, Clark and Oswald (1994) found no systematic relationship between income and happiness and found a negative relationship between education and happiness. In contrast, our study (similar to that of Gerdtham & Johannesson, 1997) found a positive relationship between QOL and both income and education. Finally, Clark and Oswald also found that men were happier than women; in our study and in Gerdtham and Johannesson (1997), the reverse was observed.

The observed differences may be due to differences in data samples and definitions of key variables, but it also may be because of how data are analyzed. The single component that differentiates our study from previous ones is the attempt to address the issue of spatial dependence, which has resulted in new insights from the examined data. In particular, this approach has provided a more detailed understanding of the nature of QOL relationships and their variation over space. Because of the lack of a formal spatial method for estimating probit or logit models with more than two choice outcomes, we employed a simplified approach to account for spatial dependence. A full treatment of spatial dependence is technically more demanding than the approach used in this article (see Anselin, 2001; Bell & Bockstael, 2000; Fleming, in press; Fortheringham & Wegener, 2000; Smith & LaSage, 2001). However, the absence of a formal spatial method for estimating ordered probit or logit models with more than two choice outcomes motivated us to employ the approach used in this article.

In summary, our findings support the notion that many noneconomic variables are as important for QOL satisfaction as are income and consumption. The results suggest that socioeconomic variables such as unemployment, health status, gender, marital status, regional differences, and education are as important as income in determining satisfaction or dissatisfaction with life. These findings have important implications. For example, it is important to take into account the distribution of noneconomic factors such as education, health status, and employment possibilities when assessing the welfare patterns in society.

. . . many noneconomic variables are as important for QOL satisfaction as are income and consumption.

In addition, helping people in distressed areas requires addressing factors that build or revitalize communities. Although the concept of “community” for upper income, well-educated working households may not be defined by a geographic area, for low-income people, community is most appropriately defined in terms of a geographic area or neighborhood (Butler, 1981). Thus, improving people’s well-being and developing rural West Virginia will require a place-based people strategy (Ladd, 1994) with the view that people cannot be separated from place and that an antipoverty strategy needs to treat individuals in the context of their community.

NOTES

1. Spatial dependence exists if either the dependent variables or the error terms are correlated with each other (Cliff & Ord, 1973; Ord, 1975). If the dependent variables in the analysis are spatially dependent, then spatial lag is present. If the model does not correct for the lag, regression estimates will be biased. If spatial error is present, the regression estimator will be inefficient. The presence of spatial lag, or spatial error, or both could therefore substantially change the conclusions of the analysis.

2. The multiplication of the *n* by *n* weight matrix *W* times an *n* by 1 explanatory variable vector $\mathbf{X}_i$ produces $W\mathbf{X}_i$, an *n* by 1 explanatory variable that consists of the average of the values in $\mathbf{X}_i$ from the 10 nearest survey respondents. As a concrete example, if $\mathbf{X}_1$ represents the neighborhood variable, then $W\mathbf{X}_1$ represents the average of the 10 nearest survey respondents' opinions regarding satisfaction with the neighborhood as a place to live. We hypothesize that entering these variables in the ordered probit model will produce unbiased estimates. The test for spatial dependence is based on standard *t* tests associated with the coefficients on the spatial explanatory variables.

3. Completed questionnaires were received from 1,060 individuals (return rate = 53%), of whom 532 were female and 528 were male. Of the completed questionnaires, 32 were discarded; thus, the data used in the empirical analysis are based on 1,028 questionnaires (return rate = 51.4%). See Bukenya (2001) for details on data collection.

4. This process creates a theme based on addresses in a table, using a reference feature theme. The "reference theme" (street theme with address ranges on each street segment) used is drawn from the Environmental Systems Research Institute (2000).

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