A Sensitivity Analysis of Quality of Life Indices Across Countries

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Abstract

This paper attempts to provide a comprehensive analysis of interrelationships among the determinants of the Quality of Life (QOL). We show that various measures of well-being are highly sensitive to domains of QOL that are considered in the construction of comparative indices, and how measurable inputs into the well-being indicators are aggregated and weighted to arrive at composite measures of QOL. We present a picture of conditions among the 43 countries of the world with respect to such interrelated domains of QOL as the relationship with family and friends, emotional well-being, health, work and productivity, material well-being, feeling part of one's community, personal safety, and the quality of environment. On the basis of Borda Rule and the principal components approach, we search for factor-indices that may function as QOL indices comparatively across countries. Such indices can be useful in making QOL comparisons and evaluations with reference to both time and place. Comparing and analyzing well-being conditions among countries in this way are aimed at facilitating the discovery of extant of problems with government policies impacting QOL.

Key Words: quality of life, domains, Borda rule, principal components, and rankings
JEL classification: I31, D60, D63

I. Introduction

Given that improving the quality of life (QOL) is now a common aim of international development, the long-term future of humanity lies in a better understanding of factors that may have had or will have an impact on the QOL. For a better understanding and the long term survivability of humanity during coming the coming millennia, the following seven distinct issues must be addressed: *first*, what do we mean by the term "quality of life"; *second*, how to measure QOL; *third*, what are the domains of well-being that should be included in the measurement; *fourth*, at what scale to measure the QOL; *fifth*, how various domains of well-being are related; *sixth*, how these factors affect various subgroups of populations; and *seventh*, how to provide outcomes that have practical policy implications by allowing comparisons across countries, individuals, groups, and over a period of time.

In the presence of overwhelming consensus that per capita income or related measures of income are substantially insufficient measures of well-being, the emphasis has now shifted to the identification of alternative measures. Quality of life (QOL), social indicators and basic needs are new approaches that are being discussed.[1] All these approaches are related to the concept of the standard of living. Sen (1985, 1987) has made a thorough investigation of the concept of standard of living. Improving QOL is now a common aim of international development. However, identifying robust QOL indicators, or providing a coherent and robust definition of the concept, remain problematic (Bloom, David E. et al, 2001).

Historically, life expectancy, literacy rates, per capita income, mortality and morbidity statistics have been widely employed to construct various indices of well-being. Probably the best-known composite indices of well-being are the Human Development Index (HDI), developed by the United Nations Development Program (UNDP), and the Physical Quality of Life Index (PQLI), developed by Morris (1979). These new approaches are recognized improvements in terms of capturing various dimensions of QOL, but they are still substantially limited by their inability to capture diverse domains of QOL, arbitrary assignment of weights, data used not being subjected to empirical testing, arbitrary selection of variables, non-comparability of measures over time and space, measurement errors in variables, and estimation biases due to omission of feedback effects with various indicators as environmental quality and political and civil liberties.

[1] See for example, Hicks and Streeten (1979), Hicks (1979), Drenowski (1974), Morris (1979), Sen. (1973), Streeten (1979), Dasgupta (1990b), Dasgupta and Weale (1992), Kakwani (1993), Ram (1982), Slottje (1991).

In this paper, we make an attempt to provide a comprehensive analysis of interrelationships among the determinants of QOL. We show that the various measures of well-being are highly sensitive to domains of QOL that are considered in the construction of comparative indices, and how measurable inputs into the well-being indicators are aggregated and weighted to arrive at composite measures of well-being. We also reexamine some policy relevant questions that have been addressed previously in the growth economics literature in light of the sensitivity findings.

We present an assessment of conditions among 43 countries of the world with respect to such interrelated domains of QOL as the relationship with family and friends, emotional well-being, health, work and productive activity, material well-being, feeling part of one's community, personal safety, and the quality of environment. We make an attempt to measure the various domains of QOL as comprehensively as possible given the constraint of non-availability of comparable and reliable data on a large set of countries for our present exercise. Empirical results are illustrated on the basis of data collected on well-being indicators from various sources, including Human Development Reports (UNDP) and World Development Indicators (the World Bank) for the year 1999 for 43 countries of the world (**Annex A & B**).

This paper is organized as follows: Section II briefly reviews the literature on well-being indices. In section III we discuss on our conceptual framework and the data to be used in the analysis of sensitivity of well-being measures with respect to the various domains of QOL and with respect to alternative aggregation rules to arrive at composite measures of well-being. Section IV describes three alternative aggregation rules to compute a QOL index. In particular, we derive the rankings of countries on the bases of the Borda Rule, and the principal components approach, and compare these results with the rankings of Human Development Index (UNDP, 1999). The results are discussed in Section IV. We provide concluding remarks in section V.

II. Literature Review

Traditionally, per capita gross domestic product (GDP) was considered as the sole and reliable measure of well-being and economic development. However, in the presence of overwhelming consensus that as the GDP increases, well-being does not necessarily increase along with it, there is agreement among economists that per capita GDP or related measures of income are substantially insufficient measures of well-being. Thus, the emphasis now has shifted to the identification of alternative measures. Quality of Life, social indicators and basic needs are new approaches that are being discussed (see Hicks 1979, Morris, 1979, Sen 1973, Dasgupta and Weale 1992). As early as the year 1967, Adelman and Morris examined numerous indicators of socio-economic and political change. Morris (1979) proposed the Physical Quality of Life Index (PQLI) as an alternative to per capita GDP for measuring the well-being of people. The PQLI is a function of life expectancy at age one, infant mortality rate, and literacy rate. Dasgupta and Weale (1992) constructed a measure of QOL that included per capita income, life expectancy at birth, adult literacy rate, and indices of political rights and civil liberties. However, probably the best known and the most controversial measure of well-being (the Human Development Index) has been published by UNDP in their Human Development Reports since 1990 to date. The human development index is based on the assumption that economic development does not necessarily equate to human development or improvement in well-being. The HDI is based on three indicators: life expectancy at birth, educational attainment and real GDP per capita.

The HDI is obtained by a procedure where each individual country is first placed on a scale of 0 to 100 (0 representing the worst performance and 100 the best) with respect to any indicator; and then it is obtained by a simple arithmetic average of the scale indicators.

More recently, Lars Obsberg and Andrew Sharpe have developed the Index of Economic Well-Being (IEWB) (see Osberg and Sharpe, 1998, 1999, and 2000). Their index is based on the view that the economic well-being of society depends on the level of consumption flows, accumulation of productive stocks, and inequality in the distribution of income and insecurity in the anticipation of future incomes. The weights attached to each of their IEWB component varies depending on the values of different observers. They argue that the public debate would be improved if there is an explicit consideration of the aspects of economic well-being obscured by average income trends and if weights attached to these aspects were explicitly open for discussion.

The American Demographic Index (ADI) of well-being for the United States from February 1996 to December 1998 was published by *American Demographics*. It is a monthly composite of five indicators developed, maintained, and reported by Elia Kacapyr. He selected the items on the basis of an economist's perception of well-being, free of any paradigm or QOL theory.

These new approaches are recognized improvements in terms of capturing various dimensions of QOL, but they are still substantially limited by their inability to capture diverse domains of QOL, arbitrary weights, data used not being subjected to empirical testing and arbitrary selection of variables. One weakness (among others) with indices of general well-being currently in use in such institutions as the World Bank and the United Nations Development Program (e.g., UNDP, 1990) is that they are restricted to the socioeconomic aspects of life; the political and civil aspects are for the part kept separate. When the latter are mentioned at all, they are dealt with perfunctorily (Dasgupta and Weale, 1992). Table 1 shows an overview of the various domains of QOL that are measured or captured by the various well-being indices discussed in the preceding review. From Table 1, we can easily notice that existing indices of well-being are severely limited by their inability to capture the multidimensional nature of QOL. The HDI, which is the most well-known and widely used index of well-being, captures only three domains of the QOL. It is quite remarkable that the HDI ignores the domains of relationship with family and friends, emotional well-being, work and productivity, personal safety, and the quality of environment. In fact, none of the indices of current well-being captures the domain of the quality of environment; despite the fact that it is well documented that the environmental quality has direct effect on the QOL.[2] Consequently, different indices of well-being give different rankings of countries, and can lead to potentially misleading policy recommendations.

In the next section, we discuss the conceptual framework and data sources of the indicators of the QOL employed to compute the QOL rankings of countries in our study.

III. Conceptual Framework for the QOL

In the behavioral sciences it is generally assumed that individuals' behavior is guided by the goal of seeking a higher level of the quality of life and that actual behavior

[2] For more discussion on this, see Charles Perrings (1998), "Income, Consumption and Human Development: Environmental Linkages", Background papers, *Human Development Report*, 1998.

should be seen as the reflection of that. However, economists often use the concept of utility instead of quality of life, while psychologists use the term satisfaction or happiness. Here we shall use the terms quality of life, standard of living, human well-being, and welfare interchangeably.

In consumer theory the utility function $u(x)$, defined on the commodity space *X,* is a device to describe a preference ordering among commodity bundles. Indifference curves are described by the equation $u(x) = k$ where k is constant. The function $u(x)$ can never be completely identified, but it may be estimated by observing consumer choice behavior, i.e. via revealed preferences. In principle any monotonic transformation $g(u(x))$ will describe the same indifference curves and the maximization of $g(u(x))$ will result in the same choice behavior as the maximization of $u(x)$. This is the idea of viewing utility as an ordinal concept, describing a preference ordering only.[3] If individuals or public policy makers on the behalf of people are driven by the achievement of a higher standard of living, understanding and analyzing the determinants of QOL over a population, society or a country seems a necessary condition to understand human behavior. In order to accomplish comparisons, achievements of different societies or population would have to be interpersonally comparable, and societies producing similar results need to enjoy similar standard of living. Is this plausible? The answer is yes in light of arguments that satisfaction levels or the level of standard of living are predictive in the sense that individuals or societies will not choose to continue activities which produce low satisfaction levels or the low levels of the standards of living.[4]

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[3] See for example Pareto (1904), Robbins (1932), Samuelson (1945), and Debreu (1959).
[4] See for detailed arguments and justification Kahneman et al., (1993), Clark (1998), and Frijters (2000).

Life expectancy, literacy rates, mortality and the like are usually considered as "indicators" of QOL of people and these statistics have been used by many researchers over the years to construct various indices of well-being. It is now well recognized that none of these indicators is singly adequate to measure the QOL (see Sen, 1981). The QOL is, in fact, a composite variable, which is determined by the interactions of several dimensions of well-being. Changes in the income level of people, their living conditions, health status, environment, safety, stress, leisure, and the satisfaction with family life, social contacts, and many other such variables interact in complex ways and determine the QOL and its changes.

In the present study, we interpret the QOL of people as an "abstract conceptual variable", which cannot be directly measured, but is jointly determined by changes in several (exogenously determined) causal variables. The causal variables are supposed to be measured with a reasonable degree of accuracy. In this paper, we focus on factors that may affect the QOL by identifying the following eight domains of QOL that have been emphasized at different times by different researchers depending on what were considered to be the major elements of well-being[5]:

- *Relationship with family and friends,*
- *Emotional well-being,*
- *Health,*
- *Work and productive activity,*
- *Material well-being,*

[5] These eight domains of QOL have been identified based on our review of current and historical literature on well-being indices. However, we note that these eight domains are not mutually exclusive of each other, as we don't expect zero correlation among them. Many readers might question our classification of domains, but we emphasize that it is not an ad hoc classification, as we will provide justifications in the subsequent discussions.

- *Feeling part of one's local community,*
- *Personal safety, and*
- *Quality of environment*

The QOL is a multidimensional concept, which has many distinct domains. Therefore, besides a composite measure of the QOL, we may distinguish also specific *domains* such as the eight domains mentioned above. We speak of domains of the QOL, D_1 ,…, D_J where J stands for the number of different domains. Then the QOL must be a composite of the various domains, say

$$QOL = QOL(D_1,....D_J)\text{, where } J=8 \tag{1}$$

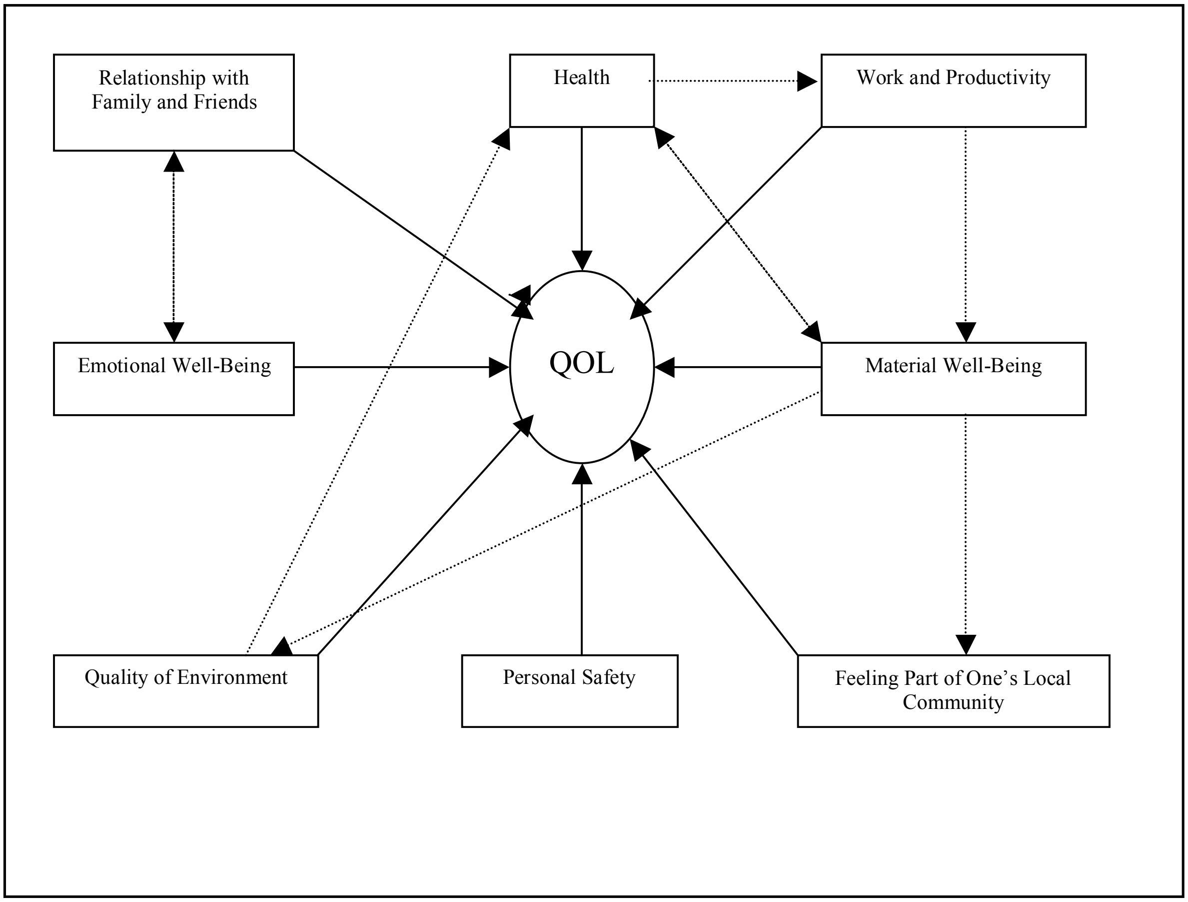
Moreover, each domain J has its own indicators, which are observable, say a vector of observable indicators $x^j = (x_1{}^j,....,x_K{}^j)$, (where j = 1… 8), will determine the achievements in the respective domains. Hence, our basic conceptualization of QOL will be:

$$QOL = QOL((D_1(x^1),.....,D_J(x^J)) \tag{2}$$

In this paper our aim is to compute a composite QOL index (say, QOLI) based on the general conceptualization in equation (2). If the QOL could be numerically measured and related to the causal variables (indicator variables in each domain), it would be straight forward to determine, say, a least squares regression of QOL on the causal variables. In that case, the partial derivative of QOL with respect to the one of the causal variables would measure the marginal rate of change of QOL for a small change in the causal variable, holding other causal variables fixed; and an estimator of QOL would be obtained as the estimator of the mean of the conditional distribution of QOL when causal variables are held fixed. Since QOL is not directly observable, some rules are needed to aggregate its various domains (in the present case eight) and corresponding indicators to arrive at a composite measure of the QOL, and that we discuss in the next section.

Figure 1 contains the schematic presentation of the conceptual framework relating to domains of QOL. Here we attempt to draw as broad a picture as possible of QOL. Some links are direct and easy to understand, but indirect links can also have a substantial effect. Policy makers often neglect indirect effects, where they need to be aware of both unanticipated consequences and positive feedback when they assess the actual effects of changes in any components of QOL. Figure 1 shows both direct and indirect links between the QOL and its various domains. As can be seen, the QOL has direct links with its eight domains, which are indicated by bold arrows. In addition, it indicates the links between domains of QOL, and shows possible indirect effects, represented by the dotted arrows. These eight domains of QOL have therefore driven the choice of indicators in the present study for the 43 countries of the world for which comparable data on various indicators of the QOL are available.

Figure 1: Schematic Presentation of Conceptual Framework



To complete the schematic presentation of the conceptual framework for the analysis of the QOL, we now briefly discuss the domains and data sources of QOL, as below:

Domain 1. Relationship with family and friends

The satisfaction with family life is an important element of an individual's well-being. It is quite reasonable to argue that in general, an individual with strong family ties will be a much happier person than without having any family relations. Therefore, relationship with family and friends should be considered in any measure of QOL. There can be many indicators to represent the domain of *relationship with family and friends*, but it is extremely difficult to find many objective and quantitative indicators, which are necessary for cross-country comparisons. Therefore due to the limitation of data availability, we consider one indicator to focus the first domain, viz., incidence of divorce rates. Increasing divorce rate is an indication of failing marriages and eroded relationship with family and relatives.[6] The data for this variable has been obtained from Gulnar and Nugman of the Heritage Foundation. The data is for the year 1999, or the nearest available date. The divorce rate is reported as the number of divorces per thousand people.

Domain 2. Emotional Well-Being

Although measures such as crime statistics, health status, and indicators of wealth are surely related to QOL, these indicators cannot capture what it means to be "happy". How happy an individual is, not only depends on his/her income, and consumption, but it is also affected by intensity of stress, depression, and psychology. Emotional well-being, like physical health, can be judged on a variety of dimensions. Yet, in both realms, it is difficult to say which of these dimensions are essential for overall well-being. We use estimates of both male and female suicide rates to focus on emotional well-being. Teenage suicide rates were used in the construction of the index of social health (ISH) by Miringoff of the Fordham Institute for Innovation in Social Policy (1996, 1999). We have obtained data for both male and female suicide rates from the Mental Health Data of the

[6] It can be argued that the incidence of divorce rate is not a good indicator of relationship with family and friends. One can dispute it on the ground that a marriage not ending in divorce does not mean that people in the marriage are happy. For instance, many researchers have argued it that low rate of divorce in countries like India and Islamic countries can be partly explained by the low status of women in the society where women are traditionally supposed to be playing the role of homemaker. However, we strongly emphasize that in these countries people attach higher importance to joint family system, social status, and marriage is considered as a *social value* rather than a *contract*, and divorce is viewed as the social *taboo.* Thus, we argue that low divorce rates in these countries are not only a result of the low status of women in the society, but also it is a reflection of a strong joint family system and relationship with family and friends.

World Health Organization (WHO). We assume that a higher incidence of suicide rates by either gender is an indication of weaker emotional well-being.

Domain 3. Health

Good health should result in a better QOL. Health has both direct and indirect positive effects on QOL. Improvement in health has an immediate impact on a person's QOL, but may also indirectly increase it by acting on other variables that in turn also have a beneficial effect. One of the most studied relationships is between health and income. Higher income leads to better health, but better health also leads to higher income because of better productivity and labor force participation.[7] To focus on the domain of health a balance has to be struck among various components of a healthy society: demography, longevity, mortality, morbidity, and health infrastructure. Thus, we use population growth rate (representing demographic pressure); life expectancy at birth (longevity); infant mortality rate (mortality); the number of AIDS cases and tuberculosis cases (representing morbidity); government expenditure on health as a percentage of GDP, and doctor/population ratio (representing health facilities) to capture the domain of health in our measure of the QOL. The data on these indicators have been obtained from HDR, 1999.

Domain 4. Material well-being

The elements of material well-being have both direct and indirect positive and negative impact on a person's QOL. For instance, rising national income due to industrialization raises QOL on the one hand, but on the other hand decreases it for those living in polluted areas. The latter may suffer further indirect effects if increased

[7] See for example Lee (1982), Ettner (1996), Pritchett and Summers (1996), Luft (1975), Grossman and Benham (1980), Bloom and Malaney (1998), Bloom and Sachs (1998), Bloom and Williamson (1998), Bloom and Canning (1999).

pollution raises the incidence of disease and chronic illness. Aspects of material well-being have been most widely used to construct various indices of well-being. One of the main reasons for its use is the availability of good data on various indicators. Traditionally measures of income or related measures of material well-being were considered adequate indicators of standards of living. To capture the extent of material well-being in our QOL we use per capita GDP (at purchasing power parity), daily per capita supply of calories, the commercial use of energy, and telephone lines per thousand people (both representing infrastructure).[8] The data for these indicators have been obtained from the HDR, 1999.

Domain 5. Feeling part of one's local community

Feeling part of one's local community and society in general depend on the factors like educational attainments, political rights, and civil liberties, among others. Many people in different countries of the world are systematically denied political liberty and basic civil rights. It is sometimes claimed that the denial of these rights helps to stimulate economic growth and is "good" for rapid economic development. However, comprehensive intercountry comparisons have not provided any confirmation of this thesis, and there is little evidence that authoritarian politics actually helps economic growth. As Sen. (1999) argued:

"-----political liberty and civil freedoms are directly important on their own, and do not have to be justified indirectly in terms of their effects on economy. Even when people without political liberty or civil rights do not lack adequate economic security (and happen to enjoy favorable economic circumstances), they are deprived of important freedoms in leading their lives and denied the opportunity to take part in crucial decisions regarding public affairs. These

[8] Since daily per capita supply of calorie is much influenced by income; one can argue we will be counting income twice. However, we note that the quality of consumption does not only depend on the level of income, but also how income is being used by the individual, which in turn depends on his/her level of education. Moreover, it is an easy matter to redo all our computations by deleting data on either of our material well-being indices.

deprivations restrict social and political lives, and must be seen as repressive even without their leading to other afflictions. Since political and civil freedoms are constitutive elements of human freedom, their denial is a handicap in itself." (Sen. (1999, p. 16-17))

Concurrent with this realization, economists who previously assumed that measures of income are the sole and reliable indicators of human well-being finally have begun to understand that political liberties and civil freedoms are as important elements of QOL as any other elements of QOL. Thus we emphasize that any measure of current well-being that does not include political and civil spheres of life, will be incomplete and misleading for intercountry comparisons of QOL. Here we use indices of political and civil liberties along with both male and female adult literacy rates to capture this domain of QOL. The indices of political rights and civil liberties are taken from Gastil, R. D. - Freedom in the World: Political and Civil Liberties (For definition see Taylor and Jodice 1983). It is also available from various human development reports of UNDP. Rights to political liberty measures citizens right to play a part in determining their government, and what laws are and will be. Countries are ranked with scores ranging from one (highest degree of liberty) to seven (lowest degree of liberty). On the other hand, the index of civil liberties measures the extent of people's access to an impartial judiciary, access to free press, and liberty to express their opinion. Countries are ranked with scores ranging from one (highest civil liberty) to seven (lowest degree civil liberty).

<u>Domain 6. Work and productive activity</u>

The estimates of unemployment rate; combined first, second, and third level school gross enrollment ratio; and female economic activity rate are used to capture the "extent of work and productive activity" that exists in countries included in our sample. At any point of time, citizens of a country can be productively engaged either in work employment, or be engaged in the process of learning in school. The female economic activity rate is used to capture the intensity of gender equality in productive activity.

Domain 7. Personal safety

For the well-being of people personal safety is as important as any other domains of the QOL. In a society where incidence of crimes is less, people can enjoy their living much better than in a society where criminal offences are high and very common. This is very important because an individual derives utility not only from the commodity bundles in her/his consumption basket, but it very much depends on her/his ability to walk, and live free of crimes on streets, material theft, good law and order situations in the neighborhoods. To capture these domains of well-being, we use two different indicators, viz., the total number of offences contained in the national crime statistics, and expenditure on military as percentage of GDP. This total number of offences includes cases of murder, sex offences, serious assaults, theft, fraud, counterfeit currency offences, and drug offences. We believe that the higher is the total number of offences; the lower will be the well-being of people. Similarly, we argue that the expenditure on military is an unproductive expenditure, and therefore it has indirect adverse effect on the QOL. We have obtained data on total offences from the International Crime Statistics of the Interpol. The data refers to the year 1997. Data on military expenditures were obtained from HDR, 1999.

Domain 8. Quality of Environment

Most indices of human well-being have ignored the interrelationships between the QOL and environmental changes. Quality of environment has direct and indirect long-term effects on the health status of the citizens, and consequently it affects the quality of life of people in the region. As we can see from Figure 1, the elements of material well-being have impact on quality of environment; the quality of environment has direct and an immediate effect on QOL, and an indirect effect on QOL through its effect on health. To capture the extent of the quality of environment, we use a measure of greenhouse gas emissions- carbon dioxide (CO_2); a measure of water pollution-access to safe water supplies (ACH2O); and a measure of the depletion of environmental resources-deforestation. Emissions of CO_2 are primarily a by-product of industrialization, and attract more attention in middle and upper-income countries. Deforestation and depletion of local water supplies attract the most attention in low-income countries. Water pollution is of the major concern because of its immediate effects on human health and productivity. Deforestation is important because it affects the hydrological cycle, and it is linked with the depletion and pollution of water supplies. We have obtained data on these variables from the World Development Indicators, 1999; and HDR, 1999.

Our aim here is to conduct a number of simple exercises with data on eight domains of the quality of life. The present method is to select and test out domains (in the present case, eight), which may function as the QOL indices. In the next section, we describe three aggregation methods to arrive at a composite measure of the QOL index. *First*, we briefly describe the computation of QOL based on the principal component approach. *Second*, we make use of the well-known Borda Rule as the aggregator of set of variables in each domain of the QOL. *Third*, UNDP's approach to Human Development Index (HDI).

IV. Computation of Quality of Life Index (QOLI)

We postulate a latent variable model where the QOL is linearly determined by a set of observable indicators (or a set of causal variables) plus a disturbance term capturing error.

Let the general model in equation (2) can be written as:

$$QOL = \alpha + \beta_1 D_1(x^1) + \beta_2 D_2(x^2) + ... + \beta_8 D_8(x^8) + \varepsilon \qquad (3)$$

where D_1 ,…, D_8 are set of indicators in each domain of the QOL that are used to capture the 'quality of life index', and $\beta_1, ..., \beta_8$ are the corresponding vectors of parameters in each domain. Thus the total variation in the QOL is composed of: a) the variation due to sets of indicators, and b) the variation due to error. If the model (3) is well specified, including an adequate number of indicators in each domain, so that the mean of the probability distribution of ε is zero, ($E(\varepsilon) = 0$**)**, and error variance is small relative to the total variance of the latent variable *QOL***,** we can reasonably assume that the total variation in *QOL* is largely explained by the variation in the indicator variables in each domain included for the computation of this composite index.

Since the number of indicators variables included in the model (3) may be large and the indicator variables may be mutually linearly related, we propose to replace the set of indicators by an adequate number of their principal components (PC). The principal components are normalized linear functions of the indicator variables and they are mutually orthogonal. The first principal component accounts for the largest proportion of total variation (trace of the covariance matrix) of all indicator variables. The second principal component accounts for the second largest proportion and so on. In practice, it is adequate to replace the whole set of indicator variables by only the first few components, which account for a substantial proportion of the total variation in all indicator variables. However, if the number of causal variables is not very large, we may, as well, compute as many principal components so that 100% of the variation in indicators is accounted for by their PCs (see Anderson, 1984). To compute PCs, we proceed as follows:

Step 1: Transform the indicators into their standardized form i.e.

$$X_k = \frac{X_k - \overline{X_k}}{std(X_k)}$$

Step 2: Then solve the determinental equation

$$|R - \lambda I| = 0 \text{ for } \lambda$$

where R is a $K \times K$ correlation matrix of the standardized vector of indicator variables; this provides K^{th} degree polynomial equation in λ and hence K roots. These roots are called the eigenvalues of R. Now let us arrange λ in the descending order of magnitude, as

$$\lambda_1 > \lambda_2 > \ldots > \lambda_k$$

Step 3: Corresponding to each value of λ, we solve the matrix equation

$(R - \lambda \mathrm{I})\alpha = 0$ For the $K \times 1$ eigenvectors α, subject to the condition that $\alpha'\alpha = 1$.

Let us write the characteristic vectors as

$$\alpha_1 = \begin{pmatrix} \alpha_{11} \\ . \\ . \\ . \\ \alpha_{1k} \end{pmatrix}, \ldots\ldots\ldots\ldots, \alpha_k = \begin{pmatrix} \alpha_{k1} \\ . \\ . \\ . \\ \alpha_{kk} \end{pmatrix}, \text{ which}$$

correspond to $\lambda = \lambda_1, \ldots\ldots\ldots\ldots \lambda_K$ respectively.

Step 4: The principal components are obtained as

$$P_1 = \alpha_{11}X_1 + ... + \alpha_{1K}X_K$$

$$P_2 = \alpha_{21}X_1 + ... + \alpha_{2K}X_K$$

.

.

$$P_K = \alpha_{K1}X_1 + ... + \alpha_{KK}X_K$$

Thus we compute all these principal components using elements of successive eigenvectors corresponding to respective eigenvalues.

Step 5: We define the weighted average of the principal components as an estimator of the quality of life index (QLI), thus:[9]

$$QOLI = \frac{P_1\lambda_1 + P_2\lambda_2 + ... + P_K\lambda_K}{\lambda_1 + \lambda_2 + ... + \lambda_K}$$

where the weights are $\lambda_1, ..., \lambda_K$ are variances of successive principal components. We assign the largest weight λ_1 to the first principal component, as it accounts for the largest proportion of variation in all causal variables. Similarly, the second principal component has the second largest weight and so on.

Step 6: Finally, we normalize the QOLI value by the following procedure,

$$QOLI^i = \frac{QOL^i - Minimum(QOLI^i)}{Maximum(QOLI^i) - Minimum(QOLI^i)}$$

where i = 1, 2 …n (=43, countries of the world). Then on the basis of estimated value of QOLI we rank 43 countries of the world where the value of 0 indicates worst performing country and therefore it gets the rank of 43. Similarly, the value of 1 indicates the best performing country, and hence it is assigned the rank of 1 (highest rank).

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[9] This methodology was originally proposed by Nagar, A. L., and Tauhidur Rahman (1999), has been subsequently used by many researchers including Nagar, and Basu (2001 a, b and 2002).

Advantages of the above procedure are the following: First, it minimizes the problem of assigning arbitrary weights since weights are based on information contained in the date set. That is, we assign weights to successive principal components based on their relative contribution in accounting the total variation in all indicator variables. Second, it overcomes the difficulties associated with the maximum likelihood method for the estimation of Multiple Indicators and Multiple Causes (MIMIC) model. For instance, the maximum likelihood method requires that the number of causal variables to be included in the model does not exceed the number of observations and none of the causal variables is linearly related with others. In fact, the method requires that the matrix of sum of squares and products of observations on causal variables is non-singular (see Goldberger, 1974; Joreskog and Goldberger, 1975). Thus, the usefulness of the principal component approach lies in its simplicity and its wide scope in providing flexibility for exploratory statistical analyses to be conducted on various domains of the quality of life.

Of the many alternative aggregation methods, the most well known and most studied is the Borda Rule. This rule provides a method of rank-order score, the procedure being to award each alternative (say, a country) points equal to its rank in each criterion of ranking (the criteria being per capita income, life expectancy, and the like), adding each alternative's scores to obtain its aggregate score, and then ranking alternatives on the basis of their aggregate scores. To illustrate, suppose a country has the ranks i, j, k, l, and m, respectively, for the five criteria. Then it's Borda score is $i + j + k + l + m$. The rule invariably yields a complete ordering of alternatives. We note that the Borda Rule suffers from various limitations (Goodman and Markowitz (1952) and Fine and Fine (1974) have investigated the strengths and limitations of the Borda rule). The fact that

Borda rule is simple, and its strengths and weaknesses are transparent, provides a good justification for using it (Dasgupta and Weale, 1992). Moreover, it provides a very simple tool to analyze the sensitivity of quality of life ranking across countries contingent on inclusion or exclusion of a particular domain of the quality of life.

United Nations Development Program (UNDP) in its first Human Development Report (1990) introduced a new way of measuring well-being by combining indicators of life expectancy, educational attainment and income into a composite human development index (HDI). Although, over the years some changes have been made in the construction of HDIs, the methodology has remained the same. The HDI is based on three indicators: (a) longevity, as measured by life expectancy at birth; (b) educational attainment, measured as a weighted average of (i) adult literacy rate with two-third weight, and (ii) combined gross primary, secondary and tertiary enrolment with one-third weight; (c) standard of living, as measured by real gross domestic product (GDP) per capita (PPPS). The HDI sets a minimum and maximum for each dimension and then shows where each country stands in relation to this scales-expressed as value between 0 and 1. Since the minimum adult literacy rate is 0% and the maximum is 100%, the literacy component of knowledge for a country where literacy rate is 75% would be 0.75. Similarly, HDI uses the minimum of life expectancy as 25 years and the maximum of 85 years, so the longevity component for a country where life expectancy is 55 years would be 0.50. For income, the minimum is $100 (PPP) and the maximum is $40,000 (PPP). Then the scores for the three dimensions are averaged in an overall index.

IV. Discussion of Results

We consider 43 countries of the world for which comparable data on eight domains of QOL and corresponding indicators were available in the year 1999. Our set of countries includes both developed and developing economies of the world. In total we make use of 26 indicators of the QOL. Table 2 summarizes the data. The first column of the table 2 represents the domain 1, the relationships with family and friends. Its indicator is the divorce rate (DR). Columns 2 & 3 represent domain 2, emotional well-being. Its two indicators are Female suicide rate (FS) and male suicide rate (MS). Columns 4 to 10 represent domain 3, health. It has in total seven indicators: population growth rate (PGR), infant mortality rate (IMR), life expectancy at birth (LE), cases of AIDS (AIDS), cases of tuberculosis (TC), health expenditure by the government as the percentage of GDP (HE), and doctor population ratio (DPR). Columns 11 to 14 represent domain 4, material well-being. It includes per capita GDP (at PPP), Commercial energy use (CEU), daily per capita supplies of calories (CS), and Phone lines available per 1000 population (PH). Columns 15 to 18 describe domain 5, feeling parts of one's local community: political rights index (PR), civil liberties index (CL), female adult literacy rate (FALR), and the male adult literacy rate (MALR). Columns 19 to 21 represent domain 6, work and productive activity, where unemployment rate (UR), combined enrollment ratio in school (CER), and female economic activity rates (FEA) are its indicators. Columns 22 and 23 show domain 6, in which the total number of offenses (TTF), and expenditure on military as a percent of GDP (ME) are its two indicators. Finally, columns 24 to 26 represent the domain of the quality of environment. Its three indicators are emissions of carbon dioxide (CO2), rate of deforestation (DEF), and the access to safe water (ACH20).

Table 3 presents the rankings of quality of life indicators data. The HDI rank is the rankings of countries provided by human development report, 1999, and the rankings of the countries have been re-assigned in accordance with countries in our set. We note that rank of 1 represents the best performing country, and the rank of 43 represents the worst performing country. Even a glance at these rankings in Table 3 tells us that well-being rankings are highly sensitive to its' domain and corresponding indicators. Also rankings of eight domains indicate that they do not quite follow the rankings provided by HDI, which uses different weighting criterion, and very limited numbers of QOL indicators. Thus, rankings in Table 3 suggest that not only the measures of well-being are sensitive to its coverage of the various domains, but also how different well-being inputs are aggregated to arrive at a composite measure of the QOL. Developed countries like Canada, USA, Japan, and Sweden perform the best in the domains of material well-being, and feeling part of one's local community, but they do not perform as good in the domains of personal safety, and the quality of environment, relationships with family and friends, and emotional well-being. On the other low ranked countries on the basis of HDI, do better in the domains of relationships with family and friends, emotional well-being, and personal safety. These exploratory and tentative results may be an indicative of differences between advanced industrial societies with nucleus family, and developing countries with traditional societies and strong family ties.

Table 4 presents a comparison of quality of life indices based on each of eight domains, an overall QOLI* based on both Borda Rule and Principal Components approach, and the HDI ranks. Let's look at the best five performing countries on the basis of both HDI and QOLI* (Borda Rule). The best five HDI countries are: Canada, USA, Japan, Belgium, and Sweden. On the other hand, the best five countries on the basis of QOLI* (Borda Rule) are: Spain, Austria, Sweden, Switzerland, and Canada. That is, there are only two countries, Canada, and Sweden, which figure in these two schemes of aggregation. Similarly, we look at five worst performing countries on the basis of both HDI and QOLI* (Borda) rankings. The five worst performing countries on the HDI rankings are: El Salvador (43), Moldova (42), Azerbaijan (41), Albania (40), and Jordan (39). On the other hand, the worst five countries on the basis of QOLI* (Borda) rankings are: Russia (43), Sri Lanka (42), Ecuador (40), Kazakhstan (40), and South Korea (39). It is quite chilling to note that there is not even single country common between two sets of five worst performing countries based on HDI and QOLI*. Now let us look at the rankings based on the QOLI* (Borda Rule) and QOLI* (principal components (PC) approach). We can clearly note from the table 4 that these two methods of weighting of well-being indicators do not produce quite similar rankings. From table 5, we observe that the rank correlation coefficient between HDI and QOLI*(Borda) is 0.624, between HDI and QOLI*(PC) is 0.813, and between QOLI*(Borda) and QOLI* (PC) is 0.544. Thus we can say that the rankings based on the principal component approach follows more closely with the HDI rankings than with the rankings based on the Borda Rule. Since these two rankings are based on all eight domains of QOL, we conclude that there is sufficient evidence that the well-being rankings are sensitive to aggregation rules.

Table 5 presents rank correlation matrix of indices of QOL domains, the HDI, and QOLI* itself. First, let us look at the correlation coefficients between QOLI*(Borda) and its eights domains. We notice that QOLI* has statistically significant correlation with only five domains of the QOL: health (0.696), material well-being (0.560), feeling parts of one's local community (0.598), work and productive activity (0.371), and the quality of environment (0.668). QOLI* has the highest correlation (0.696) with the domain of health. We were not expecting this. We did not have any reason to expect that health would be the closest to our measure of the quality of life. Nevertheless, our findings support the results obtained by Dasgupta and Weale (1992) where they found that life expectancy (an indicator of health) was closest to the measure of the QOL. Thus, if we had to choose a single ordinal domain of aggregate well-being, the domain of health would seem to be the best if the aggregation method is the Borda Rule. Moreover, if we really had to choose one indicator instead of a domain, it would be most appropriate to choose the life expectancy at birth as the indicator of the quality of life. This is also corroborated from the correlation between QOLI*(Borda) and LE, which is (0.745) from Table 6. The QOLI*(Borda) has the second highest correlation with the domain of the quality of environment. This supports our postulation that the quality of environment is very important for human well-being, and it has direct and positive impact on the QOL. Since QOLI* is highly correlated with quality of environment, any alternative index of well-being in the development literature that ignores the domain of the quality of environment, would give misleading rankings of countries and consequently misleading policy recommendations.

Moreover, QOLI*(Borda) has statistically insignificant correlation with the domains of relationship with family and friends, emotional well-being, and the personal safety. The statistically insignificant correlation of QOLI*(Borda) with the domains of relationship with family and friends, emotional well-being, and the personal safety, might mislead readers that these domains are not critical to any measures of the QOL. But we caution readers that this is not the case at all. *First*, these domains have statistically significant correlations with the QOLI*(PC). *Second*, as we mentioned in the previous section that the divorce rate is a crude indicator of relationship with family and friends, and therefore it cannot singly and adequately capture the domain of relationship with family and friends. Similarly, emotional well-being is much more diverse domain than it is being captured by suicides rates. Due to the non-availability of data we limited ourselves to the choice of divorce statistics.[10] Thus we emphasize the exploratory nature of our inquiry only because the matter is a sensitive one, and there is a great deal remaining to be done and examined in this field. The correlation coefficient of 0.824 between the domains of material well-being and feeling parts of one's local well-being mean that the claim that the circumstances which cause poverty are also those which make it necessary for government to deny citizens their political and civil liberties is simply false. There are countries in the sample which are low-income countries and which enjoy relatively high levels of civil and political liberties.

V. Concluding Remarks

This paper introduced a multidimensional approach to measuring the quality of life across countries. We operationalized Sen's concept that other factors besides measures of per capita income and mortality rates should be included into any analysis of quality of life. Using information on eight domains of the quality of life we showed that the various measures of well-being are *highly sensitive* to domains of QOL that are considered in the construction of comparative indices, and how measurable inputs into

[10] Some can argue that *emotional well-being* and *relationship with family and friends* are subjective domains of the QOL, and therefore it would be difficult to find many indicators in these domains, which will be reliable enough to perform intercountry comparisons. However, we note that people always attach higher weights to emotional well-being and relationships with family and friends in direct surveys when they are asked to rank the elements of their well-being.

the well-being indicators are aggregated and weighted to arrive at composite measures of QOL. We presented a picture of conditions among the 43 countries of the world with respect to such interrelated domains of QOL as the relationship with family and friends, emotional well-being, health, work and productivity, material well-being, feeling part of one's community, personal safety, and the quality of environment. On the basis of Borda Rule and the principal components approach, we searched for factor-indices that may function as QOL indices comparatively across countries. Our results suggest that the well-being rankings are not robust to the various aggregation methods and the domains of the QOL. Therefore, further research is needed to find an optimal and robust aggregation methods to derive appropriate weights for the well-being attributes.

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Table 1: Domains of QOL Measured by some Indexes

Domains of QOL	Human Development Index (UNDP)	Physical Quality Of Life Index (Morris)	Index of Economic Well-Being	American Demographic Index	Dasgupta & Weale (1992)
Relationship with Family and Friends	×	×	×	√	×
Emotional Well-Being	×	×	×	×	×
Health	√	√	×	×	√
Material Well-Being	√	×	√	√	√
Work and Productivity	×	×	√	×	×
Feeling Part of One's Local Community	√	√	×	√	√
Personal Safety	×	×	√	√	×
Quality of Environment	×	×	×	×	×

Note: **×:** Does not cover; √**:** Indicates that it covers

Table 2. Domains of Quality of Life and Corresponding Indicators in 1999

Country		Domain 1	Domain 2	
		Relationship with Family and Friends	*Emotional Well-Being*	
		1	2	3
	HDI Rank	**DR**	**FS**	**MS**
Canada	1	2.28	5.4	21.5
United States	2	4.1	4.5	19.8
Japan	3	1.92	14.1	36.5
Belgium	4	2.6	11.6	26.8
Sweden	5	2.4	9.2	21.5
United Kingdom	6	2.6	3.2	11.7
France	7	2	10.7	31.5
Switzerland	8	2.8	11.6	29.2
Finland	9	2.7	11.8	43.4
Germany	10	2.3	8.7	23.2
Denmark	11	2.7	11.2	24.2
Austria	12	2.4	11	34.2
New Zealand	13	2.65	6.9	23.7
Spain	14	0.9	3.7	12.7
Portugal	15	1.9	4.4	12.2
Korea, Rep. of	16	2.12	6.7	14.5
Slovenia	17	1.1	12.6	45.3
Chile	18	0.42	1.4	10.2
Kuwait	19	1.58	1.6	1.6
Czech Republic	20	2.9	8.5	25.6
Uruguay	21	2.01	4.2	16.6
Slovakia	22	1.7	4.6	23.4
Hungary	23	2.4	16.7	50.6
Venezuela	24	0.79	1.9	8.3
Panama	25	0.65	1.9	5.6
Croatia	26	0.8	9.8	29.7
Belarus	27	4.3	10	61.1
Lithuania	28	2.9	15.6	79.1
Bulgaria	29	1.3	8.1	24.1
Thailand	30	0.9	2.4	5.6
Romania	31	1.4	4.6	20.3
Russian Federation	32	4.3	13.7	72.9
Ecuador	33	0.73	3.2	6.4
Kazakhstan	34	2.35	9.4	48.9
Brazil	35	0.6	1.8	6.6
Armenia	36	0.3	0.7	2.5
Dominican Republic	37	1.17	0	0
Sri Lanka	38	0.15	16.8	44.6
Jordan	39	1.22	0	0
Albania	40	0.6	3.6	6.3
Azerbaijan	41	0.7	0.2	1.1
Moldova, Rep. of	42	2.7	8.3	29.7
El Salvador	43	0.49	5.5	10.4

Table 2. Continued

Country	Domain 3 *Health*						
	4	5	6	7	8	9	10
	PGR	**IMR**	**LE**	**AIDS**	**TC**	**HE**	**DPR**
Canada	1.2	6	79	50.4	6.5	6.9	221
United States	1	7	76.7	225.3	7.9	6.5	245
Japan	0.6	4	80	1.2	33.5	5.6	177
Belgium	0.2	6	77.2	23.7	13.3	6.9	365
Sweden	0.4	4	78.5	17.6	5.6	7.1	299
United Kingdom	0.2	6	77.2	25.9	10.7	5.9	164
France	0.5	5	78.1	81	13.1	8	280
Switzerland	0.6	5	78.6	83.8	10.6	6.9	301
Finland	0.4	4	76.8	5.2	12.6	5.8	269
Germany	0.2	5	77.2	20.7	14.4	8.1	319
Denmark	0.2	6	75.7	40.1	9.2	6.9	283
Austria	0.3	5	77	21.7	17.1	5.9	327
New Zealand	0.9	7	76.9	17.1	8.7	5.7	210
Spain	0.5	5	78	123.3	21	5.8	400
Portugal	0.4	7	75.3	48	53.2	5	291
Korea, Rep. of	1.2	6	72.4	0.2	68.7	1.9	127
Slovenia	0.6	5	74.4	3.2	28.2	7.1	219
Chile	1.6	11	74.9	13.4	28	2.3	108
Kuwait	2.5	12	75.9	1.4	23.7	3.5	178
Czech Republic	0.1	6	73.9	1.1	19.1	6.9	293
Uruguay	0.7	18	73.9	28.7	21.6	1.9	309
Slovakia	0.6	10	73	0.3	28	6.1	325
Hungary	-0.2	10	70.9	2.8	43.2	4.9	337
Venezuela	2.7	21	72.4	30.4	25	1	194
Panama	2.1	18	73.6	52.5	41.1	4.7	119
Croatia	0.2	8	72.6	2.6	48.4	8.5	201
Belarus	0.5	14	68	0.2	53.9	5.3	379
Lithuania	0.5	13	69.9	0.3	70.2	5.1	399
Bulgaria	-0.2	16	71.1	0.6	36.8	3.6	333
Thailand	1.7	31	68.8	101.1	67.4	2	24
Romania	0.3	22	69.9	22.8	106.9	3.6	176
Russian Federation	0.4	20	66.6	0.2	75.1	4.3	380
Ecuador	2.5	30	69.5	5.2	54.1	2	111
Kazakhstan	0.7	37	67.6	0.1	84.8	2.2	360
Brazil	1.9	37	66.8	69.4	54	1.9	134
Armenia	1	25	70.5	0.2	26	3.1	312
Dominican Republic	2.2	44	70.6	48.7	75.4	1.8	77
Sri Lanka	1.4	17	73.1	0.4	30.1	1.4	23
Jordan	4	20	70.1	0.9	8	3.7	158
Albania	1.2	34	72.8	0.3	23.4	2.5	141
Azerbaijan	1.4	34	69.9	0.1	32.6	1.1	390
Moldova, Rep. of	0.6	25	67.5	0.4	66.8	5.8	356
El Salvador	1.7	31	69.1	34.1	29.1	2.4	91

Table 2. Continued

Country	Domain 4				Domain 5			
	Material Well-Being				*Feeling Part of One's Local Community*			
	11	12	13	14	15	16	17	18
	Y	**CEU**	**CS**	**PH**	**PR**	**CL**	**FALR**	**MALR**
Canada	22480	7880	3056	602	1	1	99	99
United States	29010	8051	3642	640	1	1	99	99
Japan	24070	4058	2905	489	1	2	99	99
Belgium	22750	5552	3543	465	1	2	99	99
Sweden	19790	5944	3160	682	1	1	99	99
United Kingdom	20730	3992	3237	528	1	2	99	99
France	22030	4355	3551	564	1	2	99	99
Switzerland	25240	3622	3280	640	1	1	99	99
Finland	20150	6143	2916	549	1	1	99	99
Germany	21260	4267	3330	538	1	2	99	99
Denmark	23690	4346	3808	618	1	1	99	99
Austria	22070	3373	3343	469	1	1	99	99
New Zealand	17410	4388	3405	499	1	1	99	99
Spain	15930	2583	3295	392	1	2	96.2	98.4
Portugal	14270	1928	3658	375	1	1	88.3	93.7
Korea, Rep. of	13590	3576	3336	430	2	2	95.5	98.9
Slovenia	11800	3098	3117	333	1	2	99	99
Chile	12730	1419	2810	156	2	2	94.9	95.4
Kuwait	25314	8167	3075	232	5	5	77.5	83.1
Czech Republic	10510	3917	3177	273	1	2	99	99
Uruguay	9200	912	2830	209	1	2	97.8	97
Slovakia	7910	3266	3030	232	2	4	99	99
Hungary	7200	2499	3402	261	1	2	99	99
Venezuela	8860	2463	2398	117	2	3	91.6	92.5
Panama	7168	853	2556	122	2	3	90.4	91.7
Croatia	4895	1418	2458	309	4	4	96.4	99
Belarus	4850	2386	3101	208	6	6	98.5	99
Lithuania	4220	2414	2805	268	1	2	99	99
Bulgaria	4010	2705	2756	313	2	3	97.6	98.8
Thailand	6690	1333	2334	70	3	3	92.8	96.7
Romania	4310	2027	2943	140	2	2	96.7	98.9
Russian Federation	4370	4169	2704	175	3	4	98.8	99
Ecuador	4940	731	2592	73	3	3	88.8	92.7
Kazakhstan	3560	2724	3007	116	6	5	99	99
Brazil	6480	1012	2938	96	3	4	83.9	84.1
Armenia	2360	474	2147	154	5	4	98.8	98.8
Dominican Republic	4820	652	2316	83	3	3	82.3	82.8
Sri Lanka	2490	371	2263	14	3	4	87.6	94
Jordan	3450	1040	2681	60	4	4	81.8	92.2
Albania	2120	362	2523	17	4	4	85	85
Azerbaijan	1550	1570	2139	85	6	4	96.3	96.3
Moldova, Rep. of	1500	1064	2562	140	3	4	97.4	99
El Salvador	2880	700	2515	56	2	3	74.2	80.1

Table 2. Continued

Country	Domain 6 Work and Productivity			Domain 7 Personal Safety		Domain 8 Quality of Environment		
	19	20	21	22	23	24	25	26
	UR	**CER**	**FEA**	**TTF**	**ME**	**CO2**	**DEF**	**ACH2O**
Canada	6.8	99	47.9	8690.81	1.4	13.8	-0.1	100
United States	4	94	45.7	4922.74	3.6	19.7	-0.3	100
Japan	4.7	85	43.3	1570.05	1	9.3	0.1	96
Belgium	8.4	100	32.9	8072.12	1.6	10.5	0.2	100
Sweden	6	100	51.2	13520.9	2.4	6.2	0	100
United Kingdom	5.5	100	42.6	8576.46	3	9.5	-0.5	100
France	9.7	92	39.1	5972.32	3	6.2	-1.1	100
Switzerland	1.9	79	42.5	5460.56	1.5	6.1	0	100
Finland	9.8	99	47.3	14026.7	1.6	11.6	0.1	96
Germany	9.9	88	41.1	8030.71	1.7	10.5	0	100
Denmark	5.3	89	51.2	10068.3	1.8	10.8	0	100
Austria	5.4	86	37	5975.01	0.9	7.3	0	100
New Zealand	6.3	95	43.6	12586.6	1.2	8.3	-0.6	97
Spain	14	92	31.1	2344.16	1.5	5.9	0	100
Portugal	4.3	91	42.4	760.78	2.4	4.9	-0.9	92
Korea, Rep. of	4.1	90	41.2	1195.96	3.2	9	0.2	93
Slovenia	7.1	76	45.4	1890.81	1.6	6.8	0	100
Chile	9	77	25.9	1309.38	1.6	3.4	0.4	87
Kuwait	1.8	57	24.8	1326.71	11.9	25.3	0	90
Czech Republic	8.7	74	51.3	3913.27	1.8	12.4	0	95
Uruguay	14	77	36.2	3382.93	1.5	1.8	0	95
Slovakia	17	75	49.9	1714.94	2.3	7.4	-0.1	100
Hungary	9.4	74	40.5	5056.05	1.6	6	-0.5	98
Venezuela	14	67	27.2	1107.44	1	6.5	1.1	92
Panama	13	73	28.8	726.64	1.2	2.5	2.2	84
Croatia	22	67	39.9	1151.38	14.5	3.9	0	95
Belarus	2.1	80	47.8	1254.58	1.2	6	-1	100
Lithuania	10.8	75	46.9	1995.16	0.5	3.7	-0.6	67
Bulgaria	17.7	70	47.8	2891.21	1.8	6.5	-0.57	99
Thailand	3.7	59	55.5	212.16	1.9	3.5	2.6	77
Romania	11.5	68	41.5	1597.08	3.5	5.3	-0.23	95
Russian Federation	10.5	77	48.1	1629.3	3.7	10.7	0	99
Ecuador	13	73	20.7	569.45	3.4	2.1	1.6	54
Kazakhstan	6	76	43.7	1038.82	1.5	10.4	-1.9	91
Brazil	7.1	80	32.1	1403.5	1.9	1.7	0.5	87
Armenia	20	72	46	325.89	4	1	-2.7	86
Dominican Republic	20	66	26.1	862.16	1.1	1.6	1.6	68
Sri Lanka	8.8	66	30.5	392.48	6	0.4	1.1	60
Jordan	15	66	13.6	474.63	8.8	2.5	2.5	99
Albania	16	68	41.5	192.33	1.5	0.6	0	97
Azerbaijan	20	71	37.9	214.92	2.6	4	0	90
Moldova, Rep. of	1.9	70	45.9	1042.22	0.8	2.7	0	100
El Salvador	10	64	28.9	878.99	0.9	0.7	3.3	47

Table 3. Rankings of Quality of Life Indicators data

Country		Domain 1	Domain 2	
		Relationship with Family and Friends	*Emotional Well-Being*	
		1	2	3
	HDI Rank	**DR**	**FS**	**MS**
Canada	1	26	20	21
United States	2	41	17	19
Japan	3	22	40	35
Belgium	4	32	35	29
Sweden	5	29	28	21
United Kingdom	6	32	11	14
France	7	23	32	33
Switzerland	8	38	35	30
Finland	9	35	37	36
Germany	10	27	27	23
Denmark	11	35	34	27
Austria	12	29	33	34
New Zealand	13	34	23	25
Spain	14	12	14	16
Portugal	15	21	16	15
Korea, Rep. of	16	25	22	17
Slovenia	17	14	38	38
Chile	18	3	5	12
Kuwait	19	19	6	4
Czech Republic	20	39	26	28
Uruguay	21	24	15	18
Slovakia	22	20	18	24
Hungary	23	30	42	40
Venezuela	24	10	8	11
Panama	25	7	8	6
Croatia	26	11	30	31
Belarus	27	42	31	41
Lithuania	28	39	41	43
Bulgaria	29	17	24	26
Thailand	30	12	10	6
Romania	31	18	18	20
Russian Federation	32	42	39	42
Ecuador	33	9	11	9
Kazakhstan	34	28	29	39
Brazil	35	5	7	10
Armenia	36	2	4	5
Dominican Republic	37	15	1	1
Sri Lanka	38	1	43	37
Jordan	39	16	1	1
Albania	40	5	13	8
Azerbaijan	41	8	3	3
Moldova, Rep. of	42	35	25	31
El Salvador	43	4	21	13

Table 3. Continued

Country	Domain 3 Health						
	4	5	6	7	8	9	10
	PGR	**IMR**	**LE**	**AIDS**	**TC**	**HE**	**DPR**
Canada	29	10	2	36	2	6	24
United States	27	16	13	43	3	11	23
Japan	19	1	1	15	27	19	30
Belgium	4	10	7	28	11	6	6
Sweden	11	1	4	24	1	4	17
United Kingdom	4	10	7	29	8	13	32
France	15	4	5	39	10	3	21
Switzerland	19	4	3	40	7	6	16
Finland	11	1	12	20	9	15	22
Germany	4	4	7	25	12	2	13
Denmark	4	10	15	33	6	6	20
Austria	9	4	10	26	13	13	11
New Zealand	26	16	11	23	5	18	26
Spain	15	4	6	42	15	15	1
Portugal	11	16	16	34	32	22	19
Korea, Rep. of	29	10	25	3	38	37	36
Slovenia	19	4	18	19	23	4	25
Chile	34	22	17	22	21	33	39
Kuwait	40	23	14	16	18	29	29
Czech Republic	3	10	19	14	14	6	18
Uruguay	24	28	19	30	16	37	15
Slovakia	19	20	23	7	21	12	12
Hungary	1	20	28	18	30	23	9
Venezuela	42	32	25	31	19	43	28
Panama	38	28	21	37	29	24	37
Croatia	4	19	24	17	31	1	27
Belarus	15	25	38	3	33	20	5
Lithuania	15	24	32	7	39	21	2
Bulgaria	1	26	27	12	28	27	10
Thailand	35	37	37	41	37	35	42
Romania	9	33	34	27	43	27	31
Russian Federation	11	30	42	3	40	25	4
Ecuador	40	36	35	20	35	35	38
Kazakhstan	24	41	39	1	42	34	7
Brazil	37	41	41	38	34	37	35
Armenia	27	34	30	3	20	30	14
Dominican Republic	39	43	29	35	41	40	41
Sri Lanka	32	27	22	10	25	41	43
Jordan	43	30	31	13	4	26	33
Albania	30	39	24	7	17	31	34
Azerbaijan	32	39	32	1	26	42	3
Moldova, Rep. of	19	34	40	10	36	15	8
El Salvador	35	37	36	32	24	32	40

Table 3. Continued

Country	Domain 4 Material Well-Being				Domain 5 Feeling Part of One's Local Community			
	11	12	13	14	15	16	17	18
	Y	**CEU**	**CS**	**PH**	**PR**	**CL**	**FALR**	**MALR**
Canada	7	3	19	5	1	1	1	1
United States	1	2	3	2	1	1	1	1
Japan	4	12	25	11	1	10	1	1
Belgium	6	6	5	13	1	10	1	1
Sweden	13	5	15	1	1	1	1	1
United Kingdom	11	13	13	9	1	10	1	1
France	9	8	4	6	1	10	1	1
Switzerland	3	15	12	2	1	1	1	1
Finland	12	4	24	7	1	1	1	1
Germany	10	10	10	8	1	10	1	1
Denmark	5	9	1	4	1	1	1	1
Austria	8	17	8	12	1	1	1	1
New Zealand	14	7	6	10	1	1	1	1
Spain	15	22	11	15	1	10	27	28
Portugal	16	28	2	16	1	1	43	34
Korea, Rep. of	17	16	9	14	21	10	28	24
Slovenia	19	19	16	17	1	10	1	1
Chile	18	30	27	28	21	10	29	32
Kuwait	2	1	18	23	40	41	40	41
Czech Republic	20	14	14	20	1	10	1	1
Uruguay	21	36	26	25	1	10	21	29
Slovakia	23	18	20	23	21	31	1	1
Hungary	24	23	7	22	1	10	1	1
Venezuela	22	24	38	33	21	24	31	36
Panama	25	37	34	32	21	24	32	38
Croatia	29	31	37	19	37	31	25	1
Belarus	30	26	17	26	42	43	22	1
Lithuania	34	25	28	21	1	10	1	1
Bulgaria	35	21	29	18	21	24	22	26
Thailand	26	32	39	39	29	24	30	30
Romania	33	27	22	30	21	10	24	24
Russian Federation	32	11	30	27	29	31	20	1
Ecuador	28	38	32	38	29	24	33	35
Kazakhstan	36	20	21	34	42	41	1	1
Brazil	27	35	23	35	29	31	37	40
Armenia	40	41	42	29	40	31	20	26
Dominican Republic	31	40	40	37	29	24	38	42
Sri Lanka	39	42	41	43	29	31	35	33
Jordan	37	34	31	40	37	31	39	37
Albania	41	43	35	42	37	31	36	39
Azerbaijan	42	29	43	36	42	31	26	31
Moldova, Rep. of	43	33	33	30	29	31	23	1
El Salvador	38	39	36	41	21	24	41	43

Table 3. Continued

Country	Domain 6			Domain 7		Domain 8		
	Work and Productivity			*Personal Safety*		*Quality of Environment*		
	19	20	21	22	23	24	25	26
	UR	**CER**	**FEA**	**TTF**	**ME**	**CO2**	**DEF**	**ACH2O**
Canada	16	4	7	39	11	41	13	1
United States	6	7	14	31	34	42	11	1
Japan	9	15	18	21	5	32	30	21
Belgium	19	1	31	37	16	35	32	1
Sweden	13	1	3	42	28	23	15	1
United Kingdom	12	1	19	38	31	33	9	1
France	24	8	27	34	31	23	3	1
Switzerland	2	18	20	33	12	22	15	1
Finland	25	4	10	43	16	39	30	21
Germany	26	13	24	36	22	35	15	1
Denmark	10	12	3	40	21	38	15	1
Austria	11	14	29	35	3	28	15	1
New Zealand	15	6	17	41	8	30	6	19
Spain	33	8	33	27	12	19	15	1
Portugal	8	10	21	9	28	17	5	28
Korea, Rep. of	7	11	20	16	33	31	32	27
Slovenia	17	22	15	25	16	27	15	1
Chile	22	19	39	18	16	12	34	33
Kuwait	1	43	40	19	39	43	15	31
Czech Republic	20	26	2	30	21	40	15	23
Uruguay	33	19	30	29	12	7	15	23
Slovakia	38	24	5	24	27	29	13	1
Hungary	23	26	25	32	16	20	9	18
Venezuela	33	36	37	14	5	25	36	28
Panama	31	28	36	8	8	9	40	36
Croatia	43	36	26	15	40	15	15	23
Belarus	4	16	8	17	8	20	4	1
Lithuania	29	24	11	26	1	14	6	39
Bulgaria	39	32	8	28	21	25	8	16
Thailand	5	42	1	2	25	13	42	37
Romania	30	34	22	22	35	18	12	23
Russian Federation	28	19	6	23	36	37	15	16
Ecuador	31	28	41	7	33	8	38	41
Kazakhstan	13	22	16	12	12	34	2	30
Brazil	17	16	32	20	25	6	35	33
Armenia	40	30	12	4	36	4	1	35
Dominican Republic	40	38	38	10	7	5	38	38
Sri Lanka	21	38	34	5	37	1	36	40
Jordan	36	38	42	6	38	9	41	16
Albania	37	34	22	1	12	2	15	19
Azerbaijan	41	31	28	3	30	16	15	31
Moldova, Rep. of	2	32	13	13	2	11	15	1
El Salvador	27	41	35	11	3	3	43	

Table 4. A Comparison of Quality of Life Indices

Country	Dom1	Dom2	Dom3	Dom4	Dom5	Dom6	Dom7	Dom8	HDI Rank	QOLI* Borda	QOLI* PC Based
Canada	26	21	12	6	1	3	29	22	1	5	6
USA	41	18	20	1	1	3	40	20	2	18	1
Japan	22	38	13	14	9	12	9	35	3	17	17
Belgium	32	31	3	4	9	16	32	28	4	16	5
Sweden	29	24	1	6	1	1	43	7	5	3	3
U.K.	32	13	11	12	9	6	42	9	6	10	12
France	23	32	9	3	9	21	40	2	7	6	8
Switzerland	38	32	8	5	1	11	23	6	8	4	7
Finland	35	37	6	13	1	9	37	41	9	30	4
Germany	27	25	2	9	9	22	35	17	10	8	9
Denmark	35	29	7	2	1	2	39	20	11	13	2
Austria	29	34	5	11	1	19	15	12	12	2	10
New Zealand	34	23	17	8	1	7	26	22	13	12	11
Spain	12	14	10	17	20	26	16	4	14	1	20
Portugal	21	15	23	16	21	9	14	16	15	9	21
Korea, S	25	20	30	15	24	7	26	41	16	39	23
Slovenia	14	39	13	19	9	19	19	9	17	7	19
Chile	3	8	33	24	27	29	13	33	18	18	32
Kuwait	19	5	27	10	43	32	35	39	19	35	30
Czech Rep.	39	27	4	18	9	14	30	32	20	26	15
Uruguay	24	16	27	26	19	30	19	13	21	20	28
Slovakia	20	22	15	21	18	25	30	9	22	14	24
Hungary	30	42	18	20	9	26	25	14	23	25	16
Venezuela	10	10	38	31	31	41	6	39	24	28	35
Panama	7	6	37	33	33	36	4	36	25	24	36
Croatia	11	29	16	30	29	40	33	18	26	29	29
Belarus	42	36	21	22	30	5	8	1	27	27	14
Lithuania	39	43	22	26	9	23	10	24	28	31	18
Bulgaria	17	25	19	24	28	28	26	15	29	21	26
Thailand	12	7	42	34	32	14	10	43	30	38	34
Romania	18	19	36	29	21	33	34	18	31	32	27
Russian	42	41	24	23	23	18	37	28	32	43	13
Ecuador	9	11	40	34	35	37	17	37	33	40	40
Kazakhstan	28	35	33	28	26	16	7	26	34	40	22
Brazil	5	8	41	32	40	24	23	30	35	37	37
Armenia	2	4	25	40	34	30	17	8	36	11	31
Dominican Rep.	15	1	43	38	39	42	5	34	37	32	42
Sri Lanka	1	40	35	43	36	34	21	31	38	42	38
Jordan	16	1	31	37	42	42	22	26	39	32	41
Albania	5	12	32	42	41	34	1	5	40	15	39
Azerbaijan	8	3	29	39	38	37	12	25	41	21	33
Moldova, Rep. of	35	28	26	36	25	13	3	2	42	23	25
El Salvador	4	17	39	41	37	39	2	38	43	35	43

Note: Dom1: Relationship with family and friends, Dom2: Emotional Well-being, Dom3: Health, Dom4: Material Well-being, Dom5: Feeling part of one's local community, Dom6: Work and productivity, Dom7: Personal safety, Dom8: Quality of environment.

Table 5. Correlation Matrix of Domain Indices of Quality of Life

	Dom1	Dom2	Dom3	Dom4	Dom5	Dom6	Dom7	Dom8
Dom2	0.577							
	0.000							
Dom3	-0.595	-0.530						
	0.000	0.000						
Dom4	-0.660	-0.371	0.781					
	0.000	0.014	0.000					
Dom5	-0.701	-0.585	0.813	0.824				
	0.000	0.000	0.000	0.000				
Dom6	-0.723	-0.431	0.584	0.726	0.726			
	0.000	0.004	0.000	0.000	0.000			
Dom7	0.419	0.218	-0.584	-0.664	-0.518	-0.398		
	0.005	0.160	0.000	0.000	0.000	0.008		
Dom8	-0.242	-0.240	0.466	0.212	0.304	0.234	-0.135	
	0.118	0.122	0.002	0.172	0.048	0.132	0.387	
HDI	***-0.491***	***-0.288***	***0.748***	***0.930***	***0.818***	***0.662***	***-0.571***	***0.142***
	0.001	***0.061***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.365***
QOLIBord	***-0.165***	***-0.059***	***0.696***	***0.560***	***0.598***	***0.371***	***-0.202***	***0.668***
	0.290	***0.708***	***0.000***	***0.000***	***0.000***	***0.014***	***0.194***	***0.000***
QOLI*pc	***-0.806***	***-0.591***	***0.857***	***0.894***	***0.913***	***0.820***	***-0.621***	***0.359***
	0.000	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.018***

	HDI	***QOLIBord***
QOLIBord	***0.624***	
	0.000	
QOLI*pc	***0.813***	***0.544***
	0.000	***0.000***

Table 6. Correlation Matrix of Quality of Life Indicators Rankings

	DR	FS	MS	PGR	IMR	LE	AIDS	TC
FS	0.541							
MS	0.601	0.941						
PGR	-0.569	-0.638	-0.644					
IMR	-0.465	-0.518	-0.432	0.564				
LE	-0.224	-0.213	-0.098	0.301	0.846			
AIDS	-0.044	-0.185	-0.271	0.066	-0.243	-0.433		
TC	-0.218	-0.014	0.072	0.125	0.598	0.752	-0.349	
HE	-0.543	-0.494	-0.466	0.665	0.773	0.609	-0.228	0.536
DPR	-0.544	-0.385	-0.504	0.583	0.231	0.039	0.297	0.055
Y	-0.426	-0.213	-0.132	0.260	0.793	0.829	-0.536	0.596
CEU	-0.676	-0.400	-0.382	0.443	0.729	0.624	-0.142	0.520
CS	-0.609	-0.367	-0.352	0.529	0.706	0.570	-0.318	0.433
PH	-0.628	-0.438	-0.394	0.599	0.885	0.781	-0.309	0.586
PR	-0.476	-0.445	-0.359	0.514	0.782	0.725	-0.511	0.517
CL	-0.395	-0.307	-0.200	0.414	0.727	0.699	-0.522	0.508
FALR	-0.670	-0.609	-0.631	0.613	0.659	0.512	-0.011	0.437
MALR	-0.777	-0.717	-0.777	0.704	0.626	0.362	0.118	0.280
UR	-0.500	-0.295	-0.270	0.090	0.364	0.247	-0.188	0.124
CER	-0.541	-0.321	-0.330	0.455	0.708	0.624	-0.265	0.488
FEA	-0.557	-0.416	-0.454	0.515	0.269	0.020	0.211	0.058
TTF	0.660	0.482	0.471	-0.624	-0.754	-0.647	0.312	-0.590
ME	-0.173	-0.197	-0.235	-0.006	0.041	0.080	-0.146	-0.020
CO2	0.662	0.352	0.374	-0.437	-0.609	-0.475	0.016	-0.376
DEF	-0.472	-0.286	-0.423	0.579	0.251	0.166	0.240	0.125
ACH2O	-0.563	-0.350	-0.382	0.559	0.649	0.526	-0.170	0.563
HDI Rank	***-0.491***	***-0.326***	***-0.269***	***0.424***	***0.883***	***0.877***	***-0.441***	***0.619***
QOLI*Bor	***-0.165***	***-0.081***	***-0.057***	***0.390***	***0.644***	***0.745***	***-0.341***	***0.652***
QOLI*pc	***-0.806***	***-0.597***	***-0.591***	***0.681***	***0.786***	***0.610***	***-0.167***	***0.510***

	HE	DPR	Y	CEU	CS	PH	PR	CL
DPR	0.361							
Y	0.566	0.020						
CEU	0.628	0.334	0.782					
CS	0.613	0.310	0.746	0.705				
PH	0.779	0.347	0.818	0.831	0.769			
PR	0.603	0.195	0.704	0.564	0.688	0.767		
CL	0.506	0.054	0.679	0.511	0.639	0.752	0.916	
FALR	0.702	0.479	0.517	0.700	0.567	0.737	0.652	0.549
MALR	0.774	0.547	0.410	0.666	0.538	0.703	0.506	0.401
UR	0.253	-0.018	0.523	0.465	0.540	0.407	0.272	0.271
CER	0.552	0.330	0.661	0.655	0.738	0.793	0.687	0.671
FEA	0.428	0.391	0.078	0.404	0.220	0.416	0.228	0.204
TTF	-0.694	-0.360	-0.708	-0.798	-0.720	-0.854	-0.792	-0.709
ME	0.024	0.184	0.028	-0.061	0.007	0.027	0.292	0.189
CO2	-0.531	-0.331	-0.686	-0.933	-0.626	-0.701	-0.435	-0.373
DEF	0.424	0.675	0.100	0.358	0.436	0.458	0.195	0.136
ACH2O	0.776	0.482	0.507	0.605	0.638	0.694	0.483	0.386
HDI Rank	***0.670***	***0.146***	***0.939***	***0.810***	***0.754***	***0.912***	***0.791***	***0.762***
QOLI*Bor	***0.639***	***0.340***	***0.515***	***0.366***	***0.508***	***0.662***	***0.606***	***0.585***
QOLI*pc	***0.768***	***0.521***	***0.697***	***0.852***	***0.771***	***0.905***	***0.704***	***0.656***

	FALR	MALR	UR	CER	FEA	TTF	ME	CO2
MALR	0.905							
UR	0.259	0.346						
CER	0.626	0.583	0.368					
FEA	0.557	0.631	0.284	0.306				
TTF	-0.782	-0.696	-0.280	-0.743	-0.354			
ME	0.198	0.130	0.114	0.095	0.018	-0.155		
CO2	-0.647	-0.634	-0.428	-0.531	-0.437	0.669	0.068	
DEF	0.495	0.550	0.108	0.332	0.495	-0.371	-0.056	-0.341
ACH2O	0.620	0.682	0.303	0.602	0.378	-0.661	0.071	-0.524
HDI Rank	***0.662***	***0.568***	***0.444***	***0.798***	***0.240***	***-0.786***	***0.053***	***-0.697***
QOLI*Bor	***0.496***	***0.383***	***0.099***	***0.566***	***0.188***	***-0.517***	***0.221***	***-0.221***
QOLI*pc	***0.842***	***0.851***	***0.474***	***0.808***	***0.565***	***-0.856***	***0.079***	***-0.759***

	DEF	ACH2O	HDI Rank	QOLI*Bor
ACH2O	0.459			
HDI Rank	***0.239***	***0.603***		
QOLI*Bor	***0.464***	***0.691***	***0.624***	
QOLI*pc	***0.531***	***0.741***	***0.813***	***0.544***

Annex A:

The Data sources and measurements of indicators

Domains/Indicators	***Units***	***Code***	***Sources***
Divorce Rates	(per 1000 people)	DR	Gulnar and Nugman (2002) ,Heritage Foundation
Male Suicide Rates	(per 100,000 people)	MS	WHO, Mental Health Data
Female Suicide Rates	(per 100,000 people)	FS	,,
Annual Population Growth Rate	(Percent), 1995-97.	PGR	HDR, 99
Infant Mortality Rate	(per 1000 live births)	IMR	,,
Life Expectancy at Birth	(years)	LE	,,
AIDS Cases	(per 100,000 people), 1997	AIDS	,,
Tuberculosis Cases	(per 100,000 people), 1996	TC	,,
Public Health Expenditure	(percent of GDP), 1995	HE	,,
Number of Doctors	(per 100,000 people), 1993	DPR	,,
Real GDP per capita	(PPP US $), 1997	Y	,,
Per Capita Commercial Energy Use (oil equivalent)	(kg), 1996	CEU	,,
Daily per capita supply of Calories		CS	,,
Telephone Lines	(per 1000 people), 1996	PH	,,
Political Rights Index	On the scale of 1 to 7 (1 represents the most free, and 7 the least free	PR	Freedom in the World, 1997-98
Civil Liberties Index	,,	CL	,,
Adult Literacy Rate, Female	(percent)	FALR	HDR, 99
Adult Literacy Rate, Male	(percent)	MALR	,,
Unemployment Rate	(percent)	UR	Globastat
Combined first, second, and third level gross enrolment Ratio	(percent), 1997	CER	HDR, 99
Female Economic Activity Rate (age 15+)	(percent), 1997	FEA	HDR, 99
Total Number of Offences	(number), 1997	TTF	International Crime Statistics, INTERPOL
Military Expenditure	(percent of GDP), 1996	ME	HDR, 99
CO2 emissions, per capita	(metric tons), 1996	CO2	,,
Average Annual Rate of Deforestation	(percent), 1990-95	DEF	,,
Population with Access to Safe Water	(percent)	ACH2O	,,

Annex B

Countries in the Sample and Classification*

Classification (by Income Group)	***Countries in the Sample***
Low Income	Armenia, Azerbaijan, Moldova.
Lower Middle Income	Belarus, Bulgaria, Thailand, Romania, Russia, Ecuador, Kazakhstan, Brazil, Dominican Republic, Sri Lanka, Jordan, Albania, El Salvador.
Upper Middle Income	Chile, Czech Republic, Uruguay, Slovakia, Hungary, Venezuela, Panama, Croatia, Lithuania.
High Income	Canada, United States, Japan, Belgium, United Kingdom, France, Switzerland, Finland, Denmark, Germany, Austria, Spain, Portugal, South Korea, Slovenia, Kuwait, New Zealand, Sweden.

***Source: World Bank.** Economies are divided according to 2001 GNI per capita, calculated using The World Bank Atlas Method. The groups are: *low income*, $745 or less; *Lower middle Income*, $746-$2975; *upper middle income*, $2976-$9205; *High income,* $ 9,206 or more.