

# **A COMPARATIVE MEASURE OF WELFARE AMONG SMALL COUNTRIES**

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## **INTRODUCTION**

The Overseas Development Council [2] has devised a measure which includes life expectancy, infant mortality and literacy as its basic elements. It is called the Physical Quality of Life Index (PQLI) and is designed to observe the social progress or decline of nations by means other than GNP. The PQLI consolidates the data into a composite index by rating each factor on a scale from 1 to 100 and then ranking the countries according to their performance within these limits.

This paper illustrates the development of a composite index which includes the basic three factors suggested by the PQLI, but uses a taxonomic distance criterion adopted by Lin [1]. The index may serve as a means of comparison among small nations. First, since the component variables are expressed in incomparable units of measure, the data are normalized with a conventional transformation:

$$z_{ij} = (x_{ij} - \bar{x}_j) / s_j \quad (1)$$

where

$z_{ij}$  = the standardized score of country  $i$  for factor  $j$ ,

$x_{ij}$  = the given value that country  $i$  takes for the factor  $j$ ,

$\bar{x}_j$  = the average value of all observations for factor  $j$ , and

$s_j$  = the standard deviation of factor  $j$ .

The multi-dimensional distance is then computed as:

$$d(c,u) = [\Sigma(C_j - U_j)^2]^{1/2} \quad (2)$$

where

$c$  = country other than an ideal country,

$u$  = ideal country,

$C_j$  = standardized score of factor  $j$  for country  $c$ , and

$U_j$  = standardized score of factor  $j$  for the ideal country.

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The ideal country is taken to be the country with the most favorable figure for each factor. For instance, if Norway has achieved the best result in life expectancy, then Norway is chosen as the ideal country for this particular factor.

## DATA ANALYSIS AND RESULTS

For the purpose of measuring human progress for small countries by means of the proposed taxonomic distance measure,  $m$ , various comparative analyses were made for the years 1960 and 1980. The data were taken from the World Development Report 1984, published by the World Bank [4]. Countries with populations in the range between approximately one million and five million were included.

Table 1 (see Appendix) displays the computed taxonomic distance measures for 1960 and 1980. Due to missing observations, only thirty-one computations were possible for 1960, and only thirty-seven for 1980. The ideal countries for both years were Norway and Finland. That is, these two nations served interchangeably as the standards of comparison. Columns 3 and 4 supply per capita GNP for 1960 and 1980. The 1960 GNP data were estimated, using the relation  $p_{1960} = p_{1980}/(1 + r)^n$ , where  $p$  is per capita GNP,  $r$  is the average 1960-80 per capita GNP growth rate and  $n$  is the period span, 20 years. Several statistical procedures were undertaken to investigate the advance in quality of life as depicted by the composite measure of the three social indicators.

## PAIRED HYPOTHESIS TEST

In this analysis, the distance measures for 1960 and 1980 are compared. Since the observations of the two periods are not independent, a paired comparison was deemed appropriate. If we define:

$$d_j = m_{2j} - m_{1j} \quad (3)$$

where  $m_{1j}$  and  $m_{2j}$  represent the taxonomic distance measures of the  $j$ th country for 1960 and 1980, respectively, then:

$$\bar{d} = \Sigma d_j / 27 \quad \text{and} \quad s_d^2 = \Sigma (d_j - \bar{d})^2 / (n - 1) \quad (4)$$

To test the null hypothesis that  $D$ , the population mean of differences, is zero, the proper test statistic is given by:

$$t = \bar{d} / s_d \quad (5)$$

The computations yield a  $t$ -value equal to  $-6.0$ . On comparing with the tabular value of  $t_{.025, 26} = \pm 2.056$ , the null hypothesis cannot be accepted since  $-6$  is less than  $-2.056$ . Thus, it may be concluded that a significant difference between the two measures does exist.

An interpretation of this result is that the taxonomic distance between the component countries has narrowed considerably during the twenty-year period under consideration. In other words, the quality of life, as reflected by infant mortality, literacy and life expectancy, has significantly improved for the sample countries in the 1960-1980 period.

#### PAIRED CORRELATIONS

A second form of analysis involves the use of Spearman's rank correlation,  $r_s$ , given by:

$$r_s = 1 - [6\sum d_i^2 / (n^3 - n)] \quad (6)$$

where  $d_i$  is the difference between the two ranks assigned to the  $i$ th observation, and  $n$  is the number of observations. This coefficient is used to test whether rank correlation exists among specified variables. The results are as follows:

(a) $m_{60}$ vs $m_{80}$	=	.97,	$n = 27$
(b) $p_{60}$ vs $p_{80}$	=	.95,	$n = 40$
(c) $m_{60}$ vs $p_{60}$	=	-.82,	$n = 28$
(d) $m_{80}$ vs $p_{80}$	=	-.88,	$n = 35$

where  $m$  represents the taxonomic distance,  $p$  is per capita GNP, and  $n$  is the number of possible comparisons between the two variables under investigation.

The ranks for the taxonomic distance and for per capita GNP are displayed in Table 1 for both 1960 and 1980. Note that low ranks are associated with high GNP values, and accordingly the highest GNP (e.g., United Arab Emirates in 1960) receives rank 1. The reverse is true for the rankings of the taxonomic distance, and, hence the smallest distance (e.g., Norway in 1980) receives rank 1. For this reason, the coefficients for results (a) and (b) are positive, while the coefficients for (c) and (d) are negative.

Spearman's rank correlation,  $-1 \geq r_s \geq 1$ , is a distribution-free test statistic for independence based on the rankings of two variables. Results (a) and (b) suggest that during the 20 year period under investigation, very little change occurred in the relative position of the countries for the quality of life measure as well as the GNP. Thus, it may be concluded that, despite progress by individual nations, relative economic or social improvement is not easily attained. Results (c) and (d) support the general belief that quality of life and economic well-being are closely linked. In other words, the data confirm that countries with a high per capita GNP will generally support a quality of life close to the ideal.

## GROUPED MEANS

The third analysis compares the well-being (as measured by the taxonomic distance) in 1960 and 1980 of the low income economies and the lower middle income economies. The countries were categorized by the World Bank (see Appendix, Table 2). To test the hypothesis that the means of the two groups do not differ significantly, let:

$m_{1j}$  = taxonomic distance for country  $j$  in the low income economies, where  $j=1,2,\dots,n_1$ , and

$m_{2j}$  = taxonomic distance for country  $j$  in the lower middle income economies, where  $j = 1,2,\dots,n_2$ .

Then  $m_1 = \Sigma \bar{m}_{1j}/n_1$  and  $\bar{m}_2 = \Sigma m_{2j}/n$  (7)

The proper test statistic is given by:

$$t = (\bar{m}_1 - \bar{m}_2)/s_{(\bar{m}_1 - \bar{m}_2)} \quad (8)$$

where  $s_{(\bar{m}_1 - \bar{m}_2)} = [s_1^2/n_1 + s_2^2/n_2]^{1/2}$  (9)

and  $s_1^2$  and  $s_2^2$  are the estimated variances of the two classifications. For 1960, the values of  $n_1$  and  $n_2$  are 12 and 10, respectively, while for 1980, they are both 12. The proper degrees of freedom (see Snedecor [3, p. 97]) for the t-test are 11 and 15 for 1960 and 1980, respectively.

The computed t-values are:  $t = 4.35$  for 1960, and  $t = 4.77$  for 1980. On comparing with the tabular  $t_{.025, 11} = 2.593$  and  $t_{.025, 15} = 2.490$ , the null hypothesis of equality of means is rejected for both 1960 and 1980. This result indicates that the means of the distance measures for the two economies differ significantly during both periods. The implication is that better economic standards contribute positively to the basic human needs as depicted by the components of the index.

## CONCLUSIONS

This paper has undertaken to construct an ordinal measurement for a comparison in the quality of well-being among small nations. By choosing two time periods as a basis of comparison, the relative speed by which some countries were able to narrow the gap between themselves and the most favored countries could be observed. In a sense, the elements that were included in the index are value free, since it could be assumed that all nations, irrespective of culture and ideals, hope to attain these goals: longer life, reduced illness and greater opportunity.

It was possible to show that many small nations were able to improve their situation significantly, even under the constraints of low per capita GNP. Development strategies that take into account specific modest goals may be more successful than ambitious programs designed to emulate European cultural values.

## APPENDIX

TABLE 1: *Taxonomic Distance, per Capita GNP (1980 US\$) and Average Growth Rate for Selected Small Nations (1960 and 1980)*

	Taxonomic Distance (m)		Per Capita GNP		Rankings		GNP	
	1960	1980	1960	1980	1960	1980	1960	1980
<b>Low Income Economies</b>								
Chad	4.91	4.67	173	120	28	35	34	39
Rwanda	4.31	3.60	148	200	22	25	35	38
Burundi	4.17	3.96	122	200	21	29	37	37
Somalia	4.96	4.53	*	*	29	34	*	*
Haiti	4.12	3.57	244	270	19	24	32	36
Benin	4.54	3.79	286	310	24	27	29	32
Central Afr. Rep.	4.53	3.72	251	300	23	26	31	33
Guinea	5.00	5.17	273	290	30	36	30	34
Niger	4.65	4.44	456	330	26	33	24	31
Toga	4.68	4.09	227	410	27	30	33	30
Sierra Leone	5.03	5.25	*	280	31	37	*	35
Bhutan	*	*	82	80	*	*	38	40
Lao PDR	3.89	4.21	*	*	18	31	*	*
<b>Lower Middle Income Economies</b>								
Mauritania	4.58	4.30	320	440	25	32	28	27
Yemen, PDR	*	3.91	43	420	*	28	39	29
Liberia	4.15	3.36	394	530	20	23	27	26
Lesotho	*	2.88	129	420	*	21	36	28
Honduras	3.22	2.28	450	560	13	20	25	25
El Salvador	2.84	1.99	480	660	12	18	22	24
Papua New Guinea	3.88	3.31	449	780	17	22	26	22
Nicaragua	*	2.05	619	740	*	19	19	23
Congo	3.44	*	767	900	15	*	18	21
Costa Rica	*	.41	921	1730	*	8	16	16
Dominican Rep.	2.48	1.87	594	1160	11	17	21	9
Jamaica	.99	.41	923	1040	5	7	15	20
Paraguay	1.80	1.23	692	1300	8	13	20	18
Lebanon	*	*	*	*	*	*	*	*
Mongolia	2.11	*	*	*	10	*	*	1*
<b>Upper Middle Income Economies</b>								
Jordan	3.31	1.72	469	1420	14	16	23	17
Panama	1.36	.78	904	1730	7	12	17	15
Uruguay	*	.57	2128	2810	*	9	11	14
Israel	.57	*	2134	4500	3	*	10	10
Hong Kong	1.00	.34	1137	4240	6	6	13	13
Singapore	*	.64	1043	4430	*	10	14	11
Trinidad & Tobago	.82	.75	2420	4370	4	11	9	12
<b>High Income Oil Exporters</b>								
Oman	*	*	1461	6090	*	*	12	8
Libya	3.66	*	3135	8640	16	*	7	6
Kuwait	2.08	1.43	24740	19830	9	14	1	2
United Arab Em.	*	1.67	11568	26850	*	15	2	1
<b>Industrial Market Economies</b>								
Ireland	.28	.26	2650	4880	1	4.5	8	9
New Zealand	*	.26	4962	7090	*	4.5	5	7
Finland	.39	.24	4436	9720	2	3	6	5
Denmark	*	.09	6765	12950	*	2	3	3
Norway	*	.04	6358	12650	*	1	4	4

TABLE 2: *Infant Mortality, Literacy, Life Expectancy and Population for Selected Small Nations (1960 and 1980)*

	Infant Mortality		Literacy		Life Expectancy		Population
	1960	1980	1960	1980	1960	1980	1980
<b>Low Income Economies</b>							
Chad	210	161	6	15	35	44	4.5
Rwanda	167	126	16	50	37	46	5.2
Burundi	143	123	14	25	37	47	4.1
Somalia	213	184	2	60	36	39	3.9
Haiti	182	110	15	23	44	54	5.0
Benin	173	117	5	28	37	48	3.4
Central African Rep.	170	119	7	33	36	48	2.3
Guinea	222	190	7	20	35	38	5.4
Niger	178	132	1	10	37	45	5.3
Togo	201	122	10	18	37	47	2.5
Sierra Leone	235	190	7	15	37	38	3.5
Bhutan	243	163	*	*	38	43	1.3
Lao PDR	180	159	28	44	44	43	3.4
<b>Lower Middle Income Economies</b>							
Mauritania	178	132	5	17	37	45	1.5
Yemen, PDR	210	140	*	40	36	46	1.9
Liberia	173	91	9	25	44	54	1.9
Lesotho	137	94	*	52	42	53	1.3
Honduras	145	83	45	60	46	60	3.7
El Salvador	136	72	49	62	51	63	4.5
Papua New Guinea	165	99	29	32	41	53	3.0
Nicaragua	144	86	*	90	47	58	2.6
Congo, People's Rep.	118	68	16	*	48	60	1.6
Costa Rica	74	18	*	90	62	74	2.2
Dominican Republic	120	65	65	67	51	62	5.4
Jamaica	52	10	82	90	64	73	2.2
Paraguay	86	45	75	84	56	65	3.2
Lebanon	68	39	*	*	58	65	2.7
Mongolia	109	51	95	*	52	65	1.7
<b>Upper Middle Income Economies</b>							
Jordan	136	65	32	70	47	64	3.2
Panama	68	33	73	85	62	71	1.8
Uruguay	51	34	*	94	68	73	2.9
Israel	31	16	84	*	69	74	3.9
Hong Kong	37	10	70	90	67	75	5.1
Singapore	35	11	*	83	64	72	2.4
Trinidad and Tobago	45	26	93	95	68	64	1.2
<b>High Income Oil Exporters</b>							
Oman	193	123	*	*	*	52	1.1
Libya	158	95	22	*	47	57	3.0
Kuwait	89	32	47	60	60	71	1.4
United Arab Emirates	135	50	*	56	47	71	1.0
<b>Industrial Market Economies</b>							
Ireland	29	11	97	98	70	73	3.3
New Zealand	23	12	*	99	72	73	3.3
Finland	22	7	99	100	68	73	4.9
Denmark	22	8	*	99	72	75	5.1
Norway	19	8	*	99	73	76	4.1

Source: *World Development Report 1984*, (New York, Oxford University Press, 1984).

**REFERENCES**

- [1] Lin, S., "Comparative Quality of Life", *The New Economics of Less Developed Countries: Changing Perception in the North-South Dialogue*, (Ed.) N. Karmany, (Boulder: Westview Press, Inc. 1978).
- [2] Overseas Development Council, *The United States and World Development: Agenda 1977*, (New York: Praeger Publishers, 1977).
- [3] Snedecor, G.W., and W.G. Cochran, *Statistical Methods*, (Ames: The Iowa State University Press, 1980), pg. 97.
- [4] World Bank, *World Development Report 1984*, (New York: Oxford University Press, 1984).

