ECONOMIC GROWTH CENTER

YALE UNIVERSITY

Box 1987, Yale Station
New Haven, Connecticut

CENTER DISCUSSION PAPER NO. 134

INTERNATIONAL SOCIAL WELFARE COMPARISONS:

A NEW APPROACH

James Elliott

December 1971

INTERNATIONAL SOCIAL WELFARE COMPARISONS
A NEW APPROACH

James A. M. Elliott

Can differences in patterns of per capita consumption of goods and services and other, welfare-relevant variables among countries be explained in terms of one or a few basic factors with strong social welfare interpretations, permitting the estimation of relative levels of social welfare for countries varying widely in level of economic development, historical and cultural background, and political organization? If so -- as in the course of this paper we shall see is the case -- a considerable forward advance is possible in the making of international social welfare comparisons which hitherto have relied mainly on national income accounting estimates of aggregate per capita consumption of goods and services.

In this paper, major attention will be focused on application of the techniques of factor analysis to estimate, from patterns of consumption in non-monetary terms, basic welfare-relevant factors in terms of which international social welfare comparisons can be made. But first, a brief discussion of the concept of social welfare and of the inadequacies of conventional social welfare measures is in order. Social welfare is defined, following Bergson,[1] as a function of the level and distribution of economic goods and services and the workload required to produce them over the individual members of a society, given a specified set of values concerning distribution and its tradeoffs with increases in aggregate consumption of

goods, services and leisure. In this paper, it is assumed that societies' efforts to maximize their social welfare functions subject to the trade and production possibilities constraints facing them will be reflected in their chosen patterns of aggregate consumption per capita and other welfare-relevant variables.

Why is there a need for a new method of measuring social welfare, alternative or complementary to the national income accountant's aggregate per capita consumption approach? In comparing alternative consumption baskets for a community, account must be taken of all possible income distributional changes which may be involved in substituting the one basket for the other, as well as of the differences in aggregate consumption of each and every item in the baskets. The two baskets may be ranked differently with respect to different sets of prices (corresponding to different real income distributions). If income distributional considerations are to be disregarded, either because of inadequate factual information or unwillingness to make ethical judgments, we may try to interpret comparisons using national income data as providing information on a ranking of alternative baskets based on their potential social welfare superiority, without reference having to be made to the actual distribution of effects on individuals' welfare positions caused by moving from one alternative to the other. The problem with this approach, however, is that the information is never sufficient to make possible unambiguous conclusions on the potential welfare significance of one alternative against another.

The two sets of binary quantity index comparisons possible using the prices of the two countries as weights may be regarded as providing infor-

mation on the fulfillment or nonfulfillment of the Kaldor-Hicks compensation and Scitovsky nonreversal criteria, agreement of which is necessary for one country's basket to be pronounced potentially superior to the other for either of the income distributions involved. However, taking into account the curvature of the Scitovsky community indifference curves to which the Kaldor-Hicks and Scitovsky criteria refer, it is evident that quantity index comparisons cannot permit unambiguous inferences on both criteria at once, except when they may be shown to contradict each other.[2] Moreover, even if this were not the case, Samuelson has demonstrated[3] that agreement of the two criteria on the potential superiority of one situation over another does not suffice to prove that situation's superiority in general, since for this other distributions and possible aggregate goods collections are relevant and for some of these the ranking may be reversed.

Although use of a geometric average of price weights in making quantity index comparisons will avoid the possibility of a contradiction between quantity index comparisons using I's prices and II's prices separately, at a theoretical level it does not solve the problem of establishing potential social welfare superiority of one situation over another. Thus the use of this device by Gilbert and Kravis[4] and by Colin Clark[5] does not suffice to establish their measures as measures of potential economic superiority. By extension, the predicted aggregate consumption variable of Beckerman and Bacon[6] does not bear a clear social welfare interpretation, nor would any other predictions of this nature.

A commonly used alternative to the binary comparisons -- comparison of own currency measures of aggregate consumption converted at equilibrium

market rates of exchange into common unit (dollars usually) -- is especially objectionable as a social welfare measure because deviation of equilibrium exchange rates from purchasing power parity systematically biases such a comparison against the countries with absolute advantage in goods and services not entering into international trade -- in practice the poorer countries.[7] Yet, even if the purchasing power parity doctrine held in practice, since an own currency comparison between two countries would utilize a different price weight set for each country, no clear compensability interpretation could emerge even potentially.

In short, it is evident that the potential social welfare concept breaks down under examination and cannot be operationalized using national income accounting measures of whatever degree of accuracy and comprehensiveness. At the same time, the price/quantity comparisons do not permit any conclusions as to actual social welfare attainment. This suggests the advisability of an alternative approach -- one taking distributional considerations into account and paying attention to the specific pattern of per capita consumption of selected economic goods and services. Such an approach is explored in this paper.

Using this approach, we assume the existence of a social welfare function underlying a community's behavior as mediated through the market system and government policy, which can be estimated from observed patterns of per capita consumption.

It is argued that the observed per capita consumption pattern of a country can be explained in terms of one or a few components of social welfare, fewer in number than the number of individual consumption variables

themselves. The pattern can be estimated by means of a factor analysis with the individual variables as a linear combination of the factors, which are the components of social welfare. Each country is assumed, by joint operation of government policy and free market action, to maximize its social welfare function, $SW(X_1, X_2, \ldots X_m)$, subject to its resource endowment and technology constraints, summarized in a production possibility curve $P(X_1, X_2, \ldots X_m)$. Social welfare, which is a function of total income and its distribution, as reflected in the particular configuration of the society's average per capita consumption levels for the individual variables X_1, X_2, ... etc., may have one or more basic components.

In the factor analysis model, the ith variable, or in our case the ith consumption variable, can be written as a linear combination of p common factors (p equal to or less than the number m of variables), a unique factor U_i, and an error term E_i:

$$X_i = \sum_{j=1}^{p} a_{ij} Y_j + b_i U_i + c_i E_i \qquad (i = 1, 2, \ldots m)$$

If factors are mutually orthonormal, the quantity a_{ij} is the correlation of the ith variable with the jth factor, and the quantity $\sum_{i=1}^{m} a_{ij}^2$ is the contribution of the jth common factor to the total variance of the individual variables, while $\sum\sum_{i \neq k}^{mm} a_{ij} a_{kj}$ is the contribution of the jth common factor to explaining correlations between individual variables. If the common factors have been specified so as to be correlated with each other (common factor axes mutually oblique), a_{ij}^2 is the contribution made independently by the jth common factor to the variance of the ith variable. For the full contribution one would have to take into account the correlation

of the jth common factor with other common factors also related to the ith variable. In the case of correlated factors, the a_{ij} are to be treated as regression coefficients of variables on common factors.[8]

The number of uncorrelated common factors needed as basic components of social welfare to explain the interrelations of the m individual variables, using some standard criterion of when to stop extracting factors from the data correlation matrix, is taken as the number of basic components of social welfare. In the case where one factor suffices, we have a unidimensional measure of social welfare.

Since a regression of actual welfare scores on individual variable observations yields regression coefficients which are linear functions of these variables, it follows that predicted welfare scores are linear functions of the individual variables. (Actual welfare scores, of course, are not available for individual countries at any point. But in the least squares regression equation, true factor scores enter only to form, after simplification, the matrix of factor intercorrelations which is already known from the factor estimation procedure already completed). Thus, for the jth factor and the kth observation, we may write, where the $\hat{b}_{ij}$ are the least squares regression coefficients of factors on variables:

$$\hat{Y}_{jk} = \sum_{i=1}^{m} \hat{b}_{ij} X_{ik} \qquad (j = 1, 2, \ldots p)$$

with X_{ik} the observed value of the ith individual variable for the kth country. If we choose to think of individual variables as being better explained as multiplicative combinations of factors of form

$$X_i = \prod_{j=1}^{p} Y_j^{a_{ij}} U^{b_i} E_i^{c_i} \qquad (i = 1, 2, \ldots m)$$

factor analysis can be performed on the logs of the individual variables, and predicted welfare scores will be multiplicative functions of observations on the individual consumption variables:

$$Y_{jk} = \prod_{i=1}^{m} X_{ik}^{\hat{b}_{ij}} \qquad (j = 1, 2, \ldots p)$$

In either case, if a unifactor model is appropriate to the data, these predicted scores can be viewed as denoting each country's estimated social welfare, and as giving a social welfare ranking of the entire sample of countries for which the individual variable data is available.

It should be noted that the linear version of the model results in the estimation of straight line iso-social-welfare curves, whereas the logarithmic specification allows for curvature in the iso-social-welfare curves. In either case, if the transformation curve is viewed as convex from above and differing from country to country (reasonable in view of transportation cost and tariff/quota barriers in international trade), while all countries are assumed to be maximizing the same social welfare function, the scatter of individual variable consumption patterns determines a set of common social welfare indifference curves for all countries in the sample, which may be estimated by factor analysis of the consumption patterns and in terms of which the countries of the sample may be ranked.

The logarithmic specification seems intuitively more appealing than the linear version of the model since it allows for the possibility of diminishing marginal rates of substitution between consumption variables in

the production of social welfare. This is the specification chosen for the factor analyses to be discussed later in this paper.

For the multiple factor case, social welfare must be viewed as having more than one basic component. The problem with this case is: How do we interpret the factors taken individually? It would appear that the appropriate interpretation is to regard the factors as direct arguments in the social welfare function, and to treat individual consumption variables as intermediate goods. The regression equations of factor scores on variables now become the equivalent of production functions for direct inputs into the social welfare function, somewhat analogous to Kelvin Lancaster's "consumption activities" functions for the individual consumer.[8] In short, we write for our social welfare function $SW = SW(Y_1, Y_2, \ldots Y_p)$, with the usual conditions of positive first partial derivatives, diminishing marginal rates of substitution, etc., noting that the welfare component estimates Y_j, $j = 1, 2, \ldots p$, are linear functions of variable observations in the linear version of the model and multiplicative functions of the variable observations in the logarithmic specification.

For constrained maximization of the social welfare function, whatever its specific form may be, a necessary a priori condition is that the marginal rates of substitution between any two consumption variables X_i and X_j should be the same for the production of any basic component Y_k or Y_m of social welfare. The regression coefficients b_{ij} cannot be used to directly calculate these marginal rates of substitution in the multifactor case, however, for they apply to total variable quantities, whereas the coefficients relevant for calculating the marginal rates of substitution apply only to

the shares of the total quantities distinguishable as allocated to production of the basic components Y_k and Y_m in question. The regression coefficients are combinations of these coefficients, and the coefficients denoting the shares of the variables going to production of each basic component. Once this is recognized, the possibility arises of calculating implicit price ratios between variables as well as breakdowns of individual variables among basic social welfare components, both on average, and by country. We do not pursue this possibility in this paper, but mention it here as relevant for research at a later stage.

In the case of the linear model, of course, the same implicit price ratios among variables must prevail for all countries, because of the straight line indifference curve assumption. In the logarithmic case, this is not so, and it can be shown that each country has its own set of implicit price ratios between variables in the production of basic welfare components, since for a Cobb Douglas production function, the marginal rate of substitution between inputs X and Y equals the quantity $-\frac{Yf_x}{Xf_y}$.

A fundamental assumption on which we base the foregoing analysis -- the imputation of a common social welfare function to all countries, regardless of their levels of development or socio-economic systems -- or alternatively, of common components of social welfare regardless of such differences -- can be tested by running factor analyses for selected subsets of the total sample of countries, to see to what extent the factors extracted differ for the various country subsets. A statistical criterion for distinguishing significant differences might be based on the deviations of predicted factor scores for competing hypotheses of only one social welfare

function for all countries and of more than one such function. In the multi-factor case, of course, we would really be testing for the existence or non-existence of a common set of basic social welfare components, out of which it still remains to construct one or more overall social welfare functions for the sample of countries.

This construction is basically a matter of combining the different common factors measuring basic social welfare components so as to provide an overall index of social welfare. The combination might be either additive or multiplicative:

$$SW = \sum_{j=1}^{p} g_j Y_j \quad \text{or} \quad SW = \prod_{j=1}^{p} Y_j^{h_j} .$$

Clearly, given the equations for the factors themselves, the particular form in which the factor scores are combined and the particular coefficients used have implications for the implicit social welfare tradeoff ratios for the consumption variables.

A possible function for only two factors, one of which (y_1) is thought to represent consumption of basic goods and the other (y_2) luxury consumption, could utilize dollar GNP per capita figures, or Beckerman-Bacon predictions of aggregate consumption per head, where these are available, in the following way:

$$SW = Y_1^{h_1} Y_2^{h_2} \qquad \text{where } h_1 = (1 - h_2),$$

h_2 is the ratio of the country's dollar GNP per capita or estimated real aggregate per capita consumption to the world's highest such figure, Y_1 is the score on the basic goods factor and Y_2 is the score on the luxury good factor. The

rationale would be that high luxury goods consumption coupled with low $GNP or consumption per capita is indicative of a high degree of income inequality, so that to discount for this Y_2 should be given a weight positively related to a country's dollar GNP or consumption per capita. It is possible, on the other hand, that basic goods consumption should be given a constant weight rather than one which declines with rises in per capita income, or that the decline should not continue all the way to zero, since otherwise wealthy countries which score relatively low on basic goods relative to luxury goods are not sufficiently penalized. This possibility is mentioned here as an illustrative case. In seeking appropriate ways to combine welfare component factor scores it is possible to turn to countries for which data exists in greater than average abundance. Despite deficiencies of data dealing with such things as size distribution of incomes, land ownership, etc., we may in the future try comparing such data for the countries for which it is available with the welfare scores derived from our analysis, in an effort to assign more precise meaning to factors and to choose appropriate methods of combining factors scores to yield an overall index of social welfare.

At this point in this paper, I would like to focus on estimation of the welfare factors themselves, giving a description of the data set employed and of results thus far obtained.

Variables chosen for the analysis are those for which data is available in comparable form for the widest possible range of countries, and which are relevant to a social welfare evaluation of a country's development level. The 35 variables are as follows: physical measures of per capita

consumption of energy, steel, cement, aviation and motor fuel, kerosine and jet fuel, sawn lumber and fertilizers; consumption of calories as a percentage of requirements, calories from sugar and sweets, total protein, animal protein and milk protein consumption; physicians, hospital beds, dentists, pharmacists, nurses and midwives per hundred thousand population, per capita stocks of passenger vehicles, commercial vehicles, tractors, radios and telephones; cinema attendance per capita; the adjusted school enrollment ratio (first and second levels); miles of roads per 1000 square miles, miles of roads per 1000 square miles of agricultural land; proportion of the population in agriculture, proportion economically active in agriculture; proportion of population living in rural areas, proportion living in highly urban areas, a measure of the dispersion of population over localities of different population sizes; crude birth and death rates and life expectancy from zero years of age. Using this data, a large sample of 125 countries is covered, including all Communist countries except North Korea and almost all of the less developed countries. The data is in logarithmic form, for reasons discussed earlier, and to give increased weight to the less developed countries in the analysis. Data is for the early 1960's, with 3 to 5-year averages for consumption flow variables.

Referring to Table I,* we see that principal factor analysis, in which factors are extracted in order of their ability to account for the observed pattern of relationships among the variables, and are constrained to be mutually orthogonal and of unit variance, results in a total of five significant factors (using the criterion that factors accounting for less than unit variance are to be considered not significant) which together account

---

* Tables begin on page 20

for 79.7% of total variance. The first factor by itself accounts for 63.6% of total variance, and is interpretable as a measure of the overall level of consumption. The other factors, though contributing a sizable 16% to explained variance, are not so simple to interpret. However, it is clear that they all measure, each from a different vantage point, disparities between medical and nutritional variables taken as a group and the other consumption variables. Insofar as social welfare is considered to be mainly a function of the overall level of consumption, without regard to its composition, the first principal factor may be taken as a measure of social welfare, and the least squares regression equation for predicting first factor scores can be taken as defining an estimate of the social welfare function in terms of which the countries of our sample may be compared with one another. This corresponds to Niewiarowski's principal component measure of the level of living,[9] which he recommends as the best available standard for international comparisons of consumption variables and their proxies because of its maximum variance property and the fact that of all conceivable indices it accounts for the maximum amount of variance in the variable set.

However, we can accept the first principal factor as at best a special case of a welfare factor. It is certainly not the only possible factor measure of social welfare. Given assumptions concerning the differential importance of the overall level of consumption and its composition, other, more theoretically relevant factor measures of social welfare are needed.

A characteristic feature of factor analysis is that starting from an initial factor pattern, such as the principal factor pattern in Table I,

an infinite number of transformations of the original retained common factors is possible, each of which explains the configuration of variables being analyzed as well as any other, though for the purposes of a particular investigation not all of these will be equally acceptable from a theoretical point of view. It is important for the validity of our analysis to impose economically meaningful restrictions on the class of admissible transformations. (incidentally, in factor analysis a linear transformation of the original factors is commonly referred to as a factor rotation, since it corresponds to a rotation of the factor axes in the factor space in which the original variables and their pattern of intercorrelations are replicated; a transformed factor is referred to as a rotated factor, and so forth. In what follows, these terms will be used equivalently although as Rummel and Jöreskog have pointed out,[10] properly speaking, "transformation" is the more appropriate term when referring to the factors themselves.)

To be interpretable as a measure of welfare, a factor should have non-negative correlation coefficients with all variables of consumption of economic goods and services, and negative coefficients of correlation with variables for which reductions rather than increases have positive welfare significance. A similar restriction applies to the regression coefficients of welfare factors on variables in the data set. This need not necessarily be true, however, of a welfare component factor measuring the relative importance of certain subpatterns of consumption relative to others.

From a theoretical point of view, there is no reason why the components of social welfare, or different measures of social welfare, should not be intercorrelated to some extent, and perhaps even considerably so. Indeed,

we may even expect this to be the case. In light of this, any set of non-correlated factors, including the principal factors, appears unrealistic at worst, and at best needlessly restrictive to serve as measures of components of social welfare.

The most direct route to welfare-relevant factors is direct specification of the rotated factor in terms of relevant subsets of variables. To this end, factors may be rotated through the centroids of selected clusters of variables in a factor space of specified dimensions. The results may or may not approach those obtained from the analytical oblique class of rotations, which are designed to satisfy various criteria of simplicity in description of factors in terms of variables, or of variables in terms of factors, or some weighted combination of the two, but in case of conflict, economic interpretability of results should be the overriding criterion.

Since the principal factor solution disclosed five significant factors, the rotations may take place in a factor space of as many as five dimensions The examples given here are of rotations in three factor space. In the first rotation, the two specified factors are AFFL, a measure of overall affluence as reflected in a society's consumption of modern technology, manufactured goods such as passenger and commercial vehicles, aviation and motor fuel, radios and telephones, and BASLUX, a measure of the relative importance in consumption of goods important in the satisfaction of the more basic human needs (medical services, nutrition) relative to other goods. Inspection of the factor pattern matrix of variable-on-factor regression coefficients in Table III will bear out these interpretations. AFFL is determined by rotation through the centroid of the cluster of the energy, steel, cement, aviation

and motor fuel consumption and vehicle stock variables in three factor space. BASLUX is a factor rotated through the centroid of a cluster of selected basic variables and negatively weighted nonbasic variables.

The third factor in this rotation is left unspecified, except for the condition that it be uncorrelated with both AFFL and BASLUX, so that in the three dimensional space in which variable intercorrelations are reproduced in terms of these three factors, this third factor's axis is at right angles to the other two factors' axes.

It will be noted from Table II that AFFL and BASLUX are moderately highly correlated with each other. The geometrical interpretation of this is shown in the accompanying plot of variables in the plane formed by the AFFL and BASLUX factor axes. In this diagram, the BASLUX and AFFL factor axes intersect at an angle with cosine 0.806. Nutritional and medical variables, as well as the demographic indicators, tend to cluster around the BASLUX axis, while other variables cluster around the AFFL axis. The large number of variables lying approximately midway between the two axes have substantial amounts of variance explained by the joint variation of AFFL and BASLUX. Geometrically, correlation coefficients of variables with factors are given by the perpendiculars from variables to the factor axes, while the regression coefficient of a variable on a factor is given by the distance along the factor axis from the zero point to the point of intersection with a line parallel to the other factor axis and passing through the variable. Thus it is that a variable, such as life expectancy, can have a high correlation with both factors, but regresses much more highly on one than on the other, so that for pusposes of factor interpretation the factor

pattern matrix of regression coefficients of variables on factors is much more useful than the structure matrix of factor-variable correlation coefficients.

Estimated factor scores for the 125 countries of our sample are not shown here, but as implied by the high correlation coefficient between factors AFFL and BASLUX, are strongly correlated with each other. Departures from a line of regression between estimated AFFL and estimated BASLUX reflect individual country-to-country differences between overall affluence and the composition of consumption. To the extent these differences are a resultant of differences in money income distribution and in the price structure of basic goods versus other goods, these two factors are to be viewed as conceptually distinct social welfare components, in terms of which an overall measure of social welfare may be derived, along lines suggested earlier in this paper.

In our second example of an a priori specified factor rotation (Tables IV and V), the first two factors are the same, but the third factor which was unspecified except for the constraint of noncorrelation with BASLUX and AFFL in the first example is replaced by a third factor constrained to pass through the centroid of the cluster of nutritional variables. This new third factor is highly correlated with AFFL and BASLUX but quite distinct in interpretation from either of them. Although the estimated factor scores for AFFL and BASLUX cannot be affected by this substitution for the original third factor, such a replacement can in general be expected to affect the pattern matrix, which in turn can change the interpretation of the retained factors. As we note from Table V, there are some changes in the coefficients of the first two columns of the pattern matrix, but none so great as to affect the interpretation already placed on AFFL and BASLUX.

Conclusions:

It has been shown that inter-country differences in patterns of consumption of economic goods and services and other welfare-related variables can be explained in terms of a relatively small number of factors. By direct specification of factors to conform to economically meaningful restrictions, the pattern of consumption and welfare-related variables can be explained in terms of a small number of factors with strong social welfare interpretations, values for which can be estimated, thereby permitting the derivation of relative social welfare levels for a very wide range of countries.

Examples have been given for a simple three factor case. Directions which further research will take have been indicated. Specifically, rotations of the type described will be carried out for factor spaces of dimensionalities other than three, to see to what extent the analysis is sensitive to the number of retained factors. Comparisons of these rotations with rotations based on analytic criteria may also be undertaken. Attempts will be made to test for the existence of more than one social welfare function or set of components for different groups of countries. Possibilities for the combination of estimates of different components of social welfare into an overall index of social welfare will be explored and the results compared with those obtained using conventional national income accounting measures of aggergate per capita consumption or income.

In addition, looking further into the future, two possibilities for further research seem especially worthwhile.

The analysis can be extended back in time. A logical starting point

would be application of this approach to the data collected by Bennett in his pioneering early effort to construct an index of greater relevance to welfare comparisons than the standard national income estimates of income and consumption,[12] which produced interesting results but suffered from the lack of an objective basis for weighting the elements of his index.

Finally, a comparison of results by country derivable from this approach with the results of Adelman's and Morris' factor analytic study of social, economic and political patterns in less developed countries[13] would be of interest. Adelman and Morris generated an overall development factor of social and political as well as economic significance which turned out to be virtually identical with dollar GNP per capita, which, as we have seen, lacks a clear social welfare interpretation. The approach suggested in this paper makes possible the generation of factor measures of social welfare which will permit exploration of very interesting questions concerning the relationships between economic development and social welfare for countries at various stages of development and widely varying historical and cultural background.

TABLE I

CORRELATION COEFFICIENTS OF VARIABLES WITH FIRST FIVE PRINCIPAL FACTORS

	F_1	F_2	F_3	F_4	F_5	Communality
1) Energy	.941	-.058	.017	.012	.025	.890
2) Steel	.927	.008	-.012	-.042	-.005	.861
3) Cement	.829	-.024	-.079	-.189	.064	.734
$) Pass Veh	.824	.015	-.373	-.108	.144	.850
5) Comm Veh	.850	.047	-.298	.023	.092	.822
6) AvMG	.810	-.033	-.369	.095	.189	.838
7) Physicians	.941	-.009	.129	.098	-.005	.911
8) HBs	.859	.075	-.002	-.044	.052	.748
9) Dentists	.921	-.025	.059	.148	.021	.875
10) Pharmacists	.877	-.101	.150	.150	.046	.827
11) Nurses	.861	.065	.017	-.036	-.131	.764
12) Mdwvs	.643	-.235	.367	-.045	-.147	.627
13) Cal/rqts	.748	.313	.263	.034	-.297	.815
14) Sugcal	.780	.135	-.121	.135	.165	.687
15) Tprt	.659	.569	.133	-.016	-.277	.852
16) Anprt	.851	.358	-.071	.014	-.117	.872
17) Mkprt	.721	.501	-.092	.089	.101	.798
18) Adjenr	.804	-.298	.196	.131	.023	.792
19) Cinatt	.781	-.143	.144	.170	-.161	.706
20) Radios	.902	.041	-.029	-.031	.048	.820
21) CBR	-.520	-.223	-.363	.573	-.278	.858
22) CDR	-.555	.140	-.283	.492	-.399	.809
23) Life Exp	.882	.012	.203	.029	-.087	.827
24) Phones	.958	.073	-.080	-.021	.009	.929
25) Roads/land	.714	-.274	.239	-.155	-.194	.703
26) Roads/agld	.565	-.576	.130	-.023	.014	.669
27) AGPS	-.827	.037	.281	.294	.190	.887
28) AgEcAct	-.806	.134	.347	.249	.130	.867
29) RPS	-.537	.171	.240	.355	.469	.721
30) UPS	.778	-.293	-.053	.216	-.088	.749
31) DP	-.851	-.007	-.015	-.238	-.042	.783
32) Fertilizer	.828	.283	.078	.065	.152	.798
33) Tractors	.837	.057	.206	.198	.144	.805
34) Sawn Lumber	.713	-.163	.100	.298	.097	.642
35) KJF	.740	-.246	-.372	.041	.156	.772
Latent Roots:	22.294	1.799	1.514	1.302	1.000	27.909

TABLE II

MATRIX OF FACTOR INTERCORRELATIONS
FOR AFFL, BASLUX, AND UNSPECIFIED THIRD FACTOR

	AFFL	BASLUX	3rd FACTOR
AFFL	1.000	0.806	0
BASLUX	0.806	1.000	0
3rd FACTOR	0	0	1.000

TABLE III

STRUCTURE AND PATTERN MATRICES FOR AFFL AND BASLUX WITH AN UNSPECIFIED THIRD FACTOR

	Structure			Pattern		
	AFFL	BASLUX	F_3	AFFL	BASLUX	F_3
1) Energy	0.924	0.850		0.700	0.300	
2) Steel	0.909	0.840		0.680	0.290	
3) Cement	0.829	0.720		0.660	0.200	
4) Pass Veh	0.874	0.615		1.100	-0.260	
5) Comm Veh	0.883	0.673		0.960	-0.100	
6) AvMG	0.864	0.594		1.240	-0.320	
7) Physicians	0.898	0.901		0.445	0.540	
8) HBs	0.835	0.795		0.520	0.360	
9) Dentists	0.893	0.854		0.600	0.360	
10) Pharm.	0.840	0.832		0.498	0.440	
11) Nurses	0.835	0.802		0.495	0.430	
12) Mdwvs	0.582	0.672		0.080	0.620	
13) Cal/rqts	0.658	0.838		-0.120	0.940	
14) Sugcal	0.775	0.692		0.600	0.230	
15) Tprt	0.573	0.761		-0.250	0.900	
16) Anprt	0.817	0.819		0.420	0.470	
17) Mkprt	0.681	0.721		0.265	0.520	
18) Adjenr	0.776	0.743		0.500	0.350	
19) Cinatt	0.750	0.734		0.440	0.380	
20) Radios	0.885	0.818		0.765	0.295	
21) CBR	-0.424	-0.650		0.260	-0.855	
22) CDR	-0.503	-0.580		-0.110	-0.480	
23) Life Exp	0.825	0.878		0.315	0.630	
24) Phones	0.947	0.856		0.760	0.260	
25) Roads/land	0.678	0.682		0.375	0.390	
26) Rds/Agld	0.578	0.447		0.600	-0.020	
27) AGPS	-0.865	-0.641		-1.200	0.200	
28) AgEcAct	-0.864	-0.579		-1.095	0.285	
29) RPS	-0.585	-0.367		0.365	-0.790	
30) UPS	0.797	0.630		0.815	-0.030	
31) DP	-0.830	-0.781		-0.625	-0.300	
32) Tractors	0.773	0.837		0.320	0.560	
33) Fertilizer	0.777	0.847		0.250	0.600	
34) Sawn Lumber	0.693	0.652		0.420	0.320	
35) KJF	0.814	0.488		1.250	-0.510	
Sums of Squares:	21.446	18.698		14.290	7.250	

VARIABLES IN FACTOR SPACE: TWO FACTOR PLOT FOR OBLIQUE THREE FACTOR SOLUTION OF TABLE III

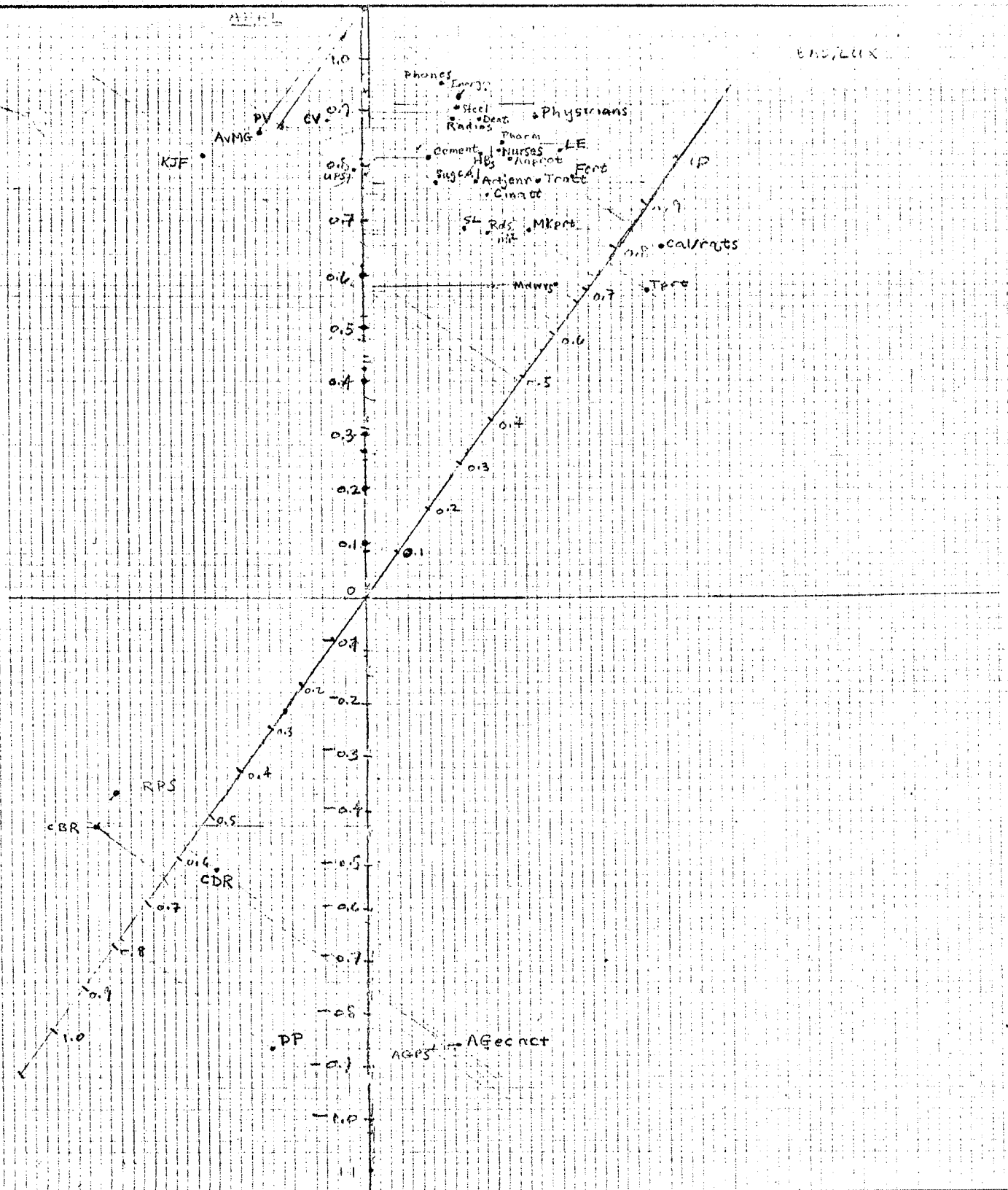

TABLE IV

MATRIX OF FACTOR INTERCORRELATIONS FOR
AFFL, BASLUX, AND NUTR

	AFFL	BASLUX	NUTR
AFFL	1.000	0.806	0.829
BASLUX	0.806	1.000	0.817
NUTR	0.829	0.817	1.000

TABLE V

STRUCTURE AND PATTERN MATRICES FOR AFFL, BASLUX AND NUTR FACTORS

	Structure			Pattern		
	AFFL	BASLUX	NUTR	AFFL	BASLUX	NUTR
1) Energy	0.924	0.850	0.816	0.680	0.498	0.020
2) Steel	0.909	0.840	0.832	0.639	0.365	0.010
3) Cement	0.829	0.720	0.729	0.690	0.172	0.060
4) Pass Veh	0.874	0.615	0.733	1.011	-0.297	0.200
5) Comm Veh	0.883	0.673	0.773	0.968	-0.170	0.227
6) AvMG	0.864	0.594	0.700	1.100	-0.288	0.100
7) Physicians	0.898	0.901	0.841	0.492	0.530	0.070
8) HBs	0.835	0.795	0.801	0.455	0.285	0.152
9) Dentists	0.893	0.854	0.815	0.580	0.397	0.099
10) Pharmacists	0.840	0.832	0.743	0.586	0.700	-0.084
11) Nurses	0.835	0.802	0.800	0.488	0.330	0.220
12) Mdwvs	0.582	0.672	0.480	0.330	0.758	-0.361
13) Cal/rqts	0.658	0.838	0.816	-0.320	0.666	0.565
14) Sugcal	0.775	0.692	0.755	0.379	0.095	0.327
15) Tprt	0.573	0.761	0.847	-0.600	0.440	1.080
16) Anprt	0.817	0.819	0.919	0.181	0.189	0.685
17) Mkprt	0.681	0.721	0.866	-0.123	0.418	-0.104
18) Adjenr	0.776	0.743	0.591	0.720	0.520	-0.374
19) Cinatt	0.750	0.734	0.638	0.580	0.470	-0.150
20) Radios	0.885	0.818	0.825	0.542	0.175	0.200
21) CBR	-0.424	-0.650	-0.574	0.455	-0.740	-0.380
22) CDR	-0.503	-0.580	-0.580	-0.240	-0.841	0.175
23) Life Exp	0.825	0.878	0.799	0.330	0.580	0.117
24) Phones	0.947	0.856	0.887	1.440	0.100	0.230
25) Roads/land	0.678	0.682	0.522	0.580	0.578	0.462
26) Roads/agld	0.578	0.447	0.252	-0.490	0.359	0.970
27) AGPS	-0.865	-0.641	-0.716	-0.921	0.132	0.098
28) AgEcAct	-0.864	-0.579	-0.652	-1.170	0.265	0.045
29) RPS	-0.585	-0.367	-0.398	-0.943	0.361	0.173
30) UPS	0.797	0.630	0.564	1.195	0.145	0.390
31) DP	-0.830	-0.781	-0.765	-0.550	-0.318	-0.100
32) Fertilizer	0.773	0.837	0.869	0.030	0.418	0.552
33) Tractors	0.777	0.847	0.779	0.245	0.680	0.163
34) Sawn Lumber	0.693	0.652	0.567	0.595	0.378	-0.190
35) KJF	0.814	0.488	0.542	1.228	-0.330	-0.175
Sums of Squares:	21.446	18.698	18.196	14.910	6.68	4.27

FOOTNOTES

1) Bergson, Abram (Burk), "A Reformulation of Certain Aspects of Welfare Economics," Quarterly Journal of Economics, May 1938.

2) See Nath, S., A Reappraisal of Welfare Economics, (London: 1969), p. 94-117.

3) Samuelson, P.A., "Evaluation of Real National Income," Oxford Economic Papers, January 1950.

4) Gilbert and Kravis, An International Comparison of National Products and the Purchasing Power of Currencies, OEEC, 1954; also, the later study by Gilbert and Associates for OECD in 1958.

5) Clark, Colin, The Conditions of Economic Progress (London: 1938).

6) Beckerman, W., and Bacon, R., "International Comparisons of Income Levels -- a Suggested New Measure," Economic Journal, September 1966.

7) Theoretical explanations of the phenomenon are given in: Balassa, B., "The Purchasing Power Parity Doctrine: A Reappraisal," (Journal of Political Economy, Vol. 72, 1964), and Usher, D., The Price Mechanism and the Meaning of National Income Statistics, (Oxford: 1968), p. 46-54 and 71-72.

8) Derivations and geometrical explanations of these relationships are given in Harman, H., Modern Factor Analysis, (Chicago and London: 1960, 1967). In addition Rummel, R., Applied Factor Analysis, (Evanston: 1970), is a most useful reference.

9) Lancaster, K., "Revising Demand Theory," Economica, November 1957.

10) Niewiarowski, D., "Level of Living of Nations," IASI: Estadistica, March 1965.

11) See Rummel, op. cit., p. 368.

12) Bennett, M.K., "International Disparities in Consumption Levels," American Economic Review, September 1951.

13) Adelman, I., and Morris, C.T., Society, Politics, and Economic Development, (Baltimore: 1967).

SELECTED BIBLIOGRAPHY

Adelman, I., and Morris, C.T., Society, Politics, and Economic Development, (Baltimore: 1967).

Balassa, B., "The Purchasing Power Parity Doctring: A Reappraisal," Journal of Political Economy, Vol. 72, 1964.

Beckerman, W., and Bacon, R., "International Comparisons of Income Levels -- A Suggested New Measure," Economic Journal, September 1966.

Bennett, M.K., "International Disparities in Consumption Levels," American Economic Review, September 1951.

Bergson, A. (Burk), "A Reformulation of Certain Aspects of Welfare Economics," Quarterly Journal of Economics, May 1938.

Clark, C., The Conditions of Economic Progress, (London: 1938).

Gilbert and Kravis, An International Comparison of National Products and the Purchasing Power of Currencies, OEEC, 1954.

Harman, H.H., Modern Factor Analysis, (Chicago and London: 1960, 1967).

Lancaster, K., "Revising Demand Theory," Economica, November 1957.

Nath, S.K., A Reappraisal of Welfare Economics, (London, 1969).

Niewiarowski, D., "Level of Living of Nations," IASI: Estadistica, March 1965.

Rummel, R., Applied Factor Analysis, (Evanston, 1970).

Usher, D., The Price Mechanism and the Meaning of National Income Statistics, (Oxford: 1968).

PRINCIPAL DATA SOURCES

1) A.I.D., Economic Data Books, 1967: Physicians, Hospital Beds, Caloric Intake, Road Density.

2) Akademiia Nauk SSSR, Ekonomika Stran Sotsialisticheskogo Lageria v Tsifrakh, Moscow 1961, and Ekonomika Sotsialisticheskikh Stran v Tsifrakh, Moscow, issues 1962 through 1965:
Physicians, Hospital Beds, Road Density, Fertilizers for Communist Countries

3) A.T.T., World Telephones, various years:
Telephones

4) F.A.O., Production Yearbook, and Yearbook of Forest Products, various years:
Nutrition, Agricultural Population, and Sawn Lumber variables.

5) New York Times: Family Almanac, 1972:
Life Expectancy, Crude Birth and Death Rates, Telephones, Radios, Passenger and Commercial Vehicle Stocks.

6) United Nations, Statistical Office, Statistical Yearbook and Yearbook of International Trade Statistics, also World Energy Supplies, various dates:
Cement, Energy, Steel, Refined Petroleum Products, Medical Variables, Radios, Telephones, Motor Vehicles, Cinema Attendance.

7) United Nations, Statistical Office, Demographic Yearbook, various dates:
Crude Birth & Death Rates, Life Expectancy

8) United Nations, Statistical Office, Compendium of Social Statistics, various dates:
Radios, Caloric Requirements.

9) UNESCO, Statistical Yearbook, various issues:
Adjusted Primary and Secondary School Enrollment Ratios, Cinema Attendance, Radios.

10) Urban Land Institute, "Technical Bulletin No. 43;"
Urban/Rural Population Distribution variables.

11) U.S. Dept. of the Interior, Bureau of Mines, International Petroleum Quarterly and other Publications:
Refined Petroleum Products.

12) World Health Organization, World Health Statistics Annual, various issues
Medical personnel.