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A Multivariate Approach to the Measurement of Development: Asia and Latin America

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It matters little how much information we possess about development
if we have not grasped its inner meaning.
—Denis Goulet, *The Cruel Choice*

This paper examines several issues related to the measurement of development. In particular, in it we try to gain a more precise empirical knowledge about the interdependence of different types of variables that represent various aspects of the development process. In this sense, our intention in this paper is not to propose a new theory of development; instead we are searching for statistical regularities in the data that may provide us with a better insight regarding the issue of the measurement of development. In the end, our analysis will try to suggest some hypotheses relating to the different types of development indicators that researchers may wish to investigate further.

There is no clear definition of development, and even less clear are the issues of how to measure it, how to determine whether a country is developed or not, and how to undertake international comparisons. Most scholars, however, seem to refer to a multifaceted process of change, where economic as well as social, political, and institutional factors interact with the ultimate goal of enhancing people's lives.[1]

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The problem in defining development stems from the following considerations. First, there are difficulties in measuring social and political indicators (e.g., the strength of the labor movement or the degree of social tension). Second, the concept of development is subject to value judgments concerning social objectives, and different groups or societies view it differently; that is, are political freedom, pollution abatement, number of hours at work, average size of the apartment, peace, equality of opportunity, and personal satisfaction components of development? Third, the development process represents a continuum and, therefore, there is a gray area where the classification of countries becomes difficult and the distinction between developed countries (DCs) and less-developed countries (LDCs) is blurred. For example, are the newly industrializing economies (NIEs) of Asia still less-developed countries? Finally, underdevelopment is a pervasive phenomenon that appears also in most DCs, affecting either some regions or some groups; that is, is Mississippi more developed than Taiwan; is Southern Europe fully developed; or do Black Americans have a higher living standard than the citizens of Singapore? One can hardly think of any country, perhaps with the exception of some Northern European countries and Japan, where some of the regions would not be classified as underdeveloped, by either economic or social indicators. Furthermore, the diversity of aspects to which the concept refers may imply that a country fares well with respect to some indicators and badly with respect to others. For example, are Mexico or Japan, where the same party has been governing for decades, more democratic than the Philippines?[2]

Probably none of the particular findings discussed here would be surprising to those scholars working in the area of development, or familiar with Latin America and Asia, the sample of countries under consideration. Nevertheless, the results are of significant interest to the extent that they support or alter conclusions reached by development specialists.[3]

To discuss some of the issues related to the measurement of development, we have selected two groups of countries, some in Latin America and some in Asia, at two different points in time, 1970 and 1990. The reason for choosing these two groups is that, in our opinion, they clearly represent two very different development experiences from which we can gain important insights into a series of development problems. In addition, examining two periods sufficiently far apart in time will allow us to make some intertemporal comparisons. Methodologically, we use principal components (PCs), logistic regression, and cluster analysis in an attempt to show the usefulness of these techniques in this area of the social sciences, and in particular in economics.

In the first section we look at how diverse scholars have defined development. Next, we review some empirical literature dealing with development indicators. Following this, in the third section we describe briefly the techniques used and give an overview of the two regions. In section 4, we report the empirical results. First, we examine whether a large set of indicators of development can be reduced to a smaller number. In particular, we are interested in determining what measures characterize development, and which indicators offer the most information.[4] Are economic indicators—in particular GDP per capita—sufficient to identify a country as developed or underdeveloped, or do we need to complement them with the so-called social indicators? Second, we discuss how to better discriminate

between the two groups of countries. We address these topics by using both PCs analysis and a logit regression. Third, we use cluster analysis to see how the countries in our sample group together. Do the countries cluster according to geographic patterns? Is Bolivia "closer" to Brazil or to the Philippines? We end the paper with some concluding remarks.

Finally, we have one word of caution with respect to the use of these (and other) multivariate analysis techniques. On the one hand, these are techniques that allow us to take into consideration an extensive set of diverse variables that are part of the development process and that would be difficult to handle under a different framework, owing to the large number of variables involved. In particular, these techniques are especially useful in areas of investigation where adequate theoretical models cannot be developed. On the other hand, we must be prudent when we use them, since some of them are sensitive to small variations in the data. Also, they are powerful descriptive tools. If used cautiously, they can be of great help in pointing out salient facets of the phenomenon under study. Their results, however, must not be taken for inferences made with theoretical models.

On the Concept of Development

This section covers a brief review of the different methodological approaches to the analysis of development and provides some definitions of the concept. The three main approaches or schools are the neoclassical, neo-Marxist, and structuralist.

The neoclassical school attempts to adapt a system of thought designed for the study of industrial societies. During the 1950s and 1960s, the field was dominated by Walt W. Rostow's linear model,[5] according to which development follows a linear path along which all countries travel. In particular, Rostow defined five different stages of growth: the traditional society; the preconditions for take-off; the take-off; the drive to maturity; and the age of high mass consumption. The general tools of the neoclassical analysis applied to growth and development are well known and are summarized in the analytical properties of the production function. For the neoclassical economists, development is mainly seen as a problem of economic growth. The most influential work in this area is that of Robert Solow.[6] Recent contributions in the area of endogenous growth using dynamic optimization have also been directly applied to issues of development.[7]

The neo-Marxist school, very influential during the 1970s, also uses a system of analysis initially formulated for the study of industrial societies, although it is certainly very different from the neoclassical system. Its central thesis holds that the development process is a dialectic one. This means that the process is not harmonious, but one that mixes imbalances, growth, social conflicts, and stagnation. Paul Baran advanced his thesis that capitalism produces polarization, that is, development at one extreme and underdevelopment at the other.[8] Samir Amin analyzed and developed this thesis; he characterized peripheral formations by the predominance of agrarian capitalism, foreign capital, a large bureaucracy, and an incomplete proletarianization.[9] Arghiri Emmanuel analyzed how the increasing inequality between nations originates in an unequal exchange that

tends to increase over time.[10] An extension of the neo-Marxist view maintained that the international system of relations is at the core of the problem of development and neocolonialism, and is responsible for inducing and maintaining the situation of the poor countries. This is the "dependency view," used in particular within the context of the analysis of the development of Latin America. Some of its more important advocates are the Brazilian sociologist Theotonio dos Santos, Celso Furtado, Eliana Cardoso, and André Gunder Frank.[11] Frank advanced the thesis that the only political solution was a revolution of socialist character.

The structuralist school departs from the previous analyses in that it tries to identify specific rigidities, bottlenecks, lags, and in general intrinsic characteristics of the structure of developing economies that affect development policy. Scholars who have made important contributions are Raúl Prebisch, Hans W. Singer, Gunnar Myrdal, W. A. Lewis, and Albert O. Hirschman.[12] The two basic elements of the structuralist school are (1) the concept of dual economy: development takes place unevenly both within and between sectors; and (2) the concept of complementarity in demand: consumers' demand for basic items is a function of income and is not affected by relative prices.

One important issue that has been at the core of the discussions of development concerns the role of the state versus the market. The neoclassical school, since it applies methods conceived for developed nations, advocates the role of the market mechanism. Neo-Marxists and structuralists, on the other hand, contend that the market mechanism and its emphasis on the price system is ineffective, unreliable, and irrelevant for the problems of developing nations. One interesting case has been the success of eight East and Southeast Asian countries (i.e., Japan, Korea, Taiwan, Hong Kong, Singapore, Malaysia, Indonesia, and Thailand) analyzed in the "East Asian Miracle" report of the World Bank. During the last 30 years these countries have made extraordinary progress by using a peculiar set of policies that combined the market mechanism and the intervention of the state.[13]

Another issue receiving increasing attention is that of "sustainable development," that is, the acknowledgement, within the context of development, of concerns involving energy, environment, pollution, water, and population with an emphasis on their interdependent character and the scarcity of certain resources. The key question is whether it is possible to combine economic growth with the preservation of the environment, considering the argument that if the natural resources of a country are depleted owing to increasing exports, for example, the level of welfare of the society will decrease.[14] This has become a fundamental issue for the Amazonia, Southeast Asia, and West Africa.

Within these general trends that reflect the evolution of the development paradigm (i.e., the origin of underdevelopment), scholars have provided different definitions of development. Some have placed more emphasis on the economic component of development. Irma Adelman, for example, defines economic development as the "process by which an economy is transformed from one whose rate of growth of per capita income is small or negative to one in which a significant self-sustained rate of increase of per capita income is a permanent long-run feature. A society will be called underdeveloped if economic development

is possible but incomplete." But later on, referring to the previous definition, she points out that "it is in no sense a 'single criterion' definition. On the contrary, . . . assignment of an economy to the category of 'underdeveloped' must be predicated upon a rather complete examination of its economic and socio-cultural behavioral relationships."[15]

Some authors refer to underdevelopment as a "multidimensional process" and describe it in a framework that combines economic/measurable indicators (e.g., low income, low investment per capita) with noneconomic/nonmeasurable indicators (e.g., dignity, respect, honor).[16] Robert E. Lucas, on the other hand, refers to the "problem of economic development" as "the problem of accounting for the observed pattern, across countries and across time, in levels and rates of growth of per capita income."[17] As to the distinction between growth and development, he is very clear when he says "we think of 'growth' and 'development' as distinct fields, with growth theory defined as those aspects of economic growth we have some understanding of, and development defined as those we don't."[18]

Finally, Simon Kuznets provides us with an approximation of the concept of development when he says that the principal objective of the theoretical work in the development field should be

> the development of an empirically tested and confirmed general theory of growth that includes a theory of technical change, of population growth, of changes in political and social organization, and of the role of international political relations. A general theory is not only needed to encompass each of these major elements but to describe the feedback mechanisms that link them together in a dynamic context.[19]

On the Measurement of Development

In this section we review how different authors have approached the topic of the measurement of development from an empirical point of view. As we shall see, there seems to be a sense of unanimity insofar as certain indicators are viewed as good proxies of development variables. Nonetheless, different authors have stressed the importance of different variables in addressing diverse development issues.

Irma Adelman and Cynthia Taft Morris, in their seminal work on the patterns of development, used a large set of 37 economic, political, and sociocultural variables.[20] This set covers most aspects of the concept of development. They included variables such as the extent of the traditional agricultural sector, the strength of the military, and the investment rate. The work of Adelman and Morris represents the "classic" in the application of factor analysis to the study of development. Even though this work has the merit of having included those political and social factors affecting development (the so-called institutional framework), and despite the fact that this is probably the most comprehensive set of development indicators one can think of, the values assigned to the sociocultural and political indicators are arbitrary. These indicators are not considered too often in the modern growth models, even though Lucas, for example, in referring to the decrease in GDP growth in Angola and Iran during the 1970s and alluding

to the effects of political or military disruptions, pointed out: "I do not think we need to look to economic theory for an account of either of these declines."[21]

Montek S. Ahluwalia, in his study of the relationship between the distribution of income and the process of development, used a small set of variables that in our opinion does not totally capture the essence of development. The indicators considered were (1) tax revenues/GDP; (2) primary school enrollment; (3) secondary school enrollment; (4) total population; and (5) rate of growth of population.[22]

Norman Hicks and Paul Streeten calculated the correlations of a fairly comprehensive set of social and economic indicators with GNP per capita and found very different results depending on how these correlations were calculated.[23] For example, the average of the seven social indicators for all countries in the sample considered was .70; however, when the sample was disaggregated into developing and developed, the correlations dropped to .25 and .18, respectively. Something similar happened with the economic indicators. The social indicators were (1) life expectancy at birth; (2) calorie consumption (as % of required); (3) infant mortality; (4) primary enrollment; (5) literacy; (6) average persons per room (urban); and (7) housing units without piped water (%). And the economic indicators were (1) newsprint consumption; (2) automobiles; (3) radio receivers; (4) electricity consumption; and (5) energy consumption.

During the 1960s the United Nations Research Institute for Social Development (UNRISD) created a composite indicator called the Level of Living (LOL) Index.[24] This index, which considered "basic needs" as being subdivided into physical needs (e.g., nutrition, shelter, health) and cultural needs (e.g., education, leisure, and security), was defined as "the level of satisfaction of the needs of the population as measured by the flow of goods and services enjoyed in a unit of time."[25] Since the index, however, included items for which data were very difficult to obtain for many countries (e.g., amount of leisure time available), it referred to 20 indicators.

The UNRISD also created a Development Index based on 73 indicators covering economic and social characteristics. Many of the indicators, however, were found to be highly intercorrelated. Thus UNRISD decided to eliminate most of them and to reconstruct the index based on 18 core indicators, 9 economic and 9 noneconomic, even though it was discovered that the ranking of countries did not change when the number of indicators was reduced to 10. Interestingly, the resulting index was highly correlated with GNP per capita (the correlation was higher for developed than for developing countries).[26]

The Overseas Development Council (ODC) constructed a measure called the Physical Quality of Life Index (PQLI) for 150 countries, which combined infant mortality, life expectancy, and literacy. The raw data were converted into a scale of 1 to 100, and a linear combination was constructed by giving equal weights to the three variables. These three variables, however, were highly correlated with one another, and therefore all three together did not convey more information than any of the them alone.[27]

The World Bank uses GNP per capita as the leading classification indicator in its annual *World Development Report*, distinguishing between low-income,

lower-middle-income, upper-middle-income, and high-income countries.[28] The "basic needs indicators," also developed by the World Bank, include adult literacy, life expectancy at birth, number of physicians per thousand population, daily calorie supply as percentage of amount required, and percentage of population having access to safe water.[29]

The United Nations Development Program (UNDP) publishes a Human Development Index (HDI) (a measure between 0 and 1) that is basically seen as an "Index of Happiness"; it takes into account health, education (these two refer to the formation of human capabilities), and income (proxy measure for the choices people have) as its main parameters. A sample of countries from the 1991 *Human Development Report* appears in tables 1 and 2. The HDI is constructed in three steps. The first step is to define a country's measure of deprivation for the

TABLE 1
HUMAN DEVELOPMENT INDEX: INDUSTRIALIZED NATIONS

Country	Human Development Index	Life Expectancy at Birth (1980)	Real GDP per Capita (In $PPP)[1]	Mean Years School (1980)
Japan	.993	78.6	13,650	10.4
Canada	.983	77.0	17,680	11.4
Iceland	.983	77.8	16,820	7.5
Sweden	.982	77.4	14,940	9.4
Switzerland	.981	77.4	17,220	8.3
Norway	.978	77.1	13,820	9.6
United States	.976	75.9	19,850	12.2
Netherlands	.976	77.2	12,680	7.9
Australia	.973	76.5	14,530	9.3
France	.971	76.4	13,590	9.4
United Kingdom	.967	75.5	13,060	10.8

SOURCE: United Nations Development Program (UNDP), *Human Development Report 1991* (New York, Oxford: Oxford University Press, 1991), pp. 119–21.
[1]Average for 1985–88 period.

TABLE 2
HUMAN DEVELOPMENT INDEX: DEVELOPING NATIONS

Country	Human Development Index	Life Expectancy at Birth (1980)	Real GDP per Capita (In $PPP)[1]	Mean Years School (1980)
Singapore	.879	74.0	10,540	3.5
Argentina	.854	71.0	4,360	6.0
Venezuela	.848	70.0	5,650	5.3
Malaysia	.802	70.1	5,070	4.0
Philippines	.613	64.2	2,170	6.6
Indonesia	.499	61.5	1,820	3.1
Morocco	.431	62.0	2,380	1.8
Pakistan	.311	57.7	1,790	1.7
Rwanda	.213	49.5	730	1.0
Sierra Leone	.048	42.0	1,030	0.8

SOURCE: UNDP, *Human Development Report 1991*, pp. 119–21.
[1]Average for 1985–88 period.

three basic variables, i.e., life expectancy at birth, literacy rates (and, since 1991, mean years of schooling), and the log of per capita GDP calculated at real purchasing power. The second step is to define an average deprivation indicator by taking the average of the three indicators. Finally, the third step is to calculate the HDI as one minus the average deprivation index.[30] T. N. Srinivasan, however, points out that the correlations among the three indicators range between .73 and .87, and a linear combination with equal weights of the three indicators accounts for 88 percent of the variance among them.[31] He concludes: "In sum, the HDI is conceptually weak and empirically unsound, involving serious problems of noncomparability over time and space, measurement errors, and biases. Meaningful inferences about the process of development and performance as well as policy implications could hardly be drawn from variations in HDI."[32]

We do not want to end this section without mentioning the work of Robert Summers and Alan Heston. They have attempted to construct series at international prices that better reflect the purchasing power parity of the countries.[33] These series show a very different picture from the one given by conventional statistics (see note 1).

Methodology and Sample

The analysis that we present in this paper is based on the application of three multivariate analysis techniques—principal components (PCs), logistic analysis, and cluster analysis. We briefly review each of them.

PCs analysis is a multivariate statistical technique that has as its objective to take p variables Xs (standardized original variables) and to find linear combinations of these to produce indices Zs that are orthogonal.[34] The resulting indices, therefore, measure different dimensions in the data. By construction, the variance of the first component is greater than that of the second, and so on. Therefore, this technique is used to reduce the dimensionality of the data.

The first PC, Z_1, is constructed as follows:

$$Z_1 = a_{11} X_1 + a_{12} X_2 + \ldots + a_{1p} X_p ,$$

where a_{ij} are the weights, such that $\text{var}(Z_1) = Z'_1 Z_1 = a'_1 X' X a_1$ is maximized, subject to the normalization constraint

$$a_{11}^2 + a_{12}^2 + \ldots + a_{1p}^2 = 1 .$$

The second PC is

$$Z_2 = a_{21} X_1 + a_{22} X_2 + \ldots + a_{2p} X_p ,$$

such that $\text{var}(Z_2)$ is maximized, subject to the normalization and orthogonality constraints

$$a_{21}^2 + a_{22}^2 + \ldots + a_{2p}^2 = 1$$

and

$$Z'_2 Z_1 = 0 .$$

Further PCs are defined the same way. The variances of the PCs are the eigenvalues of the sample covariance matrix and

$$\text{var}(Z_1) > \text{var}(Z_2) > \ldots > \text{var}(Z_p) .$$

The logistic regression is a special form of regression in which the dependent variable is dichotomous and nonmetric.[35] Since our purpose is to find the variable that best discriminates between the two groups of countries, we can interpret the predicted probabilities of the logit analysis as the likelihood that a country belongs to one group and not to the other. The logit model is based on the cumulative logistic probability function and is specified as

$$P(C|X_i) = F(Z_i) = F(\alpha + \beta X_i) = 1 / \{1 + \exp[-(\alpha + X_i \beta)]\} ,$$

where $P(C|X_i)$ is the probability that country C belongs to one group given the development indicators X_i. This formulation has the property that the odds ratio is a loglinear function of $X\beta$ and is given by

$$\ln[P_i /(1 - P_i)] = Z_i = \alpha + X_i \beta ,$$

that is, the dependent variable in the previous expression is the logarithm of the odds that a country belongs to a group.

Finally, cluster analysis helps us to devise a scheme for grouping n objects, each of which has a score on p variables, into classes so that similar ones are in the same class.[36] Specifically, its objective is to classify a sample of entities into a small number of mutually exclusive groups based on the similarities among the entities. In cluster analysis, unlike in logit analysis, the groups are not predefined; rather they are the output. Methodologically, we use the "centroid method," a hierarchical-agglomerative procedure in which each observation starts in a cluster by itself.[37] At each level of the clustering process, the algorithm used must identify the pair of clusters with the minimum distance. The two closest clusters are merged to form a new cluster that replaces the two old clusters. Merging of the two closest clusters is repeated until only one cluster is left. This process is referred to as a *dendogram*. The various clustering methods differ in how the distance between two clusters K and L is computed. In the centroid method, the distance between two clusters is defined by

$$D_{KL} = \| \bar{x}_K \bar{x}_L \|^2 ,$$

where D_{KL} is the Euclidian distance between the two clusters means and $\bar{x}_K$ is the mean vector for cluster C_K. This method is very robust to outliers.[38] The Euclidean distance is defined as

$$d_{ij} = \sqrt{[\sum_{k=1}^{p} (x_{ik} - x_{jk})^2]} .$$

The determination of the number of clusters is based on both a series of statistics and a good knowledge of the objects under analysis.[39]

Our sample of countries covers the Latin American and Asian countries in table 3.[40] Why is the comparison of these two groups an interesting exercise? We

TABLE 3
COUNTRIES CONSIDERED IN THE ANALYSIS

Latin America		
1. Argentina	8. Ecuador	15. Nicaragua
2. Bolivia	9. El Salvador	16. Panama
3. Brazil	10. Guatemala	17. Paraguay
4. Chile	11. Haiti	18. Peru
5. Colombia	12. Honduras	19. Trinidad and Tobago
6. Cost Rica	13. Jamaica	20. Uruguay
7. Dominican Republic	14. Mexico	21. Venezuela
East, South, and Southeast Asia		
1. Indonesia	6. Republic of Korea	11. Myanmar
2. Malaysia	7. Hong Kong	12. Pakistan
3. Philippines	8. China	13. Nepal
4. Singapore	9. India	14. Sri Lanka
5. Thailand	10. Bangladesh	

think they represent two very distinct development experiences during the recent past, and important lessons can be learned from their comparative study. In our analysis we compare the situation in 1970 to that in 1990 (or the latest available figure for the country or the variable in question). We think this period is sufficiently long to allow for the occurrence of some structural change.

The patterns of economic development of the two groups of countries have been radically different during the 1970s and very especially during the 1980s (see table 4). While the economies of East and Southeast Asia have recorded impressive rates of economic growth and, in general, seen important improvements in the living standards of their people, the economies of Latin America have fallen into complete disarray in all spheres of their social, economic and political lives.[41] Today, per capita income in Latin America is below what it was in 1979. No wonder that the decade of the 1980s is called "the lost decade." But what is striking is that during the 1960s and early 1970s, the region had a promising future and the living standards of most Latin American countries were well ahead of those of the Asian countries (except Singapore and Hong Kong). At that time, Latin American countries underwent modernization and growth at a rapid pace, and the levels of urbanization were higher than those in the Asian countries. The availability of resources in Latin America exceeded that of the Asian countries (in particular that of the NIEs). Also, investment as a fraction of GDP was of similar magnitudes in both areas. Finally, even though the debt problem was more severe in Latin America, we should note that Asian countries also had substantial debt.[42]

What happened during the two decades previous to 1990 that can explain this disparate performance? Some of the reasons pointed out involve differences in macroeconomic, export, and import-substitution policies.[43] First, import-substitution policies in Latin America were extended for much longer periods than in Asia. In contrast, the countries of East and Southeast Asia shifted to export-oriented policies "in due time." Second, export promotion has clearly been one of the engines of growth for the NIEs. Although countries like Brazil and Mexico (the so-called Latin American NIEs) have registered important increases

TABLE 4
ECONOMIC PERFORMANCE OF EAST AND SOUTHEAST ASIA VERSUS LATIN AMERICA

	1970		1990	
	Latin America	Asia	Latin America	Asia
GNP per capita nominal exchange rate ($US)	534	298	1,586	2,532
Growth in GNP over previous decade (%)	4.97	6.07	1.2	5.58
Growth in GNP per capita over previous decade (%)	2.43	3.37	−1.2	3.45
Real GDP per capita ($US 1985)	2,815	1,607	3,183	3,487
Real GDP per worker ($US 1985)	8,765	4,248	9,090	7,692
Agriculture/GDP (%)	18	32	14	24
Services/GDP (%)	52	43	52	44
Exports textiles/total exports (%)	7.8	22.4	8.6	28.9
Exports electrical machinery/ total exports (%)	0.5	1.5	1.0	7.6
Energy consumption per capita	851	516	986	958
Exports/GDP (%)	20	27	24	45
Percentage urban population	57	19	71	25
Percentage primary enrollment	95	81	101	98
Adult illiteracy rate (%)	25	37	15	28
Population per physician	3,067	10,185	1,597	5,724

SOURCES: World Bank: *World Development Report* (several issues), *Social Indicators of Development* (several issues), *World Tables* (several issues); United Nations, *Handbook of International Trade and Development Statistics* (several issues); Robert Summers and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950–88," *Quarterly Journal of Economics* (May 1991).
NOTE: Figures are regional averages.

in exports, there are a series of important differences between them and their East and Southeast Asian counterparts. These include the facts that Asian countries have moved up the ladder of technical change faster than Latin American countries, a circumstance enabling them to export more technologically advanced products, and in addition have emphasized quality and the growth of manufactures (e.g., consumer electronics, apparel, heavy industry). Third, the clearest difference between the two groups of countries, however, is found in their macroeconomic policies. While Asian countries have, in general, controlled inflation and have never had serious balance-of-payments problems, the environment of the Latin American countries has been characterized by permanent inflationary pressures and budget deficits.

As to the variables used (see table 5), we have found it very difficult to get good and objective indicators of political and sociocultural variables à la Adelman. It

TABLE 5
DEVELOPMENT INDICATORS

A. Economic variables
1: Real growth of GNP (1960-70, 1980-90)
2: Real growth of GNP per capita (1960-70, 1980-90)
3: Share of agriculture in GDP
4: Share of industry in GDP
5: Share of services in GDP
6: Share of agricultural employment in total employment
7: Share of industrial employment in total employment
8: Share of employment in services in total employment
9: Share of exports of food and agriculture in total exports
10: Share of exports of fuels and metals in total exports
11: Share of exports of textiles in total exports
12: Share of exports of nonelectrical machinery in total exports
13: Share of exports of electrical machinery in total exports
14: Share of exports of transport equipment in total exports
15: Share of imports of food and agriculture in total imports
16: Share of imports of fuels and metals in total imports
17: Share of imports of textiles in total imports
18: Share of imports of nonelectrical machinery in total imports
19: Share of imports of electrical machinery in total imports
20: Share of imports of transport equipment in total imports
21: Share of exports in GDP
22: Energy consumption per head (kg of coal equivalent)
23: Real GDP per capita in 1985 $US
24: Real GDP per adult in 1985 $US
25: Real GDP per worker in 1985 $US

B. Demographic variables
26: Total population
27: Growth of population (1960-70, 1980-90)
28: Birth rate (per 1,000 population)
29: Death rate (per 1,000 population)
30: Life expectancy at birth
31: Women of childbearing age (ages 15 to 49) as percentage of total women
32: Percentage of urban population

C. Education variables
33: Percentage of primary enrollment
34: Percentage of secondary enrollment
35: Percentage of tertiary enrollment
36: Adult illiteracy rate

D. Health variables
37: Calorie intake as percentage of required
38: Population per physician
39: Infant mortality

is out of the scope of this work to follow a procedure similar to that of Adelman and Morris and try to quantify the large set of qualitative variables, apart from the risk of subjectivity. In this sense, our set of indicators is lopsided, since all of them appear in published statistics. We are conscious that we might be missing an important part of the development process, the sociopolitical side. By not including these variables, however, we avoid a certain arbitrariness derived from the subjectivity of their evaluation. The 14 nonmonetary indicators included in

our study are very useful in cross-sectional comparisons, since they avoid the exchange rate conversion problem. The figures, however, tend to be unreliable because of different definitions and criteria in collecting data. Indicators such as the number of physicians per 1,000 persons can be considered an input.[44] On the other hand, indicators such as life expectancy, literacy, or access to clean water are outputs. The former reflect government intentions and commitments, while the latter reflect basic needs and achievements. Therefore, within the limitations of this study, the set of development indicators chosen is as exhaustive as possible and draws mainly on previous studies on the subject.[45]

Empirical Results

In this section we report the results for 1970 and 1990 of the principal components (PCs), discriminant, and cluster analyses, starting with PCs.

Principal Components Analysis. Our main objective is to reduce the original 39 variables (table 5) to a smaller set of orthogonal indicators. For both 1970 and 1990 we have selected the first 6 PCs, since they explain over 75 percent of the total variation in the original data.[46] This reduction indicates the existence of high multicollinearity among the 39 original indicators.[47] In order to give a meaningful interpretation to the PCs, we have to relate them, via correlations, to the original variables. Next, we proceed to identify the meaning of the PCs.

We begin with the results for 1970.

Principal Component 1. This component explains almost 40 percent of the total variation in the data in 1970. The characteristics having the highest loadings in the first PC are dispersed among the four groups of indicators (i.e., economic, demographic, education, and health). In the economic group (first 25 variables) we see a contrast between the agricultural and the manufacturing/services sector (variables 3 to 8). The other high loadings appear in variables 22 to 25, energy consumption per head (proxy for the level industrialization) and the different measures of real GDP. The last three variables (23 to 25) are taken from Summers and Heston and seem to be very good indicators of wealth and productivity, factors associated with the level and process of development.[48]

In the demographic group we see a contrast between birth and death rates (variables 28 and 29) and life expectancy and urbanization (variables 30 and 32). This shows the association between rural and underdeveloped societies and high birth and death rates. When societies become more urbanized, living standards increase owing to the positive externalities generated by the concentration of infrastructure services, such as hospitals and food distribution centers.

The education loadings reveal a contrast between adult illiteracy (variable 36) and primary/secondary education (variables 33 and 34). This stresses the importance of the latter, a proxy for basic education, as opposed to tertiary education, during the early stages of development and the efforts that LDCs have to make to reduce their illiteracy rates in order to progress.

Finally, the health variables capture the obvious positive effect of good nutrition on the reduction of infant mortality (variables 37 and 39).

We interpret PC 1 as an *index of development*, and it reveals the importance of the four groups of variables considered. Even though we started with a high

number of economic indicators (64 percent of the total number of variables considered initially), our analysis clearly shows the relevance of noneconomic factors in portraying development, and in this sense we can attest to the multidimensional character of the latter. Therefore, in 1970, underdevelopment was characterized by a situation that combined the preeminence of the agricultural sector with low productivity, high birth and death rates, low life expectancy, highly concentrated populations in rural areas, illiterate populations in need of basic education, populations poorly fed, and high infant mortality.

Principal Component 2. The highest loadings in this factor appear in the trade-structure variables, in particular imports of nonelectrical machinery and imports of transport equipment (variables 18 and 20). This reflects the effect of imports for infrastructure development. The other high loadings appear on the export side, exports of textiles and exports of electrical machinery (variables 11 and 13), the former showing the importance of light exports and the latter the efforts to move up in the development ladder, especially in the case of the Asian countries.

Principal Component 3. This component essentially registers the effect of growth of overall GNP and GNP per capita (variables 1 and 2). The 1960–70 period was one of relatively high growth for the two regions in question. Two trade variables have high loadings again: exports and imports of electrical machinery (variables 13 and 19). This may show the importance of these countries as assembly centers for multinational companies taking advantage of labor cost differentials. Finally, population growth (variable 27) indicates the relevance of this variable for developing countries.

Principal Component 4. This component seems to indicate another aspect of the trade structure. The highest loadings appear on exports of food and agriculture and exports of fuels and metals (variables 9 and 10) and underline the comparative advantage of LDCs.

Principal Components 5, 6. It is more difficult to interpret the last two components, since each of them explains only 5 percent of the variation in the data. PC 5 has a high loading in the share of exports of nonelectrical machinery, while PC 6 has high loadings in total population and again in some of the trade variables.

In 1970, then, the large group of indicators that characterizes development can be summarized in terms of six PCs. The first one is the most important, and comprises all the dimensions initially considered, that is, economic, demographic, education, and health, stressing the multidimensional character of development. The other components reflect essentially economic factors, specifically the trade structure and economic growth.

We now proceed to identify the meaning of the components for 1990.[49]

Principal Component 1. The first important point to emphasize is that, as in 1970, the indicators with high loadings belong to the four groups of variables, therefore reaffirming the multidimensional character of development. In the economic group, we see again the contrast between agriculture and the secondary/tertiary sectors, although it is now more concentrated on the employment aspect (variables 3 to 8). The share of exports in GDP (variable 21), reflecting the

openness of the economy, seems to confirm the importance of export-oriented policies versus import-oriented. Energy consumption (variable 22) is again a good indicator of the industrialization process, and the proxies of wealth and productivity (variables 23, 24, and 25) also indicate in this period the relevance of increases in productivity for development.

The information conveyed by the demographic indicators is the same as before, corroborating the necessity of considering these variables to portray development fully. Similar comments apply to the relevance of education and health indicators. In the case of the education variables we continue emphasizing the role and importance of basic education versus illiteracy; now, secondary education has a much higher loading than primary education. We stress the necessity to concentrate efforts on educating the population.

Principal Component 2. This component definitely shows the relevance of economic growth (variables 1 and 2). One could argue that this result is a direct consequence of using two groups of countries with very different growth experiences during the 1980s.[50] Despite the truth of this position, notice that these two variables have low loadings in the first PC, indicating that these are not the most important factors describing development. In any case, this component points out the relevance of economic growth as a key factor toward development. Also notice that although in 1970 growth was also one of the aspects describing development, it did not show up as a relevant characteristic until the third PC.

Principal Component 3. This component has high loadings in very diverse variables: share of services in GDP (variable 5), exports of textiles (economic 11), imports of nonelectrical machinery (variable 18), imports of transport equipment (variable 20), population (variable 26), and primary school enrollment (variable 33).

Principal Component 4. This component has to do with the demographic indicators, in particular with growth of population and birth rate (variables 26 and 28). This points to another important factor for development: the control of population growth, especially now that death rates have decreased dramatically owing to improvements in healthcare. Many developing countries have managed to reduce their death rates but still have high birth rates, which they have to control if they want to see their per capita indicators improve.[51]

Principal Component 5. This component runs parallel to PC 4 in 1970. The highest loadings appear in exports of food and agriculture (variable 9) and exports of fuels and metals (variable 10).

Principal Component 6. This component refers to the import side, specifically imports of fuels (variable 16), textiles (variable 17), and transport equipment (variable 20).

To sum up, the interpretation of the components in 1990 is very similar to that of 1970. Especially important is the fact that in 1990, just as in 1970, the first component can also be described as an *index of development* that captures the multidimensional character of the development process.

Discriminant Analysis. Our second exercise is a discriminant analysis that we performed with a view to determining which set of variables best discriminates between the two groups of countries. We used a logistic regression, since this

model can be employed to discriminate between two groups and is less restrictive in terms of assumptions than discriminant analysis.[52] Table 6 reveals the main results.

TABLE 6
LOGIT ANALYSIS FOR LATIN AMERICAN AND ASIAN COUNTRIES: DISCRIMINATING POWER OF 39 DEVELOPMENT INDICATAORS

	1970	1990
A. Economic variables		
1	15	32
2	15	30
3	20	19
4	14	11
5	20	17
6	19	21
7	19	9
8	17	19
9	13	15
10	8	9
11	21	24
12	17	22
13	20	26
14	18	18
15	18	8
16	6	11
17	17	23
18	14	10
19	13	27
20	18	13
21	17	16
22	8	5
23	19	11
24	19	10
25	23	12
B. Demographic variables		
26	24	24
27	15	12
28	15	11
29	17	15
30	16	14
31	15	15
32	19	23
C. Education variables		
33	17	13
34	13	12
35	13	13
36	19	20
D. Health variables		
37	11	11
38	24	25
39	11	11

NOTE: Variables in the same order as in table 5. The table shows the number of countries correctly assigned to the two groups. Total number of countries is 35. The criterion used for discrimination is explained in note 53.

Contrary to what could be expected, the 39 variables, one by one, have a relatively high discriminating power.[53] In general, we can assert that, for 1970, the discriminating power of the economic indicators is not higher than that of the other three groups. Within the economic indicators, the most powerful discriminator is real GDP per worker (variable 25). This variable discriminated correctly 65.7 percent of the total cases. Table 4 shows that the value of this variable for Latin America was twice that for Asia. This variable, which can be identified as a proxy for productivity, reveals that in 1970 Latin America was well ahead of Asia. Also, the share of exports of textiles (variable 11), the share of agriculture in GDP (variable 3), the share of exports of electrical machinery (variable 19), and the share of services in GDP (variable 5) discriminate correctly around 60 percent of the cases. Notice (see table 4) that the value of the first three just-mentioned variables was higher in Asia, while for the last (i.e., the share of services in GDP), the ratio was higher in Latin America. Especially interesting is the fact that Asia had higher shares of both agriculture in GDP and exports of electrical machinery in total exports. This shows that even though, as a whole, the Asian countries were more dependent on the agricultural sector (and therefore "less developed"), some of them (i.e., Korea, Hong Kong, Singapore) had already started a transformation into manufacturing economies, following the steps of Japan by taking advantage of the labor cost differential.

What is surprising is that the best discriminators in 1970 were two noneconomic variables: total population (variable 26) in the demographic group, and population per physician (variable 38) in the health group, both classifying correctly 68.5 percent of the countries. As table 4 reveals, the value of the latter variable was higher for Asia. Total population, not shown on table 4, was much higher in Asia. This latter fact points out a structural difference between the two regions. As to population per physician, recall that earlier we pointed out that the figure refers to doctors in the "Western" sense. Owing to cultural reasons, this figure is much higher for Asia.

Within the educational variables, the best discriminator is the adult illiteracy rate (variable 36) (54.2 per cent of the cases correct), which was lower for Latin America.

The poorest discriminators in 1970 were the shares of exports and imports of fuels and metals in total exports and imports, variables 10 and 16 respectively, and energy consumption per head (variable 22). The two trade variables show that the two areas have a comparative advantage in natural resources and, therefore, it is difficult to discriminate between them.[54]

As for 1990, the picture is rather different. Now, the best discriminators for the 1980–90 period are of an economic nature: the real growth of GNP (variable 1) (91.4 percent of the countries assigned correctly), and the real growth of GNP per capita (variable 2) (85.7 per cent of the countries assigned correctly). The discriminating power of these two variables is the resulting coincidence of the economic chaos in which Latin America was submerged during the 1980s and the amazing growth of many Asian countries during the decade. The share of exports of electrical machinery (variable 13) continues discriminating fairly well (68.5

percent of the cases), indicating the importance of this item for the Asian countries. Furthermore, during the last decade countries like Malaysia and Thailand have become important assembly centers of Japanese products.

Within the demographic, education, and health groups, the same variables as before are the best discriminators: total population (variable 26) (68.5 percent of the cases), adult illiteracy rate (variable 36) (57 percent), and population per physician (variable 38) (71.4 percent). Again, the illiteracy rate uncovers the existence of a better educational base in Latin America than in Asia. The share of urban population, higher in Latin America, is also a clear distinction between the two regions.

The worst discriminators are similar to those in 1970. The most interesting aspect to point out is the loss in discriminating power of the industrial sector, both in terms of share in GDP (variable 4) and in total employment (variable 7). This is the result of the important industrializing efforts on the part of most Asian countries.

In short, this analysis reveals important differences between Latin America and Asia not only from the economic point of view, but also in their demographic, education, and health structures. If in 1970 several indicators performed well in discriminating the two regions, in 1990 real economic growth is clearly the key to understanding the difference in performance between the two regions.

Cluster Analysis. In the final part of our empirical analysis we show the results of a cluster analysis in order to identify similar countries within our sample from the characteristics they possess.[55] This technique has been applied in a similar context to explore different ways and levels for clustering of diverse attributes that measure welfare.[56]

The dendograms (see figs. 1 and 2) show the cluster membership for countries based on D_{KL}.[57] The vertical axis provides the number of clusters and the horizontal axis specifies the countries. As one moves from one extreme of no aggregation (35 clusters) to the single-cluster case, larger distances are tolerated in order to force fewer clusters. As before, we have also separated the two periods.

What do the dendograms for 1970 and 1990 indicate? (The results are summarized in tables 7 and 8.) For 1970 (table 7), we think the similarities among the countries are best captured by 11 clusters. The first aspect to notice is that 6 out of the 11 clusters are monocountry. These countries split from the rest very early in the process, in particular, Honduras and Nepal. These two countries were probably the least developed from the point of view of our indicators, but they do not seem to be similar. The result for China seems to be consistent with what one would expect in 1970. China was practicing the "closed-door" policy and this appears reflected in its clustering alone.

We do not find a clear explanation for the other three monocountry clusters, and the cluster between Nicaragua and Venezuela. In clusters 8, 9, and 10 we have most of the Latin American countries, and cluster 11 clearly groups the Asian countries. Cluster 8 is dominated by the size factor. In cluster 9 we have three small Central American countries, three South American countries, and Korea. In cluster 10 we encounter five Central American and two South American countries. Cluster 11, with the exception of Jamaica, clearly groups the Asian countries,

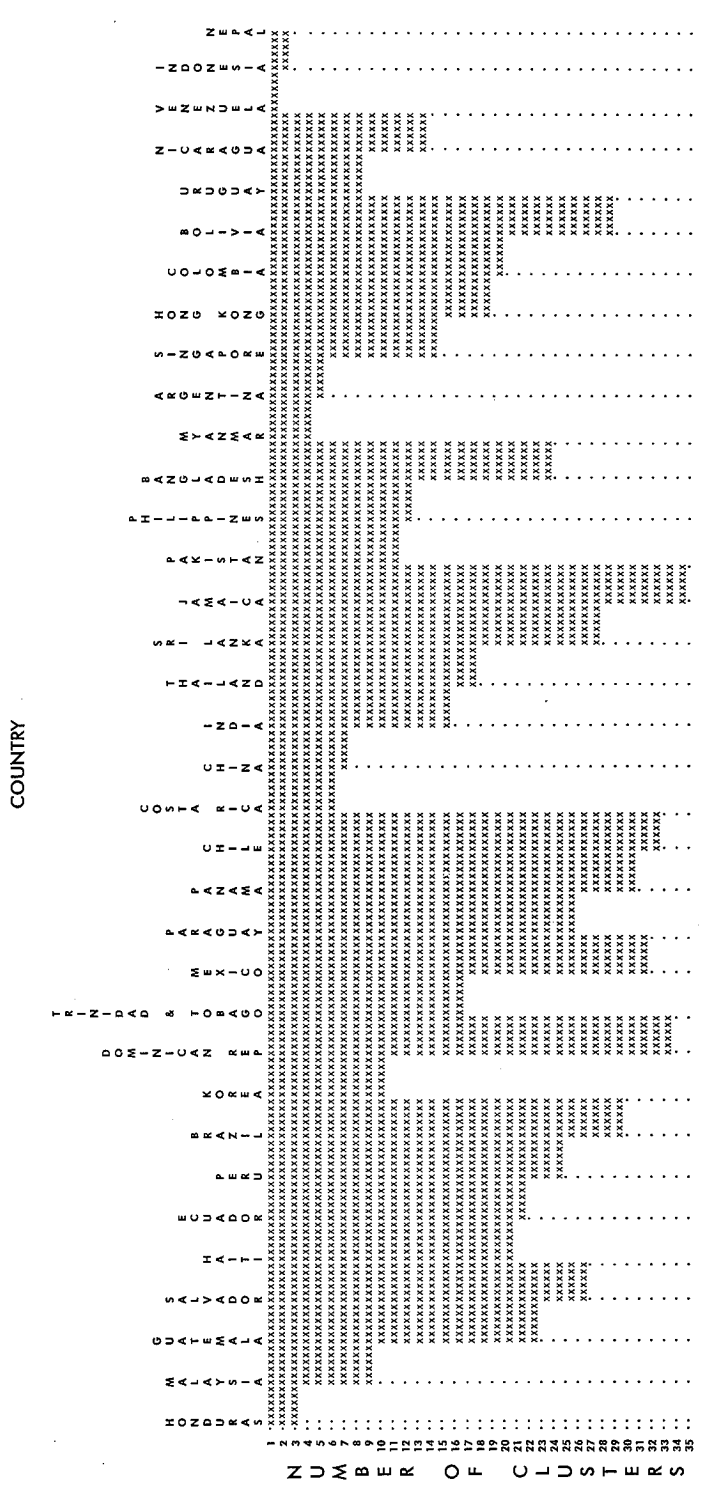

Fig. 1. Centroid Hierarchical Cluster Analysis 1970

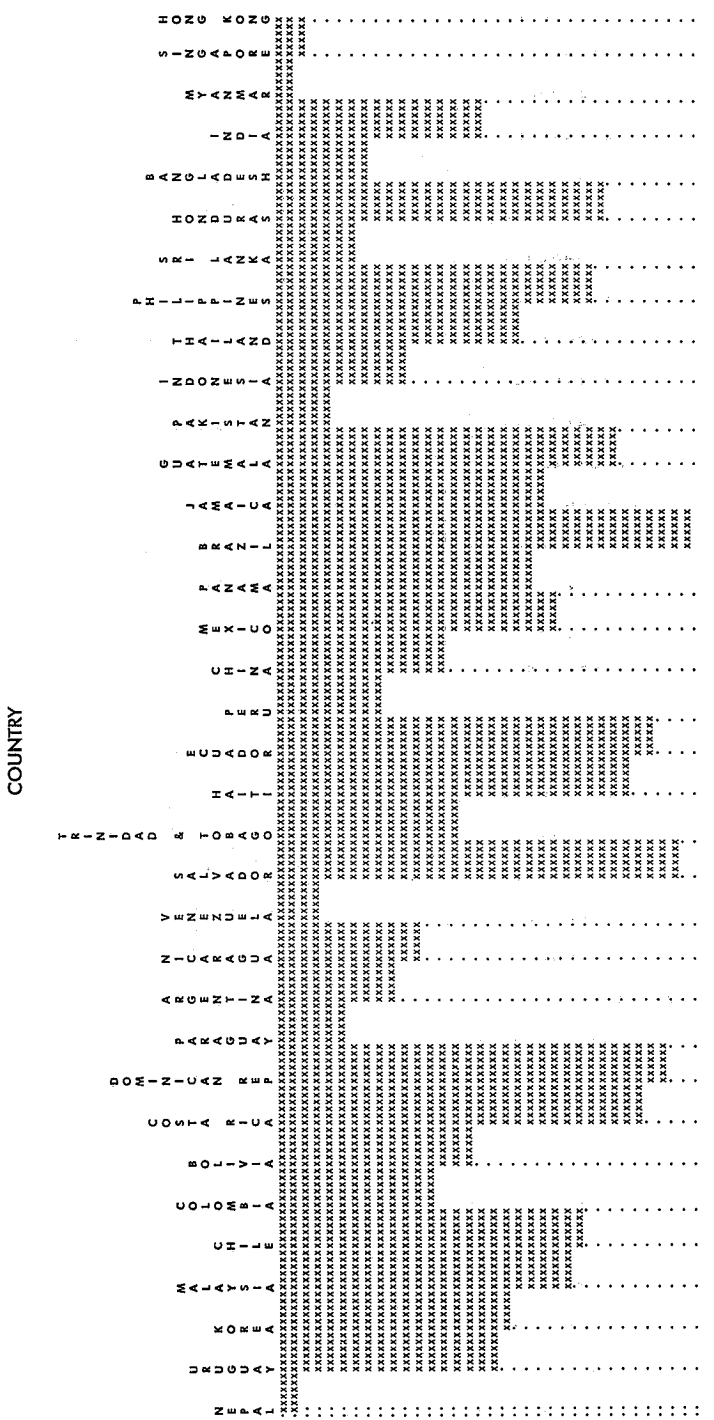

Fig. 2. Centroid Hierarchical Cluster Analysis 1990

TABLE 7
CLUSTER ANALYSIS FOR 1970: LATIN AMERICAN AND ASIAN COUNTRIES

Cluster 1: Honduras
Cluster 2: Malaysia
Cluster 3: Nepal
Cluster 4: Indonesia
Cluster 5: Argentina
Cluster 6: China
Cluster 7: Nicaragua, Venezuela
Cluster 8: Singapore, Hong Kong, Colombia, Bolivia, Uruguay
Cluster 9: Guatemala, El Salvador, Haiti, Ecuador, Peru, Brazil, Korea
Cluster 10: Dominican Republic, Trinidad and Tobago, Mexico, Paraguay, Panama, Chile, Costa Rica
Cluster 11: India, Thailand, Sri Lanka, Jamaica, Pakistan, Philippines, Bangladesh, Myanmar

which in 1970 appeared to be very homogeneous. Singapore and Hong Kong were already ahead of the other Asian countries in 1970. We do not know why Malaysia does not appear in cluster 11. Also notice that Korea appears in cluster 9, together with six Latin American countries.

These results seem to point to the existence of macroclusters organized geographically. It is difficult to assign a clear meaning to the regional clusters in Latin America, however, since most countries in this region are divided into three groups—8, 9, and 10. Economic weight (e.g., Mexico and Brazil in Latin America) does not appear to be a decisive clustering factor, and neither does size. Finally, the most similar countries in this period were the Dominican Republic–Trinidad and Tobago; Mexico–Paraguay; Chile–Costa Rica; and Jamaica–Pakistan.[58]

Regarding 1990 (table 8), we think 10 clusters capture the similarities among the countries. The situation for this second period is different from the one previously depicted. First, notice that the number of monocountry clusters has decreased. The isolation of Nepal definitely shows up as a clear distinctive feature of the small Tibetan kingdom. The other two single-country clusters are Hong Kong and Singapore. The two city economies are far ahead of the rest of the sample, especially in the economic indicators; size, probably, has also separated them from the rest. It is interesting to observe, however, that they are not clustered together. Furthermore, very early in the clustering process, they go from being together in a cluster with no other country to being separated into two individual clusters. This points to the intrinsic differences between the two, stressed in the

TABLE 8
CLUSTER ANALYSIS FOR 1990: LATIN AMERICAN AND ASIAN COUNTRIES

Cluster 1: Nepal
Cluster 2: Singapore
Cluster 3: Hong Kong
Cluster 4: Honduras, Bangladesh
Cluster 5: India, Myanmar
Cluster 6: Indonesia, Thailand, Philippines, Sri Lanka
Cluster 7: Peru, Ecuador, Haiti, Trinidad and Tobago, El Salvador
Cluster 8: Pakistan, Guatemala, Jamaica, Brazil, Panama, Mexico, China
Cluster 9: Paraguay, Colombia, Dominican Republic, Chile, Costa Rica, Bolivia, Uruguay, Malaysia, Korea
Cluster 10: Venezuela, Nicaragua, Argentina

literature.[59] Honduras and Bangladesh now appear clustered together. These two countries have performed very poorly during the last two decades and are at the bottom in most of our indicators. India and Myanmar have split from the cluster in which they were in 1970 to form a single one now. Probably geographic proximity is playing a role, also indicating their relatively better situation compared to their other South Asian neighbors, in particular Nepal and Bangladesh.

We identify cluster 6 with the lower tier of the Association of Southeast Asian Nations, ASEAN (plus Sri Lanka). The countries in cluster 7 are a subgroup of cluster 9 in 1970 and comprise Peru, Ecuador, Haiti, El Salvador, plus Trinidad and Tobago. These are small Latin American countries. The inclusion of Trinidad and Tobago is clearly influenced by the size factor, since the small island is in much better circumstances than the other countries. The case of Haiti is clearly the opposite. In cluster 8 we have a mixture of countries from both regions. It is interesting to see that Brazil, Mexico, and China appear together. These are large countries that have moved toward industrialization during the last two decades. The size factor also brought them together, although this would not explain why the other countries are in this cluster. This result also reflects China's open-door policy and the economic and political transformations going on in the country. In cluster 9 we have a group of small Latin American countries plus Malaysia and Korea. Clearly, the two Asian countries do not seem to fit in the Asian group. Economic performance in terms of growth is not playing a definitive role here, otherwise Korea should have been "closer" to the Asian countries. As to the inclusion of Malaysia in this group, it shows the heterogeneity of the ASEAN countries, with its implications for formation of regional groups. In the last cluster, we have Venezuela and Nicaragua, inexplicably again together, plus Argentina. The most similar countries in this period are the Dominican Republic–Paraguay; El Salvador–Trinidad and Tobago; Ecuador–Peru; and Brazil–Jamaica.[60]

Conclusions

In this paper we have dealt with several issues related to the measurement of development. The starting point was the definition of a set of 39 development indicators that reflected the "conventional wisdom" of the development literature. Next, we tried to identify common dimensions in the data set. To tackle this issue we used the PCs method, a multivariate analysis technique that allows the highlighting of the subset of relevant indicators characterizing development. A second consideration was the adoption of a comparative perspective between Asia and Latin America. Using a logit regression, we analyzed the discriminating power of the 39 development indicators applied to a group of 21 Latin American and 14 Asian countries. Finally, we tried to identify groups of similar countries by using cluster analysis.

Having performed these three exercises for both 1970 and 1990, we arrived at the following seven main conclusions. First, underdevelopment is a multidimensional concept that reflects a specific situation at a specific point in time in a country, which has to be defined in terms of its economic, demographic, educational, and health conditions. Economic indicators alone, such as GDP per

capita, do not fully portray the complete meaning of development. Although economic growth is not part of what we termed the *index of development*, its importance is manifest inasmuch as it is a critical factor in explaining the subsequent principal components. In this study we found that the typical underdeveloped country is characterized by the preeminence of the agricultural sector with low productivity, high birth and death rates, low life expectancy, highly concentrated populations in rural areas, illiterate populations in need of basic education, poorly fed populations, and high infant mortality. Second, the essential idea of development has not changed between 1970 and 1990. Third, most developmen indicators, within and among the four groups—economic, demographic, education, and health—considered in this study, are highly correlated with one another. This means that they convey the same information; thus, using them together, without having previously extracted common dimensions, does not add information and prevents us from understanding clearly the significance of development. Fourth, development efforts have to go in the direction of increasing productivity as measured by real GDP per worker, increasing the educational basis of the population, reducing adult illiteracy, and controlling expanding populations. Fifth, in 1970, countries in Latin America and Asia could be best differentiated in terms of their real GDP per worker, total population, and population per physician. In 1990, the economic performance during the 1980–90 decade, as measured by the real growth of GNP, is the best discriminator between the two regions. Sixth, even though, in general, geographic proximity arises as an appropriate basis for clustering Latin American and Asian countries, there is good deal of "blend" between the two regions. In 1970 we observe a lot of dissimilarity, as reflected in the large number of monocountry clusters. The isolation of China is the most easily explainable. In 1990, clusters are very different. The most salient aspects are the facts that (1) China, Mexico, and Brazil (but not India) are together in a cluster in 1990; (2) Malaysia and Korea are not clustered with the other Asian countries in either period; (3) in 1970 Singapore and Hong Kong are together in a cluster; in 1990, however, they appear as the most dissimilar countries; (4) countries belonging to the ASEAN group are split into several clusters; and (6) diversity is clearer among Asian countries, since they split in the dendogram earlier than the Latin American countries. Finally, this paper has shown the relevance of diverse multivariate analysis techniques applied to empirical problems in the social sciences. These techniques are mainly descriptive and are useful in summarizing the information contained in a large data set, especially when a relevant theory is not fully developed. In this sense, multivariate analysis can be seen as a useful first step in identifying empirical regularities that can motivate posterior theoretical assessments of some issues. Also, they permit us to analyze important information that does not show up using more classical methods applied in the social sciences (and in particular in economics), such as regression analysis. The use of any sort of discriminant analysis can be valuable for comparing patterns of development between different regions, and cluster analysis is effective in identifying groups of countries that evolve similarly. The use of these two latter techniques would be especially interesting in the case of

the availability of data regarding policy variables. In this instance, one would be able to provide a preliminary map of comparative policy strategies that could shed light on the issues that theoretical analyses should handle.

NOTES

1. According to recently released figures from the World Bank and the Organization for Economic Cooperation and Development (OECD), the GDP (gross domestic product) per capita of developing countries changes dramatically when measured at purchasing power parity (PPP):

DEVELOPING COUNTRY GDP PER CAPITA MEASURED AT PURCHASING POWER PARITY IN 1992

	GDP PER CAPITA		GDP (INTERNATIONAL $BN)
COUNTRY	Market Exchange Rate (US$)	Purchasing Power Parity (International $)	Purchasing Power Parity
China	370	2,460	2,870
India	275	1,255	1,105
Brazil	2,525	4,950	770
Mexico	3,700	6,590	590
Indonesia	650	2,770	510
South Korea	6,790	8,635	380
Thailand	1,780	5,580	320
Pakistan	400	2,075	240
Argentina	6,870	5,930	190
Nigeria	275	1,560	190
Egypt	655	2,400	180
Philippines	820	2,400	155
Malaysia	2,980	7,110	130

SOURCE: "Chinese Puzzles," *Economist* (London), 15–21 May 1993, p. 83.

THE WORLD GDP LEAGUE (AT $PPP)

Rank	Country
1	United States
2	China
3	Japan
4	Germany
5	India
6	France
7	Italy
8	Britain
9	Brazil
10	Mexico
11	Canada

SOURCE: "Chinese Puzzles," *Economist* (London), 15–21 May 1993, p. 83.

2. Assuming, obviously, that democracy and development are related concepts.

3. This point was also made by Irma Adelman and Cynthia Taft Morris, *Society, Politics, and Development: A Quantitative Approach* (Baltimore, MD: Johns Hopkins University Press, 1967), p. 5. Our analysis, in some sense, is parallel to theirs and therefore we simply restate their point since it remains valid.

4. This is what Joseph G. Hirschberg, Esfandiar Maasoumi, and Daniel J. Slotje, "Cluster Analysis for Measuring Welfare and Quality of Life across Countries," *Journal of Econometrics* 50,

no. 1–2 (1991): 131–50, call the "double counting" problem, which occurs when one addresses the issue of whether different indicators of welfare offer distinct information.

5. Walt W. Rostow, *The Stages of Economic Growth* (Cambridge, MA: Cambridge University Press, 1960).

6. Robert Solow, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics* 70 (1956): 65–94; and idem, "Technical Change and Aggregate Production Function," *Review of Economics and Statistics* 39 (1957): 312–20.

7. See Robert E. Lucas, "On the Mechanics of Economic Development," *Journal of Monetary Economics* 22 (1988): 3–42; and idem, "Making a Miracle," *Econometrica* 61 (March 1993): 251–72.

8. Paul Baran, *The Political Economy of Growth* (New York: Monthly Review Press, 1957).

9. Samir Amin, *Unequal Development: An Essay on the Social Formations of Peripheral Capitalism* (New York: Monthly Review Press, 1976).

10. Arghiri Emmanuel, *Unequal Exchange: A Study of the Imperialism of Trade* (New York: Monthly Review Press, 1972).

11. See for example Eliana Cardoso and Albert Fishlow, "Desenvolvimento Econômico na América Latina: 1950–80," *Revista Brasileira de Economia* 44 (July–September 1990).

12. Albert O. Hirschman, *The Strategy of Economic Development* (New Haven: Yale University Press, 1958); W. A. Lewis, "Economic Development with Unlimited Supplies of Labor" *Manchester School* (1954); Gunnar Myrdal, *Economic Theory and Under-developed Regions* (London: Gerald Duckworth, 1957); Raúl Prebisch, "Commercial Policy in the Underdeveloped Countries," *American Economic Review* 59 (1959): 251–73; Hans W. Singer, "The Distribution of Gains between Investing and Borrowing Countries," *American Economic Review* 40 (1950): 473–85.

13. World Bank, *The East Asian Miracle: Economic Growth and Public Policy* (New York: Oxford University Press for the World Bank, 1993).

14. Toshio Akiyama, Kazuhiro Ueta, Shun'ichi Teranashi, and Shigeaki Fujisaki, "Development and Environment: The Case of East Asian Countries," in *Development Strategies for the Twenty-First Century*, ed. Teruyuki Iwasaki, Takeshi Mori, and Horoichi Yamaguchi (Tokyo: Institute of Developing Economies, 1992), pp. 536–45; Horoichi Yamaguchi, "Social and Political Aspects of Development: Some Thoughts on the Viability of the Asian and Pacific Model," in idem, pp. 30–38.

15. Irma Adelman, *Theories of Economic Growth and Development* (Stanford, CA: Stanford University Press, 1961), pp. 1–2.

16. Michael P. Todaro, *Economic Development in the Third World*, 3d ed. (New York: Longman, 1985), p. 61.

17. Lucas, "On the Mechanics of Economic Development," p. 1.

18. Ibid., p. 13. Since the publication of this paper, growth models consider the indirect effects of human capital accumulation. This seems to be particularly relevant to explain the success of the newly industrialized economies (NIEs) of Asia. For an introduction to the endogenous growth literature, see the Symposia section on New Growth Theory, *Journal of Economic Perspectives* 8 (Winter 1994). This section contains papers by Paul M. Romer, Gene M. Grossman and Elhanan Helpman, Robert M. Solow, and Howard Pack.

19. Simon Kuznets, *Economic Development, the Family, and Income Distribution: Selected Essays* (Cambridge, England, New York: Cambridge University Press, 1989), p. 430. Foreword by Richard Easterly and afterword by Robert Fogel.

20. Irma Adelman and Cynthia Taft Morris, *Society, Politics, and Development. A Quantitative Approach.* A related work by the same authors is "A Factor Analysis of the Interrelationship between Social and Political Variables and Per Capita Gross National Product," *Quarterly Journal of Economics* 79 (November 1965): 555–78. See also the exchange between Adelman and Morris and Balu Bumb in the following series of articles: Irma Adelman and Cynthia Taft Morris, "Factor Analysis and Development: A Reply," *Journal of Development Economics* 11 (1982): 113–23; Irma Adelman and Cynthia Taft Morris, "Factor Analysis and Development: A Rejoinder to a Rejoinder," *Journal of Development Economics* 11 (1982): 129; Balu Bumb, "Factor Analysis and Development: A Note," *Journal of Development Economics* 11 (1982): 109–12; Balu Bumb, "Factor Analysis and Development: A Rejoinder," *Journal of Development Economics* 11 (1982): 125–28; Balu Bumb, "A Note on Variables and Observations in Factor Analysis: A Reply," *Journal of Development Economics* 24 (1986): 197–200.

21. Lucas, "On the Mechanics of Economic Development," p. 4.

22. Montek S. Ahluwalia, "Inequality, Poverty, and Development," *Journal of Development Economics* 3 (1976): 307–42.

23. Norman Hicks and Paul Streeten, "Indicators of Development: The Search for a Basic Needs Yardstick," *World Development* 7 (1979): 567–80.

24. As cited in Hicks and Streeten, "Indicators of Development."

25. Ibid., p. 575.

26. As cited in Hicks and Streeten, "Indicators of Development."

27. David Larson and Walton T. Wilford, "The Physical Quality of Life Index: A Useful Social Indicator?" *World Development* 7 (1979): 581–84.

28. World Bank, *World Development Report* (Oxford, New York: Oxford University Press for the World Bank).

29. Rati Ram, "International Inequality in the Basic Needs Indicators," *Journal of Development Economics* 10 (1982): 113–17.

30. For details see the United Nations Development Program (UNDP), *Human Development Report 1991* (New York, Oxford: Oxford University Press for UNDP, 1991), Technical Note 1.

31. T. N. Srinivasan, "Human Development: A New Paradigm or Reinvention of the Wheel? *American Economic Review, Papers and Proceedings of the Hundred and Sixth Annual Meeting of the American Economic Association* (May 1994): 238–43.

32. Ibid., p. 241.

33. Robert Summers and Alan Heston, "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988," *Quarterly Journal of Economics* (May 1991).

34. Joseph F. Hair, Jr., et al., *Multivariate Data Analysis with Readings*, 3d ed. (New York: Macmillan, 1992); D. F. Morrison, *Multivariate Statistical Methods*, 3d ed. (New York: McGraw-Hill, 1990); Bryan F. J. Manly, *Multivariate Statistical Methods: A Primer* (London: Chapman and Hall, 1986).

35. This type of special regression also appears in the probit regression, where a normal distribution function is assumed.

36. Hair et al., *Multivariate Data Analysis with Readings*; Manly, *Multivariate Statistical Methods: A Primer*; Morrison, *Multivariate Statistical Methods*.

37. R. R. Sokal and C. D. Michener, "A Statistical Method for Evaluating Systematic Relationships," *University of Kansas Science Bulletin* 38 (1958): 1409–38.

38. SAS Institute Inc., SAS Manual, Version 6.

39. In particular the pseudo-F and pseudo-t^2 statistics. The former measures the separation among all clusters at the current level; the latter measures the separation between the two clusters most recently joined.

40. We could not find complete and reliable series for countries such as Cuba, Taiwan, Laos, Kampuchea, and Vietnam, and for this reason they were not included in the analysis.

41. Perhaps now we can perceive some symptoms of improvement in the region.

42. Obviously, Asian countries were able to handle the debt burden much better. Furthermore, debt had a much more productive use in Asia than in Latin America.

43. F. Gerard Adams, "Economic Performance and Prospects: South East Asia and Latin America," in *Perspectives on the Pacific Basin Economy: A Comparison of Asia and Latin America*, ed. Takao Fukuchi and Mitsuhiro Kagami (Tokyo: Institute of Developing Economies, 1990); Chin-Yuan Lin, "East Asia and Latin America as Contrasting Models," *Economic Development and Cultural Change* 36, no. 3, Supplement (1988); Chung H. Lee and Seiji Naya, "Trade in East Asian Development with Comparative Reference to Southeast Asian Experiences," *Economic Development and Cultural Change* 36, no. 3, Supplement (1988).

44. Hicks and Streeten, "Indicators of Development," point out that "Western" statistics do not account for the traditional forms of medicine practiced in many Third World countries.

45. We have to admit that there is no formal theoretical model justifying the inclusion of some of the indicators chosen. We wish to make the following observations. First, in some cases we could not find a variable for both 1970 and 1990; in other cases, we could not find the variable for some countries in one of the two years. In all these instances we used the nearest year we found. Second,

we could not find complete and reliable series on other important aspects possibly influencing development, such as defense and education expenditures and research and development expenditures. Third, one can argue that some of the indicators used are not, strictly speaking, "development" indicators, especially within the economic group. We think, however, that they, or a linear combination of them, portray the situation and overall level of development of the countries studied. For example, the fact that a country exports oil and minerals means only that it is well endowed in natural resources and that it is exploiting them (comparative advantage). If, however, we also know that the share of agriculture in total GDP is high, the share of exports of manufactures in total exports is low, and GDP per worker is also low, we may be starting to get closer to the "typical" profile of a less-developed country.

46. In an exercise to see the degree of correlation among the indicators in each group, we have calculated principal components (PCs) for each of them separately. The results for 1970 follow.

PRINCIPAL COMPONENTS FOR EACH GROUP IN 1970

Group	No. of Indicators	No. of Components	% of Variance Explained
Economic	25	4	72
Demographic	7	2	73
Education	4	2	89
Health	3	2	91

These results indicate the existence of high multicollinearity within each group of indicators. If we use the first 6 economic PCs, the first 3 demographic, and the first 2 for education and health, that is, a total of 13 PCs, and we run a second round of PCs, we need only the first 5 to explain 73 percent of the total variation. This shows in a way parallel to the one in the text the existence of high multicollinearity among the four groups of indicators. The results of this second round of PCs are very similar to the ones using the 39 indicators together. The only difference is that the interpretation of the components becomes much more complex.

47. For reasons of space we do not show the PCs, but they are available upon request.

48. Summers and Heston, " Penn World Table (Mark 5)."

49. In an exercise parallel to the earlier one for 1970, we have calculated PCs for each group using our data for 1990. The results follow.

PRINCIPAL COMPONENTS FOR EACH GROUP IN 1990

Group	No. of Indicators	No. of Components	% of Variance Explained
Economic	25	4	72
Demographic	7	2	72
Educational	4	2	82
Health	3	2	92

These results show, again, the existence of high multicollinearity within each group of indicators. If we use the first 6 PCs, the first 3 demographic, and the first 2 educational and health, that is, a total of 13 PCs, and we run a second round of PCs, we need the first 5 to explain 71 percent of the total variation. This shows in a way parallel to the one in the text that high multicollinearity also exists among the four groups of indicators in 1990.

50. And as we shall see in the next section, these variables are powerful discriminators between the two regions.

51. Recently, an editorial in the *Far Eastern Economic Review* (13 May 1993) criticized the position of the UNDP and World Bank for trying to control population growth and dismissed the argument that Asia's large populations are a cause of poverty. The article proposed using density as a better indicator. Then, countries such as China, India, the Philippines, and Indonesia are among the least densely populated in the region, while Hong Kong, Singapore, Taiwan, Korea, and Japan are at the top of the list. The article sees "economic freedom" as the most crucial factor in development.

52. Hair et al., *Multivariate Data Analysis with Readings*, p. 91. Also, George G. Judge et al., *Theory and Practice of Econometrics*, 2d ed. (New York: John Wiley and Sons, 1985), p. 768.

53. The criterion chosen to establish whether a country has been correctly assigned is the following: $Y = 1$ iff $P(Y = 1) > 0.6$; $Y = 0$ iff $P(Y = 0) < 0.4$. For the cases in between, we say that the model does not discriminate correctly. This is a much more stringent requirement than the one proposed in Hair et al., *Multivariate Data Analysis with Readings*, p. 60.

54. We have also used the six PCs described in the text as discriminators. The result is that they classify correctly 28 countries, so that they outperform the single variables.

55. We have not standardized the 39 indicators, since standardization is not always appropriate. See G. W. Milligan and M. C. Cooper, "An Examination of Procedures for Determining the Number of Clusters in a Data Set," *Psychometrika* 50 (1985): 159–79. Also, idem, "A Study of Variable Standardization," College of Administrative Science Working Paper Series 87–63 (Ohio State University, Columbus, OH, 1987).

56. Hirschberg et al., "Cluster Analysis for Measuring Welfare and Quality of Life." Interestingly, their analysis was applied with a view to identifying "double counting" in measures of welfare. This application is more in line with our PC analysis.

57. The dendograms upon which our analysis is based are available upon request. Here we report only the results of the centroid method. We also performed the analysis using the average linking method and obtained very similar conclusions.

58. This is measured in terms of how long it takes the countries to split in the dendogram.

59. Lawrence B. Krause, "Hong Kong and Singapore: Twins or Kissing Cousins?" *Economic Development and Cultural Change* 36, no. 3, Supplement (1988). Also Alwyn Young, "A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong and Singapore," in National Bureau of Economic Research (NBER), *NBER Macroeconomics Annual* (Cambridge, MA: MIT Press, 1992).

60. In both periods the level of similarity among Latin American countries is higher than that among Asian countries, since the former remain together in the dendogram much longer than the Asian countries do.