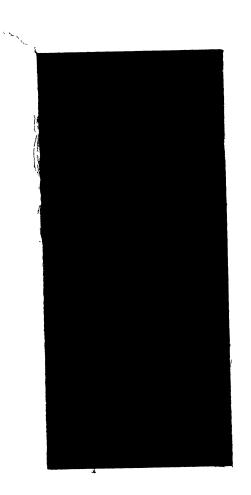Center for Research on Economic Development

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Quantitative Measurement
of
Development   Performance

A Critique by Peter Eckstein
and
a
Reply by Irma Adelman
and Cynthia Taft Morris

7

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Editor's Note

Discussion Paper Number 7 consists of two parts. The first, written in April, 1969, by Peter Eckstein of CRED, is a critique of the "econometric model of development" presented in the December, 1968, American Economic Review. The second part is a reply, written in July, 1969, by the authors of that model, Irma Adelman of Northwestern University and Cynthia Taft Morris of American University. The reply was prepared in response to a shorter version of the Eckstein critique and to a discussion of the model by Sara Berry of the University of Indiana.

Quantitative Measurement of Development Performance:
A Critique of the Adelman-Morris Model[1]

by
Peter Eckstein

As more is learned and written about each of the world's many underdeveloped economies, comparative statistical studies become more possible and more attractive to investigators. While no two countries can be expected to have the same historical experiences, such scholars as Kuznets, Chenery and Maizels have succeeded in identifying some persistent economic characteristics of the development process; at the very least, such studies can reveal statistical norms of past behavior. As both the economic and the non-economic data grow richer, however, the hope increases that the associations revealed in cross-section (and eventually comparative time-series) studies can yield insights into the basic causes of different levels and rates of development--and perhaps can even supplement economic analysis and country case studies as means of isolating those policies most likely to promote rapid development. This is the very ambitious goal of the "econometric model of development" presented by Professors Irma Adelman and Cynthia Taft Morris.[2]

At least five difficulties are known to inhere in any such enterprise: (i) many of the most important characteristics of countries seem to defy quantification, particularly in ways which can be standardized both across countries and over time; (ii) data for even basic economic time series either do not exist or are highly unreliable for most of the relevant countries; (iii) the very similarity of the development process means that a myriad of variables--causes, effects and joint effects of similar causes--all vary together as countries develop;

(iv) cross-section relationships cannot be expected to replicate temporal relationships; and (v) existing statistical techniques, however sophisticated, do not permit us to infer the direction of causation from the fact of covariance.

Professors Adelman and Morris have dealt imaginatively--if not always successfully--with the first of these difficulties by developing "judgmental" measures of a number of qualitative variables. Unfortunately, they have not seriously addressed themselves to the remaining four. Rather, their model compounds those problems through its complete reliance on unstructured statistical techniques and its neglect of a prime rule of scientific inquiry--that the definition and measurement of the variable being explained must be completely independent of the definition and measurement of the variables being used to explain it.

The implications of these shortcomings are best evaluated by following their "econometric model" through its three stages. The model consists of: A) a discriminant analysis of 73 underdeveloped countries grouped according to "development potential";[1] B) a series of multiple regression equations for the four explanatory variables that emerge as important from that analysis; and C) a set of "multipliers" based on these two results and designed to measure the impact on "development potential" of some 18 political, social and economic variables. Each of these stages will be examined in turn.

A. The Discriminant Function

Discriminant analysis is a method of finding those characteristics which most clearly set off the members of one group from the members of other groups. The

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[1] The authors presented their discriminant analysis in "Performance Criteria for Evaluating Economic Development Potential: An Operational Approach," _Quarterly Journal of Economics_, May, 1968, and the rankings for each variable in _Society, Politics and Economic Development: A Quantitative Approach_, Baltimore: Johns Hopkins Press, 1967, pp. 9-129.

analysis assigns a weight to each of the characteristics so that the scores or ratings on individual characteristics can be added together to obtain a single score for each member. The weights are chosen so that each member's score will be close to the mean for all the members of the same group but distant from the means for the other groups.

Like regression analysis, discriminant analysis is a means of explaining or predicting a dependent variable (here called a "criterion variable") in terms of several independent (or "prediction") variables. Unlike regression analysis, in which both dependent and independent variables are ordinarily defined continuously, only the prediction variables of discriminant analysis are continuous. The criterion variable is the group membership of the observation, where this membership is known beforehand for all the cases in the sample (but may have to be predicted for cases not in the sample).[1]

In the stepwise discriminant analysis used in the Adelman-Morris model, the discriminant function is built one variable at a time. At each stage the computer "scans the entire list" of prediction variables "not already in the discriminant function." It then "selects that variable which adds most" to the explanation of the differences in group membership, "given the other variables already included."[2]

Professors Adelman and Morris begin their analysis by classifying 73 non-Communist underdeveloped countries by their average annual rates of growth of per capita Gross National Product between 1950/51 and 1963/64: "high" for rates above

[1]See, for example, M. G. Kendall, A Course in Multivariate Analysis, 1957, p. 144. One of the earliest economic applications was by D. Durand, who discriminated between good and bad loans on the basis of a weighted sum of the scores for size of down payment, purchase price, monthly income of borrower, and length of contract. (Cited in Gerhard Tintner, Econometrics, New York: 1952; p. 98.)

[2]"Econometric", p. 1188.

two per cent; "intermediate" between one and two per cent; and "low" below one

per cent. They explicitly reject, however, growth of GNP per capita as a measure

of the "prospects for sustained economic growth" on the grounds that there are

many cases of "growth without development." They therefore modify the membership

of these groupings in several ways (discussed below) in order to arrive at a

classification according to high, intermediate and low "developmental potential."

Although they begin with 29 potential prediction variables, their final discrimi-

nant function requires only four to assign each of the 73 countries a score closely

approximating the mean for its own group and to account for "over 97% of the over-

all variance in membership." The four prediction variables are (i) "the degree

of improvement in financial institutions," (ii) "the degree of modernization of

outlook," (iii) "the extent of leadership commitment to economic development,"

and (iv) "the degree of improvement in agricultural productivity."[1]

Before accepting this result as the basis of an "econometric model" we should

examine carefully the ways in which both the criterion variable and the prediction

variables are defined and measured.

1.   Defining "Development Potential"

There are two prior reasons for regretting the decision to move from indivi-

dual estimates of country growth rates to groupings of countries by "development

potential." In the first place, arbitrarily dividing the sample into only three

groups means losing potentially-valuable information about the substantial

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[1]Definitions of these and other variables in the model are reproduced in the Appen-
dix to this paper.

differences in growth performance within each of the groups.[1] In the second

place, attempting to transform groupings by growth rates into groupings by "dev-

elopment potential" means resting the entire analysis on a concept that could

easily elude the most careful efforts at definition and measurement.[2]

The most glaring difficulty with the discriminant analysis, however, is that

"development potential" is neither defined prior to the analysis nor measured in-

dependently of the prediction variables. The authors, in moving from estimates

of growth of per capita GNP to their concept of "development potential," undertake

three distinct steps, each of which quite openly reduces the extent to which the

variable being explained is observed independently of the variables being employed

to explain it.

a) Even before the 73 countries are finally categorized as to growth rates,

both the high and intermediate growth categories are purged of four African

countries "in which, as of about 1960, over 90 per cent of the population was in

the traditional subsistence sector where per capita GNP had not changed signifi-

cantly since 1950."[3] The effect is to reduce the independence of the prediction

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[1]For example, Turkey (with a per capita GNP growth rate of 2.1%) is grouped (and therefore assumed identical in "potential") with Greece (5.9%) but not with Costa Rica (1.9%). (Growth rates calculated from data in Agency for International Development, Gross National Product: Growth Rates and Trend Data, March 31, 1967.) Hubert Blalock offers the general rule that "the greater the number of categories that can be retained, the more likely that one can measure differences accurately." (Causal Inferences in Nonexperimental Research, 1964, p. 124.) Of course, the greatest number of categories would have been retained if the growth rate data had not been grouped at all, in which case regression techniques could have been app- lied instead of discriminant analysis.

[2]Several issues should have been faced: Can any but the most completely foreign- exploited economy really undergo siginificant "growth" without at the same time "developing?" (In a forthcoming paper my colleague Elliot Berg casts serious doubt on the concept of "growth without development" and its application to the prototypal case, Liberia.) Can "potential" be measured independently of perform- ance? Can the potential of a country (e.g., Argentina) be defined independently of its propensity to adopt policies which prevent it from fully and efficiently utilizing its physical and human resources.

[3]Society, op. cit., pp. 89-90.

and criterion variables by moving four countries low in "improvement in agricultural productivity" (and predominantly low on the other three prediction variables) out of the "high development potential" category. When they begin grouping countries for the discriminant analysis, the authors lump these four countries--along with Panama and Burma--as "unclassified" as to "development potential". The latter are both high in growth rates but intermediate or low on the four prediction variables in the discriminant function.[1]

b) Because they are interested in "development" rather than "growth", the authors seek to eliminate from the high-potential category these countries whose high growth rates "had only a limited overall impact within the economy." They therefore relegate to the intermediate category 11 fast-growing countries that do not rank "at least moderately high" with respect to five out of seven "economic performance characteristics."[2]

Sound experimental practice would seem to dictate that these seven variables, thus used in an important way to define the criterion variable, should be denied any role in influencing the values of the potential prediction variables. In fact, however, all seven are included among the 29 variables which the computer scans in order to build the discriminant function. Not surprisingly, two of the seven--"improvement in financial institutions" and "improvement in agricultural productivity"--that are used to categorize countries as to "development potential" are also among the four variables that are eventually "found" to be the best predictors of the categories to which countries belong.[3]

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[1] The authors assign Burma the high growth rate. Data comparable to that used in the study indicate a 3.1% growth rate for Panama. (See A.I.D., op. cit.)

[2] The seven characteristics are: change in degree of industrialization; improvement in agricultural productivity; improvement in physical overhead capital; improvement in financial institutions; improvement in the tax system and improvement in human resources.

[3] Examination of the ratings for the high-growth countries confirms that those rated low on either of these two characteristics were far more frequently demoted to the "intermediate potential" category.

c) The third step by which growth-rate groupings are transformed into "development potential" groupings is the most disturbing. On the basis of the rankings already described, an initial discriminant function is developed which contains four prediction variables--three of the four mentioned above, plus "degree of improvement in physical overhead capital" instead of the agricultural productivity variable. This discriminant function is then applied to the prediction variables for each of the six "unclassified" countries to determine the "development potential" categories to which they seem to belong. It is also applied to the 67 countries included in the analysis, revealing that 12 countries had ratings on the prediction variables more characteristic of countries in different categories of "development potential."

The authors could have taken these 12 discrepancies as a reflection on either i) the explanatory power or validity of the discriminant function or ii) the accuracy of the prediction variables. They conclude, however, that any fault lies with the criterion variable: "the original classifications with respect to development potential may have been mistaken."

> Since our confidence in our initial country classification was not high, we decided to repeat the analysis, omitting those countries which our first discriminant study indicated might be misclassified and allocating to their respective groups those countries which had originally been left unassigned. The results of this second discriminant analysis were then used to reclassify the countries left out in the second analysis. A third discriminant analysis was then made. No revisions were required in the third analysis, as no misclassifications were indicated on the second.[1]

The contrast with sound procedure should be emphasized. A careful investigator, if he has produced a theoretically-satisfying and statistically-powerful discriminant function, might well wish to use that function to predict the unknown classifications of excluded or new observations and perhaps even to doubt

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[1] "Performance," p. 278.

the anomalous classification of an occasional included observation. He would recognize these predictions and doubts as hypotheses, not empirical facts, and subject them--like any other hypotheses--to confirmation by external evidence.

This is not, however, the spirit of the Adelman-Morris approach. They admit that their confidence in the initial classification of the criterion variable is "not especially high." What they do not explain is (i) how their discriminant function can possess more validity than the criterion variable from which it is directly derived, or (ii) why their prediction variables--apparently measured no more carefully or objectively than the criterion variable--can greatly exceed it in validity. Nevertheless the authors use both the discriminant function and the initial classifications of the prediction variables not only to classify the six countries for which "development potential" had been treated as unknown but also to declassify 15 other countries for which "development potential" had been assumed to be known.[1] They then use these new classifications and declassifications not as hypotheses but as the equivalent of data--that is, as the input to another discriminant analysis. The resulting discriminant function is next used to reclassify the unknown "development potential" of the 15 countries, and these classifications are treated as part of the data input to a third discriminant analysis. When this procedure is complete all 73 of the countries have been classified--although for 21 countries observed growth performance has been treated as irrelevant, and classification has been based entirely on ratings on the four prediction variables included in the first two discriminant functions. When the third and final function is calculated from those classifications it accounts (as did the first) for "over 97 percent of the overall variance," and it renders "the separation between groups...

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[1] In addition to the twelve countries listed by the authors, three others--Bolivia, Cyprus and Ecuador, whose prediction scores are marginal in the first discriminant function--eventually migrate unheralded to new classifications, apparently as part of the same process.

considerably better...and the dispersion within the groups...substantially reduced."[1] This should not be surprising, since the new function employs three of the four prediction variables used in classifying so many of the observations.

As an example of the evolution of the criterion variable, consider four countries--Algeria, Iraq, Libya and Zambia. They are first demoted from the "high growth" to the "intermediate potential" category in part because of slow "improvement of financial institutions"; they are then reclassified as "low potential" on the basis of a preliminary discriminant function which gives heavy weight to "improvement of financial institutions." These four countries are thus eventually rated low both on "development potential" and "improvement of financial institutions," and this fact contributes both to the role of the financial variable in the final discriminant function and to the power of the function to distinguish among cases.

It may be useful to summarize the effects of redefining the criterion variable from rate of GNP growth to "development potential." There are a total of 32 reclassifications, in which 26 of the 73 countries end up in new categories. Table 1 presents the average country scores on the final discriminant function at each stage in the evolution of the criterion variable. The table suggests two characteristics of that evolution.

i) From the beginning the low growth countries score distinctly lower than the intermediate and high growth countries, but the latter begin as virtually indistinguishable from each other. The effect of repeatedly redifining the criterion variable is primarily to separate the scores of the high and intermediate groups.

ii) This separation is virtually completed after the first discriminant function has been used to reclassify the six originally-unclassified countries and to declassify the fifteen which the function fit poorly (see column 5). The final

[1]"Performance", p. 278.

reclassification of the fifteen on the basis of the second discriminant function serves merely to add numerical weight to a result which has already been substantially achieved through the elimination of awkward cases.

The only real definition of "development potential" we can infer from the discussion is an operational one; a country is high on "development potential" if it shares the characteristics of those countries that the authors, through their choice of methods, have finally classified as being in the highest group. The discriminant function is a statistical effort to summarize those characteristics. As such it is more accurately seen as a statement of a definition than as an empirical finding.

2. Defining and Measuring the Prediction Variables

The fact that the prediction variables play so important a part in the ultimate definition of the criterion variable certainly invalidates the Adelman-Morris discriminant function and any econometric model built upon it. The reader might be tempted, however, to place some reliance on the ability of the function to distinguish broadly between slow-growing and faster-growing countries. Unfortunately, a closer examination of the four prediction variables makes it unclear that any of them can appropriately be considered a cause of more rapid growth of GNP. Some of the variables could easily have been influenced by the same empirical phenomena that lay behind the growth-rate categorizations; others do not clearly play roles in their own right but may merely serve as proxies for more basic explanatory variables.

a) "Leadership commitment to economic development" was one of several qualitative or "judgmental" variables quantified through initial classifications by the authors (based on their own examinations of recent country studies) and subsequently checked by country experts (largely A.I.D. and State Department

Table 1
Average Scores on Final Discriminant Function (D_2)
(Number of countries in brackets)

	(1) Original Growth Ratings-- Narrow Groupings		(2) Original Growth Ratings-- Broad Groupings	(3) Unclassify Six Countries	(4) Demote Eleven Countries to Intermediate	(5) Reclassify Six Countries, Unclassify Fifteen on basis of First Discriminant Function b/	(5) Reclassify Fifteen Countries on basis of Second Discriminant Function	
High Growth >2%	A+	185 (3)	132 (32)	145 (27)	174 (16)	191 (12)	191 (13)	High "Potential"
	A	132 (6)						
	A-	179 (2)						
	B+	165 (2)						
	B	122 (8)						
	B-	140 (7)						
Intermediate Growth 1-2%	C+	149 (3)	127 (14)	129 (13)	117 (24)	125 (18)	123 (27)	Intermediate "Potential"
	C	118 (10)						
	C-	153 (1)						
Low Growth <1%	E	72 (18)	64 (27)	64 (27)	64 (27)	57 (28)	59 (33)	Low "Potential"
	F	50 (9)						
Total Number of Countries	(69) a/		(73)	(67)	(67)	(58)	(73)	

a/ Four high-growth countries classified D+ or D could not be assigned to a particular letter category on the basis of the data reported.

b/ The fifteen include three which the tables (but not the text) suggest were unclassified at this stage.

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officials).[1] Countries were to be ranked highest on "leadership commitment"

if the government and central economic leadership undertook "concerted efforts"

to promote growth, "serious attempts" to alter "institutional arrangements unfav-

orable to growth" and "some reasonably effective development planning."[2]

The problem is that those making the evaluations necessarily had to rely upon

indirect evidence. From a desk in Washington and periodic visits to an underdev-

eloped country it must be perplexing to try to decide whether commotion over

planning and development really represents "concerted" and "serious" effort. Can

a frequently-shifting leadership really be judged "committed," can the planning

really be judged "effective," can an institution being reformed really be judged

as a key bottleneck to growth--if the country is in fact not growing?[3] Until more

objective measures can be developed, we must remain skeptical that unavoidable

biases of judgment, not underlying causal relationships, account for the correla-

tion between "leadership commitment" and economic growth upon which the importance

of the variable is ultimately based.[4]

b)   It is not clear that a second prediction variable, "improvement in agri-

cultural productivity," was--or even could have been--measured independently of

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[1] Society, p. 13; "A Factor Analysis of the Interrelationships Between Social and Political Variables and Per Capita Gross National Product," Quarterly Journal of Economics, November, 1965, p. 555.

[2] Society, pp. 79-80; "Econometric," pp. 1216-1217.

[3] Clearly some independence of judgment can be--and was--exercised. For example, two countries with conspicuous development bureaucracies, India and Pakistan, were both credited with high commitment to development despite only intermediate level growth performance. Two beneficiaries of oil windfalls--Iraq and Libya--as well as Nicaragua were ranked low in leadership commitment despite rapid growth performance. But is it not possible that such countries as Trinidad, Jamaica, Mexico and Venezuela looked a bit more "serious" because they were growing fast, while such countries as Ceylon, Morocco, Syria and Uruguay showed "little or no evidence" of leadership commitment in part because they were growing very slowly?

[4] The simple correlation coefficient is .35. (For the full correlation matrix, see Society, pp. 281-3.

growth of GNP per capita for many of the 73 countries in the sample. As the

authors concede in their book, even "reasonably reliable" data for either vari-

able are simply not available for most countries--and particularly not for the

many low-income African countries.[1] The paucity of data and the large size of

the agricultural sector in most of the countries in the sample could easily have

combined to reduce the independence of the measures of "improvement in agricultural

productivity" and "growth of GNP per capita". Particularly for the African coun-

tries it must have been extremely difficult to go beyond the crudest estimates of

growth of output per worker in agriculture--either in the one direction toward a

more sophisticated estimate of total-factor productivity in agriculture, or in

the other direction toward an estimate of growth of output per capita in the eco-

nomy as a whole. The three sets of concepts might easily have tended to merge in

the mind of the most careful investigator.[2]

Indeed, for economies dominated by agriculture even accurate and complete

data would be expected to show a high correlation between output per worker (or

per factor) in agriculture and output per worker (or per capita) in the economy

as a whole. We cannot be expected to find a great deal of theoretical interest

in an empirical result which suggests that, across countries in which agriculture

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[1]As for growth of GNP per capita, "reasonably reliable estimates for the entire
period were available for only 29 of the countries." For countries with shorter
series the authors built upon "quantitative data and qualitative information on
trends in standards of living"; but a "number of countries for which no data ex-
isted," largely low-income African countires, were "classified on the basis of
purely qualitative indications." (Society, pp. 87-89.)
   As for the "improvement in agricultural productivity" variable,"data on em-
ployment and product in the traditional and modern agricultural sectors are gen-
erally unavailable," and the authors had to resort to "qualitative information"
for the modern agricultural sector and to "estimates" for the traditional subis-
tence sector. (Society, pp. 104-108.)

[2]Eleven of the tropical African countries in the sample were relegated to the low-
est growth category, and eight of these were also rated as having shown "no signi-
ficant improvement in agricultural productivity since 1950."

accounts for a large share of GNP, agricultural productivity and GNP growth rates are highly correlated.[1]

c)   "Modernization of outlook," another "judgmental" variable, could easily be a proxy for such basic economic variables as level of GNP per capita or the extent of subsistence agriculture. In particular, the high negative correlation of "modernization" with the "size of the traditional agricultural sector" implies that very few countries were ranked very differently on the two variables.[2] When differences were recorded, they may have been due to actual differences in popular "outlook," but they also may have been due to the concommitants of high or low growth which colored the interpretations of the experts. Indeed, the fact of growth itself could easily have been taken as evidence of popular support for "programs of political and economic modernization"--one of the major components of the "modernization" variable. Even small differences of this sort would be sufficient to account for the greater explanatory power of the variable at the point that it enters the discriminant function.

d)   The variable "improvement in financial institutions" could easily be a surrogate for the "widespread pattern of dynamic improvements" that the authors find "well correlated" with it--"changes in the degree of industrialization, improvements in agricultural productivity, improvements in tax institutions, and to a lesser extent, improvements in human resources."[3] Its statistical superiority over these other variables (several of which were also involved in the definition of the criterion variable) may be partly explained by the fact that one of its two components is "the approximate increase in the real value of private domestic

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[1] The simple correlation coefficient is .61. The more interesting relationship to investigate would be that between the rates of growth of agriculture and in the rest of the economy.

[2] The simple correlation coefficient with the extent of "traditional agriculture" is -.82; the coefficient with level of GNP per capita is .70.

[3] "Performance," p. 269.

liabilities to the banking system"[1]--apparently measured absolutely, not in relation to a growing GNP. Thus, even if all countries maintained a constant ratio of financial liabilities to GNP, this measure would be larger for the faster-growing economies.

Our examination of the four prediction variables in the discriminant function, then, provides no basis for confidence that they do represent important causal forces explaining even the broad differences between the slow-growing and the faster-growing countries which the function is mathematically able to represent.

B. Regression Analysis

The regression stage of the model is an effort to explain the four prediction variables used in the final form of the discriminant function. These are introduced as the dependent variables in four regression equations, each of which is permitted to include no more than three independent variables. Five more regression equations are developed to explain some of the independent variables in the first set of equations, and four more are then developed to explain some of the independent variables in the second set.

The authors begin by expressing the basic dilemma of regression analysis: "one cannot deduce from any given association expressed in a regression equation that causality runs from the independent variable to the dependent variable rather than the other way around." Yet they offer no guidance as to how lines of causation can be inferred from the many strong associations inherent in their data.

In building a regression equation for each dependent variable, they apparently began with all 28 remaining variables as candidates for inclusion and let the computer choose those most strongly associated with the dependent variable. In a few cases "variables were omitted from equations in which their inclusion would lead to a clear-cut violation of the direction-of-causality constraint," but this

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[1]Society, p. 121.

criterion was applied only "sparingly." The unfortunate result of this restraint is that very few of the actual regression equations appear to describe genuine causal relationships between independent and dependent variables. There are three general sources of doubt.

1. Definitional Overlap

Several of the "dependent" variables have definitions which seriously overlap with those of the "independent" variables being used to explain them. The most blatant cases concern the variables measuring subsistence agriculture. Regression equation (6) finds "the character of agricultural organization" most strongly explained by the "size of the traditional sector". Yet "agricultural organization" is defined as running from "communally owned agricultural lands in which the marketing of crops is only of incidental importance," up to large and viable "commercial owner-operated farms." The "traditional sector" is defined as "traditional subsistence agriculture in which...marketing surpluses (is) of incidental importance"; it specifically excludes "modern commercial agriculture."[1] Equation (7) in turn partly explains "the size of the traditional sector" as negatively dependent on "the extent of dualism." Yet the low point of the "dualism" scale is defined as "the largely agrarian society having an extremely small exchange sector." All we really know from these relationships is that there are many countries with a large share of the population in subsistence agriculture--whether this be classified as high on a "traditional sector" dimension or low on "dualism" or "character of agriculture" dimensions. If a high degree of correlation among

[1]The authors nod toward this definitional overlap when they say that the relationship between the two variables "expresses directly" the "fact that the monetization of the traditional subsistence sector represents an improvement in agrarian structure." This does not prevent them, however, from interpreting it as an explanatory empirical relationship.

these dimensions holds any interest at all, it is only as a reliability check on the coding techniques.[1]

Other examples of overlapping definitions can readily be cited. For example, in regression equation (13) "the extent of political stability" is found to depend negatively on "the degree of social tension." The former variable is in part defined by the absence of "domestic violence," while the latter is in part defined by the presence of "social instability." In equation (14) "the extent of social mobility" is found to be negatively dependent upon the "political strength of the traditional elite"--those powerful elements who support "the preservation of traditional political, social and economic organizations, institutions and values." Presumably such persons can be judged strong only insofar as those institutions persist, and low social mobility would be one index of that persistence.

2. Implausible Causation

Many of the regression equations associate effects with very implausible "causes."

One general difficulty is that variables which express short-run rates of growth are sometimes used to explain variables which express long-run levels. In equation (11) "the extent of literacy" (level for population aged 15 and over in 1958) is explained in part by "the rate of improvement in human resources" (measured by attendance ratio of school-age population in 1961). The two variables

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[1]The chain of overlap does not really end there. Equation (8) goes on to find "dualism" to depend in part upon "the degree of modernization of outlook." This variable is not explicitly defined in terms of the size of traditional agriculture, but is partly defined on the basis of rural support for "programs of political and economic modernization." In regression equation (3) the "modernization" variable is found to depend both on "the extent of dualism" and (negatively) on "the size of the traditional agricultural sector." If, as suggested earlier, all we really know from so strong a statistical association is that country experts find it easier to imagine urban dwellers and commercial farmers than subsistence farmers understanding and supporting modernization policies, then the relationships described are completely circular.

should be related--some countries have stronger traditions of mass education than others--but hardly causally, given that almost no one aged 15 or over in 1958 was of school age in 1961. In equation (12) the size in 1961 of the "indigenous middle class" is explained by the extent of social mobility in 1961.[1]

A second difficulty is that some of the equations seek to explain very "hard" economic realities in terms of rather "soft" social or political rankings. For example, equation (8) explains the degree of "dualism" in the economy as partly depending on the size of the middle class and parly on "modernization of outlook." Equation (6) explains the "character of agricultural organization" partly in terms of "leadership commitment to development." Equation (7) expresses the size of the traditional agricultural sector as a function of the extent of literacy. Undoubtedly these things are associated, but a convincing case for the direction of causation has not been made. Any implication that such attitudinal variables as "leadership commitment" and "modernization of outlook" can help to explain the size of subsistence sector would seem better postponed to the day when the scientific bases of Couéism are more firmly established.

3. Inferences of Mutual Causation

Strong associations are far too readily interpreted as evidence of mutual causation. When two variables are strongly associated in a sample, it is not unexpected that each will figure prominently in a multiple regression equation for the other. In five cases where this occurs the authors do not hesitate to attribute this result to "reciprocal causation" or, more grandly, to a "mutually

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[1] Size of the middle class is also explained by the improvement in financial institutions since 1951, which the authors interpret as having provided the financial credit which is "an essential condition for the growth of an indigenous entrepreneurial class." This variable, of course, cannot help explain any of those who became entrepreneurs before 1951 or any of those in the bulk of the middle-class occupations--"managerial, technical, administrative, commercial and banking employees."

reinforcing feed-back relationship." For example, the variable "rate of develop-

ment of human resources" is found in equation (10), which seeks to explain the

"change in the degree of industrialization," while the industrialization variable

is found in equation (9), which seeks to explain the human resources variable.

In the authors' interpretation, not only does human investment remove constraints on

industrialization, but industrialization creates a necessary demand for human in-

vestment.

If the association in the sample seems so strong as to preclude the absence

of association in the universe, there would a priori be three alternative in-

terpretations as to what that association represents: (i) the unidirectional im-

pact of industrialization on human investment: (ii) the unidirectional impact of

human investment on industrialization; or (iii) the impact of a third variable

(e.g., governmental activism) on both phenomena. The authors offer no justifica-

tion for automatically discarding all three alternative interpretations. Nor do

they consider whether the regression coefficients should be adjusted downward

from their observed levels so that they do not each reflect individually a full

association that they are assumed to be "causing" together.[1]

C. The Multipliers

The culmination of the econometric model is the calculation of multipliers

estimating "the relative impact of the various economic and non-economic forces

represented in the model upon the potential for economic development."

The impact multiplier for each variable is treated as an unknown sum of its

direct and indirect impacts on "development potential." The direct impact is

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[1] A similar criticism could be leveled against each of the other four "mutually-
reinforcing feed-back relationships":"dualism" as both cause and consequence of
"modernization of outlook"; "improvement of human resources" and "extent of liter-
acy"; rate of industrialization and "improvement of financial institutions"; and
size of the middle class and "rate of social mobility."

defined (for the four prediction variables only) as the size of the coefficient of the variable in the discriminant function. The indirect impact is defined as the weighted sum of the multipliers of all the dependent variables which the varialbe is used to explain in the regression analysis, where those multipliers are weighted by the appropriate regression coefficients. The 18 equations are then solved simultaneously for the 18 unknown impact multipliers.[1]

The ten variables that emerge from the analysis with the largest multipliers are (in order): 1) improvement in financial institutions; 2) modernization of outlook; 3) extent of dualism; 4) adequacy of physical overhead capital; 5) change in degree of industrialization; 6) importance of the indigenous middle class; 7) improvement in human resources; 8) leadership commitment to economic development; 9) extent of literacy; and 10) improvement in agricultural productivity.

There are two important problems with this multiplier analysis.

1. Utilization of Cross-Section Relationships

The authors argue that "the estimated multipliers yield indications of the prospective relative gains with respect to development potential from changes in various characteristics." Yet, as econometricians have long recognized, there are substantial limitations on our ability to use cross-section analysis either to

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[1]One example may serve both to illustrate the calculation and to show how the multipliers can be inflated by the assumption of mutual causation. The "industrialization" variable appears as an independent variable in only two regression equations, those for "improvement in human resources" and "improvement in financial institutions." Its multiplier is thus the sum of its coefficients in each equation times the multipliers of the dependent variables. But both the "human resources" and "financial institutions" variables appear in the regression equation for industrialization and derive part of their multipliers from the size of its multiplier. When the system of equations is solved simultaneously, the multiplier for the industrialization variable appears prominently twice in its own equation, and in the end at least 35 per cent of its value is based on itself.

infer intertemporal relationships from the past or to project such relation-

ships into the future.[1]

The inference of past time-series relationships from cross-section esti-

mates requires that those relationships have been neither exaggerated nor ob-

scured by such factors as: (i) differences among countries in their economic

institutions;[2] (ii) differences in the environment--external and internal--

within which different economies function;[3] (iii) causal interactions among

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[1]For example, Edwin Kuh finds large enough differences between his time-series and cross-section estimates of the same elements of an investment function to conclude: "In general, we cannot estimate dynamic coefficients from cross-sections with any degree of confidence unless there is supporting time series information..." ("The Validity of Cross-Sectionally Estimated Behavior Equations in Time Series Applications," Econometrica, 1959, pp. 197-214.) For so seemingly-straightforward a relationship as that of savings to income, D. W. Johnson and J.S.Y. Chiu conclude that savings behavior over time differs among countries "in a significant manner", and cross-section analysis of that simple relationship is inappropriate. ("The Saving-Income Relation in Underdeveloped and Developed Countries," Economic Journal, June 1968, pp. 321-333.)

[2]Cross-section equations would provide reliable estimates of the time-series coefficients on independent variables only if those coefficients were equal across countries and if there were no correlation between the constant terms and the independent variables in the time-series relationships. Any positive correlation (e.g., where level of development or size of country influenced both terms) would be sufficient to provide an upward bias to the cross-section estimates of the coefficients, since the impact of the constant term on the dependent variables could only be attributed to the independent variable. For example, the standard time-series relationship for the growth rate of GNP might be a constant term for each country plus .2 times the rate of investment. A relatively developed country might have a constant term of 2% and an investment rate of 20%, making for a GNP growth rate of 6%; a less developed country, with a smaller capacity for "self-sustained" growth, might have a constant term of only 1% and an investment rate of only 10%, making for a GNP growth rate of 3%. The two observations would be perfectly consistent with a cross-section estimate that growth of GNP is simply .3 times the rate of investment.

[3]Differences in individual elements of country performance may be rooted in comparative advantage and hence may be poor universal indices of development or "development potential". For example, Lebanon's failure to industrialize rapidly and to improve its financial institutions might be seen as evidence of slow development (as the authors imply when they demote Lebanon to the intermediate potential category on these grounds). It might also be seen, however, as evidence of an increasing exploitation of a comparative advantage in financial services, an exploitation that was already well underway before the period for which "improvement in financial institutions" was measured and that concentrated on the expansion of foreign business rather than the domestic transactions represented by that variable.

variables;[1] (iv) disequilibria in relationships at the time of observation;[2] and

(v) that the absolute level of performance is all that matters and the level rela-

tive to other nations is unimportant.[3] Even if the cross-section estimates ac-

tually do reflect intertemporal relationships, their use as a basis for projec-

tions into the future requires: (i) that no significant lags will exist in a

country's response to a new level of performance; (ii) that there are no other

persistent characteristics of "low potential" economies--including those that ten-

ded to make for poor performance in a specific area--that would continue to limit

"potential" even if the specific performance could somehow be improved;[4] and

(iii) that dynamic considerations--technological progress, changing consumer

tastes and a shifting structure of world demand at higher world income levels--

can be safely ignored.[5]

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[1] As an example of interaction, assume that in every country growth will be higher in periods of greater political stability. If, at the same time, a high average growth rate makes a country more likely to experience political upheaval, the countries that are growing more slowly may show as much overall political stability. (The Adelman-Morris data show a low cross-section correlation between growth and stability.)

[2] For example, equation (11) implies that the extent of adult literacy is partly a function of "the extent of mass communication." If the latter has been rapidly increasing in many of the countries covered, how can we be sure that its full impact is reflected in the regression coefficient?

[3] For example, any real relationship between "leadership commitment" (as judged by A.I.D. and State Department officials) and development might stem from a greater ability to attract foreign aid away from other countries without at the same time causing the total supply to be enlarged.

[4] For example, some countries may have failed to generate "leadership commitment to development" because of the inadequate training of their elites. A few leaders might be induced to increase their commitment, as were the leaders of the Chinese Imperial government in 1898, but this could remain irrelevant for development without the additional trained manpower to carry out development decisions; in the Chinese case, bewildered provincial bureaucrats simply ignored the industrialization decrees of the new central government and waited out the three months required for it to fall.

[5] For example, it is impossible to project the implications for growth of any of the elements of physical overhead capital without knowing the prospects for the development of substitutes; the airplane and the motor vehicle have certainly rendered obsolete any 19th century notions of the role of railway lines. Simon Kuznets has a useful discussion of the complications that dynamic considerations create for cross-section analysis. (Modern Economic Growth: Rate, Structure and Spread, 1966; pp. 431-437.)

The authors do not address themselves to any of these thorny issues. It seems unlikely, however, that most--let alone all-of these requirements are met by very many of the relationships described in their model.

2. Lack of Independent Basis

The authors never attempt to establish a logical relationship between the discriminant analysis and the multipliers. In the earlier analysis all 29 variables were examined for their relationship to "potential development" and only four of these were found sufficient to account for more than 97% of the variance between groups. Are we to take that result as meaningful, or must we go beyond it and see as somehow significantly related to development a whole slew of variables that were already tried and found unable to account for more than 3% of the remaining variance? If we must go beyond the results of the discriminant function, would we not be more interested in the direct association of each of the variables with "development potential" itself, rather than the indirect association through the four variables in the discriminant function?[1]

These questions have very practical implications for the interpretation of the Adelman-Morris results, because there are wide discrepancies between the importance of some variables in the discriminant and the multiplier analysis. Two variables--"the degree of improvement of financial institutions" and "the degree of modernization of outlook"--emerge from the multiplier analysis as still the most

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[1] The estimation of complex structural relationships among variables is an established part of the discipline of econometrics. In constructing econometric models, however, careful investigators--employing their prior knowledge and theory about the structure being studied--begin by separating out primary and secondary causes of the phenomena they seek to explain. Some variables, if they cannot be shown to be primary causes, may still be weighed as possible secondary causes by examining their relationships to particular primary causes. But never should all variables be given an equal crack at the major dependent variable and, if proven to be unrelated, then given an equal fresh crack at all the independent variables in the primary relationships.

important influences on "development potential." The other two variables in the discriminant function, however--"leadership commitment to economic development" and "improvement in agricultural productivity"--fall to eighth and tenth places respectively! What advice, then, are we to give to the development planner who might wish to act on the basis of the values in the Adelman-Morris analysis? Should he seek to inculate "leadership commitment to development" and to increase agricultural productivity, as suggested by the discriminant analysis? Or should he attempt to reduce "dualism," to make physical overhead capital more "adequate," to accelerate industrialization, and to increase investment in human resources and literacy--all of which have higher or equal importance in the multiplier analysis?[1]

Anyone tempted to employ the Adelman-Morris multipliers should examine more closely the highly indirect relationships on which they are constructed. For example, the seventh largest multiplier is that for "rate of improvement in human resources." Why is human resources investment so potent? As the authors describe it, fully 61 per cent of its total multiplier comes from making possible "the more rapid growth of the industrial sector." Why is industrialization so important? Fully 85 per cent of the total multiplier for industrialization comes from "bringing about improvements in financial institutions." That variable carries the largest multiplier of all, and on its size both these earlier multipliers are largely based.

Those with childhood memories of reciting "For want of a nail, ...a kingdom

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[1]The authors obviously intend their disparate results to be taken seriously by policymakers. We have already cited their conclusion that the multipliers provide estimates "of the prospective relative gains" from changes in characteristics of underdeveloped countries. ("Econometric," p. 1211). In presenting their discriminant analysis, however, they argue that the score on the discriminant function "constitutes a single figure of merit which can meaningfully be used to assess the cumulative contributions of both domestic reform and external assistance to the raising of a country's development capacity." ("Performance," p. 280)

was lost" may have no difficulty with the logic of the Adelman-Morris multiplier analysis. They may, still, however, be skeptical about its policy implications: that one should attempt to influence a variable that has no directly-demonstrated relationship to development primarily because it in turn may influence another variable that has no directly-demonstrated relationship to development but that may in turn influence a third variable which itself may have a direct influence on development. They will be especially skeptical if they recall that the influence attributed to that third variable--"improvement in financial institutions"--is in part based on its being defined as an important part of "development potential."

D. Structured vs. Unstructured Models

Throughout their joint work--including the factor analysis not covered in this discussion--Professors Adelman and Morris have relied on completely unstructured statistical techniques. They have "consciously avoided a priori specification of the functions" but rather presented the computer with a long list of variables and "let the data specify the model." Thus, in both the discriminant and the regression analysis, the computer was instructed at each stage in the building of the equations to select for inclusion that independent (or prediction) variable that would add the most to the power of the equation to reduce the unexplained variance of the dependent (or criterion) variable.[1]

The approach is complicated by two general problems of identifying causal relationships from the cross section analyis of countries at such different levels

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[1]Under this technique, additional variables are added to the equation only insofar as they account for variance unexplained by those already included. Once one of a set of highly collineal variables has been selected, the others will rarely be given serious consideration--even though, as the equation is built up, one outside the set might come to assume more explanatory power than several variables already chosen. Thus, even by the crude test of percentage of variance explained, the unstructured technique has serious limitations.

of development. In the first place, a glance at the correlation matrix confirms that there is tremendous multicollinearity among the variables. In the second place, while time-series analysis can at least pervent investigators from attributing the causation of a prior event to a subsequent one, single period cross-section analysis denies them even this clue to the direction of causality.

Denied the guidance of temporal sequence, and denying themselves the guidance of prior specification of the relationships, the authors are forced to judge variables entirely by their contribution to the explanatory power of the equation. Multicollinearity, however, renders this doubly dangerous. One of its results is typically very large standard errors of estimate for the coefficients of the variables, which means that those coefficients are highly unreliable and must be interpreted with great caution.[1] Even when such a coefficient is significantly different from zero (as are most of those in the Adelman-Morris regression equations), it is very unlikely to be signigicantly different from the coefficients of other closely-related variables. Thus, the discriminant function and the regression equations are built on the basis of very narrow statistical differences, and the authors have left themselves prey to the power both of random influences and of systematic biases.

Professors Adelman and Morris briefly acknowledge this problem when they concede that "the particular subset of variables selected from the larger set may be a proxy for underlying forces rather than of importance in and of itself." Recognition of this danger, however, does not prevent them from taking their discriminant and regression results at face value and assuming that the 25 variables not included in the discriminant function are important only insofar as they influence the four variables that are included. A more prudent course would have been to recognize that when the data are highly collineal, the case is stronger than ever

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[1] See, for example, A. S. Goldberger, *Econometric Theory*, 1964; pp. 192-194.

for using such logic, theory and prior knowledge as the investigators can muster to preclude a capricious selection among available explanatory variables.

The authors argue that their unstructured statistical techniques are necessary at this stage in the study of development, "since there are no firmly validated theories in the process of socio-economic and political change."[1] Yet even if we have very few answers--established quantitative measures of the empirical relationships among variables--certainly we know enough about the logical relationships among variables and levels of analysis to be able to pose questions in an orderly manner.

Several different kinds of frameworks might have been considered. For example, the rate of growth of GNP per capita might have been expressed as the rate of growth of GNP minus the rate of growth of population. The growth of total GNP might then have been disaggregated either into the growth of sectors, each weighted by the average share of those sectors in the total, or into the growth of individual factors of production, each weighted by their shares in total income and supplemented by a growth rate for productivity. The growth of population might have been expressed as the difference between crude birth rates and the rates of mortality and net emigration. In such ways far more specific questions could have been posed concerning past growth performance.

The various social, political and economic dimensions the authors sought to invoke as explanatory variables might have been roughly separated into two categories: those which represent the "resources" of the country broadly defined--its natural wealth, physical and human capital, institutions, values, attitudes and energies; and those which represent its "economic actions"--the economic policies of the government and the behavior of private economic agents. The problem could

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[1]Note that the authors themselves must have had such a theory in mind when they required that a fast-growing country score high on five out of seven particular variables in order to qualify as having "high development potential."

then have been conceived of as a three-stage process in which "resources" become translated through "economic action" into "economic performance"--or into larger resources for later economic performance.[1]

The point, however, is not the operational or theoretical merit of a particular framework, but merely that the absence of "firmly validated theories" of a process does not prevent us from conceptualizing that process in a way that may lend some order--and greater meaning--to empirical analysis.

E. Conclusions

There are many problems inherent in attempting to separate out the strands of causation in the complex web of differences in the performance and potential of underdeveloped countries. Unfortunately, Professors Adelman and Morris have not adequately addressed themselves to these problems. There may be methods of direct observation that would permit the objective measurement of such subjective phenomena as "commitment" and "outlook"; but it is impossible to be confident that purely "judgmental" measures can ever be purged of the judge's preconceptions as to the causes and concomitants of those phenomena. Measures of the rate of growth of per capita GNP in the underdeveloped countries are themselves fraught with great uncertainty; but even the best of empirical measures would prove an inadequate foundation for the elusive notion of "development potential." Comparisons across countries can offer clues as to intertemporal relationships; but careful justification would be required before policy implications could be safely inferred from even the best-established of cross-section findings. No statistical techniques can by itself separate out causes, effects and joint effects--or even

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[1]This would imply that very unlike processes are being mixed in the authors' attempt to compare in one function the relative importance of two "resources" (modernization of outlook and leadership commitment), one set of "actions" (improvement in financial institutions), and one element of "performance" (improved agricultural productivity).

the most important associations among closely-correlated variables; but completely unstructured techniques--in which theory and prior knowledge are neither tested nor used to order the relationships--are the least likely to produce meaningful results.

The greatest problems with the study, however, are not the inherent ones. In order to persuade us of the validity of their model as a whole, the authors would have to demonstrate first the soundness of both of their empirical analyses and then the legitimacy of their "mulitpliers" as a separate level of inquiry. Yet in neither the discriminant nor the regression analysis do they establish either the independent measurement of the variables they are relating or the structural logic of the relationships they are describing. They also fail to make clear why the indirect associations with "development potential" described by the "multipliers" should be taken more seriously than any direct associations that might be observed.

The general conclusion the authors offer is that "the important impediments to increasing capacity to develop" that emerge from the model "are social and political as well as economic." This is intrinsically a rather plausible statement. Unfortunately, neither its plausibility--nor that of the specific relationships described--has been augmented by any of the statistical results which comprise the "econometric model of development." On the contrary, our analysis of that model suggests that formidable obstacles remain to be confronted before the measurement of cross-sectional statistical associations can begin to challenge economic analysis--the creative interaction of general theory and the knowledge of particular institutions--as the fundamental tool of policymaking for economic development.

Appendix

Definition of Variables in the Econometric Model[1]

1. Variables used in the Discriminant Function

Degree of Modernization of Outlook (1960). This classification is a composite measure of the degree of modernization of outlook of educated urban groups and of the extent to which programs of political and economic modernization had gained the support of both rural and urban population.

Improvement in Financial Institutions Since 1950. Countries were classified on the basis of statistical measures of the extent of increase from 1950 to 1963 in both the volume of private savings flowing through the banking system and the volume of medium-and long-term lending by the banking system to the private sector.

Extent of Leadership Commitment to Economic Development (1957-1962). Three broad categories of leadership commitment were distinguished on the basis of the following judgments: (1) whether the heads of agencies involved in direct or indirect central guidance of the economy typically made concentrated efforts to promote the country's economic growth; (2) whether or not this planning effort included serious attempts to alter the institutional arrangements which clearly block the achievement of planning goals; and (3) whether or not there was a national plan and a planning group functioning within the government which was charged full-time with executing the plan.

Improvement in Agricultural Productivity Since 1950. This indicator distinguishes among countries by the extent to which they had experienced from 1950-1963 an increase in output greater than could be accounted for by additional inputs of the same quality as those prevailing in 1950. Indications concerning increases in the use of chemical fertilizer and mechanical power, the completion of modern irrigation systems, and extensions in the use of other modern agricultural techniques, provided the basis for this classification.

2. Variables used in the Regression Analysis

A. Economic Variables

Change in Degree of Industrialization Since 1950. This index is a composite of three statistical elements: the average rate of change (in constant prices) in industrial output; the increase in the proportion of GDP originating in industry; and the change in the proportion of industrial employment, all over the period 1950-1963.

Size of the Traditional Agricultural Sector (1960). This classification indicates the proportion of the population of less-developed countries engaged in traditional subsistence agriculture in which production was largely for self-contained indigenous communities and marketing of surpluses of incidental importance. Both modern commercial agriculture and indigenous cash-crop agriculture are excluded.

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[1]Definitions are taken from "Econometric," pp. 1212-1217. Longer definitions--sometimes cited in the text of this paper--may be found in Society, Chapter II.

Level of Adequacy of Physical Overhead Capital (1961). Countries were grouped into four categories based upon the adequacy of internal transport systems (including roads, rail and waterways) and power networks in meeting current requirements for economic development.

Character of Agricultural Organization (1960). This index combines indices of land tenure patterns and size and orientation of farming units. Various types of agrarian structure are located along a scale, one end of which is represented by communally owned agricultural lands in which the marketing of crops is only of incidental importance, and the other end of which is depicted by commercial agriculture in which owner operated farms are sufficiently large to be economically viable. Intermediate on the scale are tenant-operated subsistence farms and large owner-absentee commercial farms or plantations.

Extent of Dualism (1960). This index stratifies countries by the presence and extent of socio-economic and technical dualism. At one pole are the largely agrarian societies having extremely small exchange sectors; at the other pole are countries with continuous interaction between modern and non-modern elements. Intermediate are societies in which a foreign-financed and directed modern sector is superimposed upon a predominantly agrarian society and countries in which the growth of an indigenous small-scale cash-crop sector using conventional techniques evolves at the expense of a traditional subsistence sector.

B. Social and Socio-Economic Variables

Importance of the Indigenous Middle Class (1960). This classification is based upon the relative size and political importance of indigenous people in middle class occupations in less-developed countries. Middle class occupations are interpreted to include entrepreneurs, and managerial, technical, administrative, commercial and banking employees.

Extent of Social Mobility (1960). This classification is based upon a composite measure of several aspects of social mobility, including the extent of racial or cultural barriers to mobility, the extent of educational opportunity, and access to membership in the middle class.

Extent of Literacy (1958). This classification groups countries by the percentage of population aged 15 and over which is literate.

Extent of Mass Communication (1960). This classification is based upon a composite measure of newspaper circulation and of radios in use, in which the former is given the greater weight.

Degree of Social Tension (1957-1962). This classification is a qualitative one based on the extent of evidence of overt social tension in the form of considerable and social instability arising from racial, tribal, religious or cultural tensions.

Rate of Improvement in Human Resources (1961). This indicator is based upon the Harbison-Myers composite index of level of human resource development and is a weighted average of secondary and higher level school enrollment ratios as a percentage of the relevant age group.

C.   Political Variables

Political Strength of the Traditional Elite (1957-1962). This indi-
cator groups countries into three categories according to the politi-
cal strength of the tradition-oriented elites during the period 1957-
62. Traditional elites were interpreted to include both traditional
land-holding elites and bureaucratic, religious, or military elites
who favored the preservation of traditional, political, social and eco-
nomic organizations, institutions, and values.

Political Strength of the Military (1957-1962). In defining this in-
dicator countries were grouped into three broad categories, determined
respectively by a marked, moderate, or negligible extent of military
interference in the political arena.

Extent of Political Stability (1950-1963). This classification groups
countries according to the stability of their political systems over the
period 1957-63. The degree of stability was judged by the frequency of
changes in form of government, the frequency and violence of coups, the
extent of political subversion and domestic violence, and the effect-
iveness of internal security.

"An Econometric Model of Economic Development: A Reply"[*]

by

Irma Adelman and Cynthia Taft Morris

The comments of Mr. Eckstein and Miss Berry on our paper, "An Econometric Model of Development," highlight the major methodological issues involved in our several cross-section analyses of socio-economic and political change in underdeveloped countries. Our purpose in this reply is to elucidate more fully than the comments have done those characteristics of our research design and data which distinguish them from more conventional approaches; to note our agreement or disagreement with the major comments; and to indicate briefly our own procedures for handling the principal difficulties involved in our approach. Our reply touches on both our earlier and our current work since "An Econometric Model of Development" represents only one segment of our research and treats only sketchily the underlying methodological issues. This note considers in turn the general nature of our statistical methodology, the character of our data, and the specific characteristics of our discriminant and regression analyses.

Before proceeding further, we would like to emphasize that we feel under no obligation to defend ourselves for failure to achieve purposes which the paper was explicitly not designed to achieve. We have not claimed to offer a "reliable guide to policy-making."[**] We have not attempted to explain

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[**] Eckstein, "An Econometric Model of Development: Comment," p. 1.

differences in rates of change of per capita GNP.[*] We certainly have not

claimed at this early stage of inquiries into the process of economic develop-

ment to have "separated out causes, effects, and joint effects."[**] We have

used an empiricist approach to construct an exploratory model and have described

cause and effect relationships <u>implied by the model</u>. There are no statements

about cause and effect in our discussion of the regression model or in our

conclusions which do not explicitly say "according to the model" or "in the

model." We can make no better correction of Mr. Eckstein's view of our purposes

than to repeat the final statement of the paper:[***]

> "... it is to be hoped that the various noneconomic and economic features
> of low-income countries that appear <u>in the present model</u> to have partic-
> ularly strong effects upon development potential may give some indication
> to social scientists of the most profitable directions for research into
> the determinants of inter-country variations in overall capacity to per-
> form well economically in the long run."

I. Statistical Methodology: General Comments

A key criterion for choosing an appropriate statistical methodology for

the study of a particular research problem is necessarily that of efficiency in

the use of limited resources for research. The most efficient research design

for each investigator would ideally be that which minimizes research cost

subject to constraints such as the availability of research personnel and

physical capital (computers, space and so forth). The choice of design is

complicated both because the payoff of the most interesting and worthwhile

research is uncertain and because each researcher has different doses of

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[*] Ibid., pp. 6,7.

[**] Ibid., p. 16

[***] Adelman, Irma and Cynthia T. Morris, "An Econometric Model of Socio-Economic
and Political Change in Underdeveloped Countries," <u>American Economic Review</u>,
Vol. LVIII (December, 1968), p. 1212. The italics have been added.

"natural" endowments such as mathematical training, empirical sense, theoret-
ical aptitudes and experience which affect the optimal solution to research
design. Thus, for a given research problem at a particular point in time there
presumably exists for each researcher an optimal research methodology which
differs from researcher to researcher, although the actual choice of design, as
most of us have learned from experience, is never adopted purely a priori.
Consequently, we do not wish to be dogmatic or universalistic about our
methodology.

In designing our recent research on economic development, we use statistics
as a tool for indicating the structure of the underlying phenomena involved in
economic development rather than as a device for testing hypotheses. We have
chosen this approach as the most efficient one in view of our limited resources
and the extremely small quantity of even approximately validated knowledge
concerning the "laws" governing the manifold and complex interactions between
economic, social and political forces in the process of economic development and
modernization. The problem, as we see it, was not the paucity of a priori
hypotheses, but rather the existence of an extremely large number of alternative
hypotheses whose empirical validity still required testing.[*] The use of
statistics inductively to test a large number of alternative hypotheses seemed
to us inefficient both because of the huge research expenditure required and
because of the early stage of development of the statistical theory for testing

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[*] In a recent project undertaken by political scientists at Northwestern
University to investigate the sources of intercountry differences in the
extent of national integration among African countries, 800 different
hypotheses concerning the forces which govern changes in the extent of
national integration were culled from the literature.

a given hypothesis against more than one alternative.[*]

In general, the use of statistics for hypothesis testing is an efficient procedure only when (a) an operationally testable hypothesis can be formulated and (b) the equally plausible alternative hypotheses capable of formulation are few in number and empirically distinguishable. Neither of these prerequisites appear to be satisfied in research on noneconomic and economic influences on economic development and modernization in underdeveloped countries. One possible solution, the one preferred by Mr. Eckstein, is to simplify the problem of economic development in such a way that it becomes equivalent to the problem of economic growth narrowly conceived as changes in per capita GNP. The problem can then be treated in a manner familiar to economists.[**] The transformation of a difficult and intractable problem into a simpler tractable one can be profitable if the essence of the problem is still captured by the simpler model. Our own view, however, is that models of economic growth lack relevance in a significant degree to the problems of economic development. The reason is familiar: the raising of rates of growth of per capita GNP can take place, even over periods of a decade or so, without inducing fundamental economic change in other than a sporadic and limited way. In contrast, genuine economic development involves the transformation of the institutions of developing countries so that their economies gain a capacity for widespread and continuous economic growth.

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[*] For a discussion of this point see Theory of Testing Hypotheses: Lectures by E.L. Lehman (mimeographed notes by Colin Blym, Berkeley, Calif., n.d.). Lehman develops the theory of hypothesis testing against multiple alternatives for the case in which the alternative hypotheses can be parametricized. The latter condition is seldom met for the kind of alternative hypotheses relating to our present research.

[**] For a standard treatment of this class of models, see Irma Adelman, Theories of Economic Growth and Development (Stanford: Stanford University Press, 196)

Our choice of focus for our discriminant and regression analyses was a classification by development potential in which a "gain" of information on the breadth of recent economic change would, for our purpose, more than compensate for any "loss" of information on changes in per capita GNP.[*] Given our explicit concern with the broader phenomenon of economic development, the most efficient research design appeared to be to seek the best empirical relationships which could be derived from the data. Our purpose, as in our previous work, was to provide hypotheses for future testing on other bodies of data (such as historical observations and microdata). The statistical techniques employed to construct the model are quite powerful in their ability to simplify in accordance with a priori specified criteria a complex mass of data. The particular stepwise regression procedure we applied is the one recommended by Draper and Smith for deriving optimal empirical relations from a body of data.[**] Specifically, at each step in the procedure, a reexamination is made of the contribution of each variable in the equation as if it had been the most recent variable entered. This is done by computing the F ratio for each variable in the regression and comparing it with a preselected percentage point of the appropriate F distribution. Any variable whose contribution is no longer significant is removed from the equation.

The evaluation of any methodology involves an estimate of its success in achieving its purpose. As we stated clearly in the introduction of the paper under discussion, estimates such as those derived from our model represent a

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[*] It should be noted that we had already devoted an entire book to a factor analytic study of intercountry differences in rates of growth of per capita GNP.

[**] Draper, N.R. and H. Smith, Applied Regression Analysis (New York: John Wiley, 1966), pp. 171-2.

starting point for a process of experimentation in which empirical testing and
theoretical reasoning must interact. It is only by repetition of experiments,
by an examination of differences between the results of one experiment and
another, and by analyses of the sensitivity of results to differences in
theoretical and empirical specifications that science can make progress. The
aim of our recent research has been to stimulate just such a process of
experimentation in the study of the interrelationships of noneconomic and
economic influences in economic development. In the six years of our own
research on this subject, the present model represents one step only in a
lengthy series of experiments designed to formulate hypotheses and test further
the validity of generalizations based upon our own earlier investigations.

With respect to Mr. Eckstein's and Miss Berry's criticisms of the various
simplifying assumptions we have made in the application of our methodology, the
accepted way of determining the appropriateness of simplifying abstractions
(whether ours or those made on the nature of the production function or the
distribution of statistical errors) is to test the sensitivity of results to
variations in the relevant specifications. Mr. Eckstein, in particular, has
made many statements concerning the supposed sensitivity of our results to the
assumptions we have made in constructing data and performing statistical
analyses. He has of course every right to make suppositions regarding the
probable outcome of sensitivity tests; however, there are two indications that
he has approached his task of evaluation with a strong bias against his subject
matter. First, he has not even hinted at the possibility that a sensitivity
analysis might reveal our results to be insensitive to some of the assumptions
and procedures he criticizes; and second, he has not in any of his criticisms
of our approach and data pointed out the similarity between a problem in our

analysis and those in a host of well reputed conventional analyses.

In general, it is our belief that there are many different ways to approach subjects of scientific inquiry, each with its own special defects as well as defects held in common with other approaches. We are not recommending the rejection of structured techniques nor objecting if others prefer to apply them to our subject of inquiry. We simply consider them less suitable than unstructured techniques for our particular research with our particular resources at this point in time. At the same time, we would regret it greatly if economists generally joined Mr. Eckstein in rejecting the use of unstructured techniques for the purpose of exploration and hypothesis-making. Such a rejection would represent both an inexcusable refusal to learn from techniques fruitfully applied in psychology over the years and a highly regrettable narrowing of point of view toward the rich variety of potential approaches to scientific endeavor.

II. Data: Theory and Taxonomy

Since Mr. Eckstein has reproached us without distinction both for difficulties peculiar to our data and for the full range of difficulties our data share with all conventional economic data, we wish to clarify what, in our view, are the essential attributes of our data: in particular, their multidimensionality, their qualitative and ordinal character, and the translation of ordinal ranks into cardinal scores.[*] We will then discuss in some detail the crucial problem of the conceptualization and definition of qualitative indicators.

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[*] For a more detailed discussion of the characteristics of our data, see our reply to O.T. Brookins to be published in a forthcoming issue of the Quarterly Journal of Economics.

Multidimensionality of data

Almost all our variables are composites of several component elements. Consequently, as for all composites including such indices as GNP, cost of living and intelligence, either a formal theory or, at the very least, an a priori conceptualization of the phenomenon is required in order to construct an aggregate index. What distinguishes our data from conventional aggregates is not the use of theory in measurement but the fact that the a priori judgments we have made in aggregating the components of each index are less securely based in explicit theory than is the case for conventional composites because of the rudimentary state of knowledge about the social and political phenomena involved.*

Qualitative character of data

Most of our indicators are either purely qualitative or partly qualitative variables in which descriptive information and expert opinion were used to classify individual countries. The ranking of individuals by expert opinion is a completely accepted procedure in psychology; nevertheless, we found several pitfalls in its application: specifically, experts may interpret concepts and definitions differently; their opinions about the facts may differ; or they may be biased; or all three. We took several steps to minimize differences in interpretations and opinions including substantial work on conceptualization and preliminary classification prior to the consultation of experts and the use of face-to-face interviews in which differences in point of view about both definitions and country classifications could be probed, and used for successive reformulations designed to improve our conceptualizations. When experts disagreed on country ranks, our major means of achieving consensus was to attempt

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* This point is discussed further below.

to conceptualize more clearly the phenomenon involved before consulting further sources of information. After successive reformulations, it became rare that any expert corrected our classifications by more than one letter grade. Consequently, our procedure of averaging corrections which differed in degree only, did not result in scores significantly different from those which would have resulted from alternative procedures.

While it is likely that experts had biases of various sorts, we reject the contention that there is a systematic bias in our data due to the presumed tendency of experts to assume that good growth performance is achieved by committed leaderships and so forth. The evidence is easily available in the matrices of intercorrelation presented in our book.[*] To take the example of our index of leadership commitment to economic development which Mr. Eckstein attacks on the ground of presumed systematic bias, the evidence is that the simple correlations between rates of growth of GNP and leadership commitment are sharply different for the subsamples representing "high", intermediate and low levels of development, .59, .16, and -.02, respectively. To maintain that the correlation of .35 for the full sample is due to bias, it is necessary to assert that the bias of experts varies significantly with the level of development![**] To reemphasize our basic and important point, we do not claim that some or even many experts were not biased in various ways but only that these biases do not appear to have systematically distorted our results.

Since the possibility of biases in both interview and written sources was

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[*] See the Appendix of Adelman and Morris, Society, Politics and Economic Development.

[**] Marked variations in correlation coefficients between subsamples characterize most of our data, hence the variations in factor analyses for the three levels of development reported in Society, Politics and Economic Development.

obvious, we sought to minimize their role by seeking relatively objective
criteria for judging degrees of performance with respect to each index. With
respect to the extent of leadership commitment for economic development, for
example, these criteria included (1) the presence or absence of cooperation
between the government ministries, planning agencies, national banks, etc.
engaged in central guidance of the economy in actions to promote growth,
(2) the presence or absence of leadership measures for institutional changes to
promote economic growth (e.g. land reform), (3) the presence or absence of
full-time planning groups engaged in both planning for and execution of
national plans.[*]

In general, on the subject of our use of qualitative information, written
and interview, we are keenly aware of the experimental nature and limitations
of our data; it is obvious that they could be significantly improved with
greater resources than were available to us. We suspect, however, that their
reliability is probably significantly above the average standard for quantitative
data on underdeveloped countries in the sense that country scores on our quali-
tative indices are less likely to diverge strikingly from those which might be
produced by intensive field research than is the case for such standard quanti-
tative indices as GNP, crude fertility and investment.[**]

<u>Cardinal translation of scores</u>

The third special characteristic of our data, the assignment of numerical
scores to ordinal data, is criticized by Miss Berry. We have discussed this
elsewhere in detail,[*] but let us note here again that this procedure is an

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* Adelman and Morris, <u>Society, Politics and Economic Development</u>, pp. 79-80.

** See our reply to O.T. Brookins referred to above.

accepted and conventional one in the field of psychology and is no more
arbitrary than a host of other commonly accepted econometric simplifications
and abstractions such as the specification of production functions in macro-
analysis and assumptions regarding the distribution of error terms in statis-
tical analysis. The practical point, surely, here as elsewhere is the
sensitivity of the results to the choice of scale. In our reply to O.T.
Brookins' criticism on this point in the Quarterly Journal of Economics we have
presented factor analytic results based upon three alternative transformations
on our numerical data inputs (logarithmic, squaring and rank). Not only does
the mean absolute differences in factor loadings never exceed .08, but in only
one instance in all the three test analyses is the assignment of a variable to
a factor different from our original assignment. Thus, the factor analytic
results tested proved strikingly insensitive to variations in numerical scale.

The conceptualization of qualitative indicators

The major difficulties of our data lie, in our opinion, neither in the
fact that they are qualitative and based on judgmental information nor in the
translation of ordinal ranks into cardinal scores. The core difficulties lie
rather in the conceptualization and definition of phenomena which are only
imperfectly understood by social scientists. The difficulties of defining
indices for such phenomena as social mobility, dualism or the effectiveness of
financial institutions are considerably greater than for conventional economic
indices because there are no theories as precise and acceptable as those on
which quantitative economic measures are based. In addition, few available
theories are suited to the purpose of defining, for each socio-economic or
political characteristic, a continuum along which the full range of under-
developed countries can be ranked. Finally, there are little data to fit such

theories as are current.

The process of conceptualization and definition which we followed in constructing our composite indicators is a procedure well tried in the history of scientific inquiry -- in the physical as well as the social sciences. Abraham Kaplan in The Logic of Scientific Inquiry has the following to say about the derivation of scientific concepts in the early stage of scientific inquiry:*

> In short, the process of specifying meaning is a part of the process of inquiry itself. In every context of inquiry we begin with terms that are undefined--not indefinables, but terms for which that context does not provide a specification. As we proceed, empirical findings are taken up into our conceptual structure by way of new specifications of meaning, and former indications and references in turn become matters of empirical fact ...
>
> What I have tried to sketch here is how such a process of "successive definition" can be understood so as to take account of the openness of meaning of scientific terms. For the closure that strict definition consists in is not a precondition of scientific inquiry but its culmination. To start with we do not know just what we mean by our terms, much as we do not know just what to think about our subject-matter. We can, indeed, begin with precise meanings, as we choose; but so long as we are in ignorance, we cannot choose wisely. It is this ignorance that makes the closure premature. I do not think that Freud was merely rationalizing the shortcomings of his own semantic patterns in making explicit this methodological precept ... "We have often heard it maintained that sciences should be built up on clear and sharply defined basic concepts. In actual fact no science, not even the most exact, begins with such definitions. The true beginning of scientific activity consists rather in describing phenomena and then in proceeding to group, classify and correlate them.... It is only after more searching investigation of the field in question that we are able to formulate with increased clarity the scientific concepts underlying it, and progressively so to modify these concepts that they become widely applicable and at the same time consistent logically. Then, indeed, it may be time to immure them in definitions. The progress of science, however, demands a certain elasticity even in these definitions." The questions the scientist puts to nature and the answers she gives have the form of a Platonic dialogue, not an Aristotelian treatise; we do not know just what has been said till we have done--and then new questions crowd in upon us.

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*Kaplan, Abraham, The Logic of Scientific Inquiry, pp. 77-8.

In the preparation of our qualitative multidimensional indicators, we began with a priori definitions. Next, we studied the descriptive data in order to see how well actual country situations fit our formulation of the concept. The inadequacies of the initial fit were then used to reformulate the concept to fit better the characteristics of the real world. We then consulted expert opinion and again reformulated the definitions. We continued this process of confronting successive reformulations with information on actual country situations until we were able to classify the 74 countries in our sample with reasonable confidence.

Our efforts at definition were constrained by lack of data and the frequent necessity for using indirect rather than direct evidence. For example, our measure of social mobility is a composite of three kinds of indirect evidence concerning the capacity of a socio-economic system to provide social mobility. (It would be better to have direct evidence on the extent of individual and intergenerational mobility based on 74 field surveys.) As is generally recognized, the use of indirect evidence requires inferences concerning "presumed connections, usually causal, between what is directly observed and what /̄ a ̄/ term signifies ..."[*] Thus, in this regard too, a priori reasoning enters into our measurements as it does in many conventional composites.

We do not claim that the blend of conceptualization and evidence we have used in constructing our indicators has led to either "correct" or very precise concepts. However, the test of any concept is not its "correctness" but rather its usefulness a tool in empirical work which in turn should stimulate improved formulations of the concept. We believe that the exploratory conceptualizations in our data, with all their limitations, do serve this purpose. Our reason for

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* Kaplan, The Logic of Scientific Inquiry, p. 55.

so maintaining is that ground work such as ours on the kinds of interrelation-
ships involved between social, economic and political forces in development is
essential before large research expenditure can be fruitfully applied to major
improvements in social, political and institutional data on underdeveloped
countries. Major improvements in data require better concepts; and concep-
tualization, to be useful, requires knowledge of the relationships involved in
the phenomena being conceptualized. To quote Kaplan again,[*]

> "... a significant concept so groups or divides its subject-matter that
> it can enter into many and important true propositions about the sub-
> ject-matter other than those which state the classification itself.
> Traditionally, such a concept was said to identify a "natural" class
> rather than an "artificial" one. Its naturalness consists in this,
> that the attributes it chooses as the basis of classification are
> significantly related to the attributes conceptualized elsewhere in
> our thinking. Things are grouped together because they resemble one
> another. A natural grouping is one which allows the discovery of many
> more, and more important, resemblances than those originally recognized.
> Every classification serves some purpose or other (the class-term has a
> use): it is artificial when we cannot do more with it than we first
> intended. The purpose of scientific classification is to facilitate
> the fulfillment of any purpose whatever, to disclose the relationships
> that must be taken into account no matter what."

With respect to the precision of our definitions, we would only comment
that the sharpening of definitions serves the immediate purposes of scientific
inquiry only if it promises to be empirically applicable. The important
practical constraint to improved definition of concepts in research on low-
income countries is lack of knowledge concerning the congruence with the
characteristics of the real world of the theoretical constructs in terms of
which one might like to study the development process. To illustrate from our
work, we could have chosen any of a large number of possible precise definitions
of social mobility in terms of the extent of individual or intergenerational

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[*] Kaplan, The Logic of Scientific Inquiry, pp. 50-51. Our own current work on
a conceptualization and definition of political participation suitable for the
ranking of the full range of underdeveloped countries, for example, could not
have been undertaken without the knowledge of the statistical relationships
among the political characteristics of underdeveloped countries which we gained
from the factor analyses reported in our book.

mobility; such definitions would not, however, at this point in time, have served the purpose of our empirical research because of the impossibility of determining the extent to which such definitions fit actual country situations.

Example of the dualism indicator

The construction of our indicator of the extent of socio-economic dualism illustrates the interaction of conceptualization and testing against the actual world which took place in the preparation of our data. We choose this indicator for discussion because Miss Berry criticizes it in her comment and it illustrates our general procedures.

Before proceeding further, we would like to note that Miss Berry has for some reason chosen not to discuss our actual definition of the extent of dualism. The definition consists of a set of descriptions of A, B, C, and D categories which we found in practice to be sufficiently clear to classify almost all the countries in the sample with reasonable assurance.[*] In our view, it is upon this set of criteria that the usefulness of the indicator depends. Miss Berry's criticism is directed exclusively at the general statements in our book about the concept of dualism in which we attempt to visualize the processes of change which would be involved if individual countries moved from lower to higher categories. While our visualization of the transformations over time implied by the category descriptions have obviously influenced our definitions, our primary effort was to achieve a relatively unambiguous ranking among countries at a given point in time. As of 1960, according to our sources of information, the particular countries mentioned by Miss Berry met reasonably well the criteria we specified for the categories of dualism to which we assigned them.

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[*] The definition is given in Adelman and Morris, Society, Politics, and Economic Development, pp. 24-5.

Miss Berry has not discussed their fit to the definition itself.

The great majority of our indicators are amenable to conceptualizations in terms of transformations over time which do not violate in a major way the characteristics of the real world. However, some of our indicators, such as the dualism index, and the index of the centralization of political power represent multidimensional phenomena sufficiently complex so that they cannot be visualized in terms of a single time path of change encompassing all the categories necessary to rank the full range of underdeveloped countries. It may be possible, as we did with the dualism indicator, to find grounds for ranking a particular definition of one category above a particular definition of another even though the two categories represent different paths of change. However, the definition then fails to state that given degrees of change along one path rank the same as given degrees of change along another path. The ideal solution, in our view, would be to resolve the phenomenon into unidimensional components, rank countries on each component, and then construct a composite using a priori reasoning and testing against actual country situations. This is a very lengthy and expensive process with which we are currently experimenting.[*] Our much rougher solution with the dualism indicator is discussed below.

Our purpose in constructing an indicator of the extent of dualism was to seek a continuum along which the full range of underdeveloped countries could be ranked. The first step was a priori definition. We conceived of both ends of the continuum as marked by the absence of marked dualism, but for different reasons. At the lower end, dualism was absent by reason of the overwhelming predominance of subsistence agriculture combined with the extremely limited

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[*] The concept with which we are working is that of political participation.

growth of a market-oriented sector. The upper end we conceived of as not dualistic because of the absence of a relatively clearcut geographic or sectoral cleavage between a market-oriented sector and an important traditional subsistence nonmarket sector. In our initial definition we visualized a single intermediate category characterized by sharp social, economic and technological contrasts between a geographically distinct modern plantation, extractive or industrial sector and an important traditional subsistence nonmarket agricultural sector.

Our next step in defining dualism was to examine a large number of written country studies to see whether the countries in our sample could be grouped in the manner we had envisaged. We immediately discovered that the scheme made no provision for countries with two clearcut sectors in which the geographically quite distinct, important, and rapidly growing market sector was an indigenous cashcrop sector using conventional techniques. In exploring the differences between these countries and countries with extractive or market sectors, usually foreign-directed, using advanced technologies we came to the view that they differed significantly in the extent of interaction between their market and their traditional nonmarket sectors. In economies with extractive or plantation sectors with advanced technologies resource flows were limited primarily to labor and were thus more limited than in countries with extensive peasant cashcropping in which land, labor and capital flowed between market-oriented and nonmarket sectors.

In reformulating the dualism indicator we therefore decided to give weight to the extent of resource flows between modern market and traditional sectors, as well as to the extent of socio-economic and technological contrasts, and the presence or absence of a clearcut cleavage between important market and

traditional nonmarket sectors. Thus, in ranking the two intermediate categories with clearcut geographically distinct market sectors and relatively large non-market subsistence sectors, higher scores were given to countries in which the market sector was dominated by important indigenous cashcropping, less marked contrasts between technologies and styles of life and more extensive economic interaction between traditional and modern sectors.

With a reformulated four-way classification, we consulted additional country studies and again attempted to rank the 74 countries in the sample. While the majority of them could now be ranked, a number of reformulations of the descriptions of all but the lowest category were required to take reasonable account of the diversity of country situations. Thus, we came finally to the category descriptions presented in our book.* These descriptions, it must again be stressed, proved precise enough to rank the actual countries in our sample reasonably well. They are not, and did not need to be for our purpose, precise enough to specify ranks for a variety of conceivable country situations not represented by actual countries in our sample as of about 1960.

In general, with respect to the remaining ambiguities in our definitions, we could fill several books with the relatively precise concepts of social, political and economic characteristics we examined in the literature which proved unsuitable to the practical task of ranking the 74 underdeveloped countries in our sample. Although our data are necessarily imperfect, they have proved sufficiently reliable to serve the purpose of our analyses and to constitute a fruitful basis for further intensive research to improve specific operational criteria for measuring the qualitative characteristics of low-income countries.

* Adelman and Morris, Society, Politics and Economic Development, pp. 24-5.

III. The Discriminant Function

Mr. Eckstein's criticisms of our discriminant analysis consist of an attack on the original grouping by development potential; objections to our procedures in obtaining the final discriminant function; criticisms of the variables in the function and; criticisms of our interpretations. We will consider each in turn.

Grouping by development potential

As discussed above, we chose to focus our discriminant and regression analyses on capacity for overall economic performance and did not consider changes in GNP as a suitable measure for this purpose. We reject the view that a precise but inappropriate concept is better than a less precise but more appropriate concept. Our classification is akin to a more recent effort by Paul Clark and Alan Strout to devise measures of economic performance. To quote their recent paper,[*]

> "The concept of a developing country's economic or development performance can cover many different phenomena. The growth process consists of a complex and convoluted series of cause and effect relationships ranging from plans and rhetoric to eventual improvements in the level and conditions of living. Performance can apply to the effectiveness of pursuing either intermediate or ultimate goals and can be observed at a wide variety of points in the development process.

> "Thus performance can include such diverse aspects as (a) choice of effective policies to promote desired growth and development; (b) effective implementation of policies chosen; (c) mobilization of additional resources for growth and development; (d) efficiency of use of both domestic and foreign resources; (e) structural and other changes necessary for longer-run economic, political and social growth; (f) final effects on level and distribution of income and welfare."

Clark and Strout develop a composite measure of growth performance based on seven indicators (growth of real GNP, growth of agricultural production,

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[*] Clark, Paul and Alan Strout, Aid, Performance, Self-Help, and Need (Agency for International Development, Discussion Paper No. 20, Washington, D.C., July 1969), p. 3.

growth of investment, growth of exports, growth of real government revenues, cost-of-living inflation and marginal savings rates); they also devise a composite of measures of policy performance based upon judgments regarding the gap between actual policies and feasible more desirable policies in such areas as fiscal, trade and agricultural policy.[*] Our three-way classification of countries by development potential would rank countries somewhere between the two ranks on the Clark and Strout index since our grouping is based on both growth and policy performance indicators.[**]

In grouping countries by development potential for our analysis, we sought, as do Clark and Strout, to distinguish between countries in which registered increases in per capita GNP were narrowly based and those in which they were accompanied by widespread economic change. We have not claimed more than moderate reliability for our classification; nevertheless, we prefer a moderately reliable index which is appropriate to our purpose to a finely graded index which is neither appropriate to our purpose nor all that reliable.

We agree with Mr. Eckstein that independent evaluations of country development potential comparable to those used, for example, by Clark and Strout in deriving their estimates of policy performance would be preferable to the wide range of indirect evidence on which our classification by development potential was based. We would, however, make two points. First, we see no particular reason to expect that intensive field research would produce country rankings very different from those we obtained from our second-best procedure because of the breadth of information we took into account. Second,

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* Clark and Strout, "Aid, Performance, Self-Help, and Need".

** Exact comparisons cannot be made because the time period for their measures is different from that for ours.

our procedure led to significantly less interdependence of measurement than is present, for example, in macroanalyses of consumption and income in which the consumption component of income is not measured independently of the index of consumption.

Procedures for obtaining discriminant function

The iterative procedure we used to obtain our second discriminant function is attacked by Mr. Eckstein as unsound. We disagree. We have made no claims regarding the second function which invalidate the procedures we followed. We were testing the sensitivity of the first discriminant function to changes in possibly doubtful classifications. Such a procedure is similar to the use of forecast data to reestimate a regression equation while simultaneously omitting the observations with outsize deviations in the original equation. Our aim, as explained in our original article, was to seek the best means for classifying countries into performance groups using a small number of performance characteristics; the procedure we followed seems to us an acceptable way of seeking an alternative estimate which improves the discrimination between groups.[*]

How much difference does our decision to use the second rather than the first discriminant function make to the final multipliers derived from the stepwise regression model? Table 1 presents the multipliers obtained using both D'_1 and D'_2. It indicates that the ranking of the multipliers of the first nine variables is virtually unaffected. The primary effect is to reduce the multiplier of the agriculturally related variables (the size of the traditional subsistence sector, improvements in agricultural productivity, and the character of agricultural organization and tenure) while leaving the order

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* See the next section for further discussion of this point.

of magnitude and ranking of the other multipliers virtually unchanged. This was to be expected since the replacement of the index of improvements in physical overhead capital by the indicator of improvements in agricultural productivity is the principal way in which D'_2 differs from D_1. Whether to use D'_2 or D'_1 to construct the model was a marginal decision based to some extent on the evidence of dual economy models that improvements in agricultural productivity play an important role in determining growth potential. Our preference for D'_2 is supported also by the fact that an alternative stepwise discriminant procedure which uses F ratio instead of the generalized distance criterion for adding and deleting variables yields results identical to D'_2.

The variables in the discriminant function

We can hardly disagree with several of Mr. Eckstein's comments on the limitations of the variables contained in the discriminant function since his propositions are elementary ones related to the interpretation of any set of statistical results including ours. First, we certainly have <u>not</u> obtained "independent causes of faster growth rates"; nor have we claimed to obtain them. As we indicated in our article on the discriminant analysis in the <u>Quarterly Journal of Economics</u> the role of the variables in the discriminant function was "to classify countries into performance groups, using a relatively small number of performance characteristics."[*] In our only studies of differences in economic growth rates,[**] we have been at pains to take account of the fact that statistical associations may represent causality in either

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[*] Adelman and Morris, "Performance Criteria for Evaluating Economic Development Potential," p. 261.

[**] Adelman and Morris, "A Factor Analysis of the Interrelationship between Social and Political Variables and Per Capita Gross National Product," <u>Quarterly Journal of Economics</u>, Vol. LXXIX (Nov. 1965), and <u>Society, Politics and Economic Development</u>, passim.

Table 1

Comparison of Final Multipliers Resulting from the Use of

Discriminant Functions D'_1 and D'_2

Variable	Multipliers		Ranks based on Multipliers	
	D'_1	D'_2	D'_1	D'_2
X'_{13}	2.212	2.309	1	1
X'_{31}	1.705	2.169	2	3
X'_{21}	1.832	2.13	3	2
* X'_8	1.545	1.98	4	$4\frac{1}{2}$
X'_4	1.545	1.624	5	$4\frac{1}{2}$
X'_{24}	.913	1.062	6	6
X'_{33}	.873	.955	7	7
X'_{49}	.727	.940	8	9
X'_{26}	.754	.884	9	8
* X'_7	.095	.823	10	13
X'_{25}	.685	.797	11	10
X'_{50}	.414	.536	12	11
X'_{27}	.347	.407	13	12
⌐ X'_{20}	.033	.288	14	15
X'_{47}	.052	.018	15	14
X'_{29}	-.232	-.300	16	17
X'_{46}	-.253	-.310	17	18
X'_5	-.168	-.320	18	16

* One needs to add to this the change in physical overhead capital

⌐* Agriculturally related

direction or be the result of common forces affecting both dependent and independent variables. Mr. Eckstein may wish to examine these earlier studies for our conclusions regarding the "causes" of differences in economic growth rates.

Second, each variable in the discriminant function certainly represents closely related influences not directly measured by the variable itself as well as those directly represented. We pointed this out both in the present article and in the original article on the discriminant analysis. For example, the index of the modernization of outlook is certainly closely related to basic economic influences.* Nevertheless, since the analysis was free to select direct economic measures and did not do so, it seems reasonable to interpret the choice of the modernization index as indicative of some independent influence of the noneconomic forces represented by the measure itself. With as many as 74 observations, there is no reason to suppose that the choice of the modernization index rather than an economic index was the outcome of purely random influences.** To take another example of the representation of forces other than those directly measured, we would expect the index of improvements in financial institutions to be to some extent a surrogate for forces underlying the phenomena represented by the dependent variable. This

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* See Adelman and Morris, Society, Politics and Economic Development, row 4 of Appendix Table A-1 (correlation matrix for social, political and economic indicators: full sample)

** The division of scientific inquiry into "disciplines" involves a priori distinctions between proximate and ultimate causes, the exogenous variables being treated as ultimate: it has been our feeling that the arbitrary division of variables between endogenous and exogenous on the basis of "disciplinary" divisions needs restudy, and it is this very problem that our original factor analyses were designed to study. See Adelman and Morris, Society, Politics and Economic Development, especially pp. 3ff.

possibility is surely self-evident for any statistical analysis in which the influences measured are proximate ones only. In the present instance, it seems perfectly possible, for example, that fundamental attitudinal influences not directly represented by our data are ultimate causes of both specific economic improvements and the raising of overall development potential. As a matter of fact, we would be fascinated to find a statistical analysis in which common ultimate underlying forces do not influence both sides of the equation.

The appropriate method for understanding better the influences represented by a particular variable in a set of statistical results is to analyze carefully those variables which are the next-best alternatives to the particular variable chosen at each step in the analysis. Since the publication of the results of our original discriminant analysis, we have rerun the discriminant function with a stepwise program having an F-ratio criterion for the entry and rejection of variables and giving F ratios for all variables at each step.[*] The index of modernization of outlook is consistently the first variable to enter the discriminant function. As would be expected, the variables which are the next-best alternatives (as indicated by high original F ratios combined with striking decreases in F ratios as a result of the entry of the modernization index) represent a complex of closely interrelated economic and social influences, including the level of development of financial, agricultural and industrial structures, the extent of social mobility, the importance of the indigenous middle class, and the extent of secondary and higher education.[**]

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[*] Unfortunately, no program giving information on all variables is available for the stepwise discriminant procedure which applies the criterion of the greatest contribution to explaining the variance between group means.

[**] The next-best candidate as indicated by a combination of the next highest F ratio and largest subsequent drop in F ratio is the level of effectiveness of financial institutions.

The third point about the variables in the discriminant function on which we agree with Mr. Eckstein is that a positive relationship between improvements in agricultural productivity and growth performance (actual or potential) was to be expected since agriculture forms a very important sector in less-developed countries. One would similarly expect improvements in industrial technology to be closely related to growth performance in advanced economies. But, what is the point? Is one to eliminate variables for which there is a strong a priori reason to expect a high intercorrelation? Certainly, a significant positive relationship may be expected, but the interesting question may be the variations in the strength of the positive relationship at different levels of income. In our factor analyses for the three levels of development, for example, the relationship between economic growth and technological improvements in agriculture varied considerably from one level of development to another in a manner which might or might not have been expected a priori. In fact, the positive relationship was less strong for the sample of countries with the largest agricultural sectors at the lowest of the three levels studied than for those at the highest.* The paper under discussion does not, it is true, discuss the three subsamples. However, research is best done in an orderly manner; it seems to us perfectly reasonable to present full sample results prior to the lengthier process of studying differences among different levels of development.

In section II we discussed Mr. Eckstein's criticism of the index of leadership commitment to economic development and concluded that there is clear evidence of no systematic bias of the sort described by Mr. Eckstein.

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* The simple correlations between rates of change of per capita GNP and improvements in agricultural productivity for the "high", intermediate, and low samples, respectively, are .78, .28, and .44.

In conclusion, on the variables in the discriminant function ,
Mr. Eckstein has discussed both these difficulties which are peculiar to our
data and approach and common well-known difficulties which our analysis shares
with conventional statistical analyses. The special problems arise primarily
from difficulties in conceptualizing, in a manner which fits actual countries,
qualitative country characteristics for which the body of even approximately
validated knowledge is extremely small. The common "problems" of significance
are the possible biases caused by the interdependence of measurement of
dependent and independent variables and the problem of the interpretation of
empirical relationships.

IV. The Stepwise Regression Model

We now turn to the specific criticisms of the stepwise regression model
by Mr. Eckstein and Miss Berry. Since we have already discussed their objec-
tions to our approach, data and the specifics of the discriminant analysis, we
will consider in turn in this section their criticisms of our interpretation
of the stepwise model and the general problem, which they fail to discuss, of
how to determine the robustness of our statistical results (or indeed any
statistical results).

Interpretation of the Model

We have already pointed out that every statement about cause and effect
in our paper is qualified by a phrase such as "in the model." In addition,
the introductory paragraphs of the paper specifically make the points both
Mr. Eckstein and Miss Berry stress concerning the causal interpretation of
statistical associations. We certainly wholeheartedly agree with both critics
that the two or three sentences per equation offer only an outline of plausible
interpretations. Indeed, how could they imagine that any set of three sentences

we devised could begin to do full justice to the interpretation of an equation?
To do justice to a single equation along the lines we discuss below requires at
least a dozen paragraphs; yet our original six sentences or so per equation
were halved when the editors of the journal requested us to cut our paper by
50 percent. No matter. Since neither critic has done much more than give us
an elementary lesson on the interpretation of statistical associations, the most
useful response we can make is to outline the resource-consuming procedures we
are currently applying to handle the three major problems of interpretation
they raise: (1) the problem of direction of causality, (2) the problem connected
with the fact discussed above that any variable entering a statistical equation
may be a surrogate for influences other than those directly measured by the
variable, and (3) the problem of interpreting cross-section results as repre-
senting historical processes.

To handle the problem of direction of causality we have established a
list of potential causal indicators for each variable which is not clearly
exogenous using a priori reasoning based upon a quite thorough examination of
the relevant literature of sociology, political science and economics. Each
list of possible independent variables is limited to those which can reasonably
be considered proximate or direct causes of the phenomenon measured by the
particular dependent variable. The regression equations obtained from the
application of a stepwise procedure to these restricted lists of variables are
thus free of cases of clearcut violations of the correct direction of causality.
We have not found, however, an ideal solution to the problems posed by genuine
cases of mutual causation; nor has anyone else, to our knowledge. To include
an interacting "independent" variable violates the direction-of-causality
constraint; yet to exclude it leads to results which are biased by the omission
of relevant influences.

To understand better the influences represented by the variables included in each regression equation, we have studied several kinds of statistical information. First, we have examined the F ratios of the omitted variables at each step in the analysis; we interpret a marked drop in the F ratio of an omitted variable as a result of a given step in the regression analysis to indicate that the relationship between the dependent variable and that particular omitted variable is to some extent represented by the variable included at that step. Second, we have studied both simple correlations between included and unincluded variables and net correlations between the dependent variable and the omitted variables. Third, we have studied the individual country residuals at each step in the analysis. We are following these procedures for each variable in turn for both the full sample and each of three subsamples representing different levels of development.

These procedures can be briefly illustrated with the equation in the present model which gives a statistical "explanation" of social mobility. The list of potential explanatory variables for our reruns was restricted to 18 variables and included the three entering the present regression equation. The equation was unchanged and thus included literacy, middle class and traditional elite. A study of F ratios and so forth indicates that the literacy index, in addition to representing directly the effect of literacy on social mobility, also represents the impact in expanding opportunities for social advancement of those social and economic changes associated with the break-down of traditional social organization which are summarized by Factor I of our full-sample factor analysis[*]: traditional sector, dualism, modernization of outlook, mass communication, human resources, among others, and, to a lesser

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[*] Adelman and Morris, <u>Society, Politics and Economic Development</u>, pp. 153-4.

extent, the levels of development of industry and financial institutions (these are variables with both high initial F ratios and sharp drops in F ratios with the entry of literacy into the equation). The second variable in the equation represents directly the role of the expansion of the indigenous middle class in promoting increased social mobility; the other potential explanatory variables for which our analysis suggests this variable also stands are, foremost, the structural changes summarized by the dualism indicator and, next, the development of physical overhead capital, industry, financial institutions and education. There is no close substitute for the third variable in the equation, the strength of the traditional elite. Here, in brief, is the material for a thorough discussion of <u>one</u> of the 14 equations in the model. Thus, to handle fully the problem of interpretation requires, in our view, a lengthy process of analysis, study of available hypotheses for understanding strands of causation, and finally, interpretation; it is a process which we think gives a reasonable idea of the forces for which each variable in a regression equation may be presumed to stand. It must, of course, be emphasized that the success of these procedures depends greatly on the extent to which the list of potential independent variables for each equation represents the full range of forces likely to influence the phenomenon summarized by the dependent variable.

The third problem of interpretation to which our recent research is addressed is the question of the relevance of cross-section results to understanding changes over time. As we stressed in our book, strictly speaking, cross-section analyses cannot be interpreted to have any specific time dimension, nor to indicate that the implied transformations will take place at all, nor even to infer the time direction of changes.[*] Historical

* Adelman and Morris, <u>Society, Politics and Economic Development</u>, pp. 265-6.

evidence on directions of change and a priori reasoning are required in order to lend meaning to even the most conventional of cross-section statistical studies. Because of the clear desirability of studying the historical relevance of our cross-section analyses, an important part of our current research effort is directed to a series of cross-section studies for several different periods in the 19th and 20th centuries and a series of individual country time-series studies of the process of economic development.* Our motivation for these studies is that there seems to be no shortcut for original research to determine the historical validity of generalizations based upon our cross-section analyses of contemporary data.

We have presented in some detail our current procedures for handling the major problems involved in the interpretation of the cross-section results of our "Econometric Model of Development" because of the failure of our critics to suggest any solutions to the problems of interpretation which do not involve scapping the general framework of our approach.

The robustness of the regression model

Mr. Eckstein has employed some fine rhetoric to indicate that a number of decisions made in the course of our research could affect the results we obtained. Since neither he nor Miss Berry has performed any sensitivity tests, it is surprising that they are so sure the results would vary greatly with specific alternative definitions, measurement of the variables, and choices of procedures. They certainly are aware, although they refrain from mentioning it in evaluating our work, that arbitrary assumptions do not invalidate a model. The appropriate way to condemn a model for its arbitrary assumptions is to show

that the results obtained from the model are significantly sensitive to reasonable changes in its various specifications, that is sufficiently sensitive so that the model fails to achieve its purpose. Consider the arbitrariness of the assumptions regarding the nature of aggregate production functions in statistical analyses of factor contributions to economic growth; the extreme abstractions from reality on which the concepts of GNP and cost of living are based; the known unreality of assumptions regarding the "economic man" on which classic models of price behavior are based; and the overwhelming simplification of the actual world of models of economic growth which "explain" growth rates without reference to noneconomic influences. By comparison with the heroic assumptions of standard econometric analyses and model building, the assumptions involved in, for example, our cardinal scales for scoring, our three- or four-way classification schemes, or our procedures for estimating alternative discriminant functions pale considerably. We are not claiming to have made no assumptions to which our results will prove sensitive upon further testing; on the contrary, an important part of our current research is devoted to further testing of the results. We are only suggesting that the appropriate procedures for an overall evaluation of our model include the usual procedure of testing the robustness of the results produced by the model.

We have ourselves made some tests to date of the robustness of our results which indicate that they perform quite well by comparison with other econometric models. As we indicated above, the choice of D'_2 rather than D'_1 as the starting point for the model leaves the ranking of the leading multipliers virtually unaffected. Then too, the application of two different stepwise criteria (F ratio and distance criteria) for obtaining the final discriminant function leads to the choice of the same variables. Another check on the

"robustness" of the results is provided by the consistency of the multipliers

obtained through the present stepwise procedures with the results obtained by

the application of the technique of canonical analysis to the same data.[*]

Canonical analysis is equivalent to a limited information simultaneous equation

procedure.[**]

How many other econometric models perform as well? In different estimates

of consumption functions with similar data but over different (though over-

lapping) time periods the estimated coefficient of past peak income varies

between a significant value of -.625[***] to an insignificant value of -.241;[****]

the marginal propensity to consume out of quarterly disposable income varies

between .1 and .6 and the long-run marginal propensity to consume between .60

and .98.[*****]   In alternative estimates of production functions for the

United States the elasticity of output with respect to labor varies between .18[******]

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[*] Adelman, Irma, Marsha Geier, and Cynthia T. Morris, "Instruments and Goals in Economic Development," American Economic Association, Papers and Proceedings, Vol. XIX (May 1969). See Appendix B, pp. 425-6.

[**] E.J. Hannan, "Canonical Correlation and Multiple Equation Systems" (Technical Report 4, Sept. 1964, Institute of Mathematical Studies in the Social Sciences, Stanford University).

[***] Duesenberry, J., O. Eckstein and G. Fromm, "A Simulation of the U.S. Economy in Recession" Econometrica October, 1960.

[****] Griliches, A., G.S. Medala, R. Lucas, and N. Wallace, "Notes on Estimated Aggregate Quarterly Consumption Functions" Econometrica (30 Vol. 3, July 1962) pp. 491-500.

[*****] Zellmer "The Short Run Consumption Function" Econometrica (Oct. 1957); Griliches et al, op. cit.

[******] Valavanis, S. "An Econometric Model of Growth: USA 1949-1953", American Economic Association, Papers and Proceedings, XLV (May 1955) 208-21.

and 195[*] with the use of similar functional forms. In the study of investment

behavior the major unresolved question is the appropriate specification of

investment functions: estimates of the elasticity of capital stock with

respect to relative price range anywhere from a value of .8 to a value of .09,[**]

and the elasticity of capital stock with respect to output ranges from a value

of .6 to a value of 1.0.[**] All of these estimates were obtained by well

recognized econometricians sharing a common theoretical framework and applying

similar econometric techniques to analogous bodies of empirical information.

There is a final set of points we wish to make on the subject of the

results of our model. We do not understand the grounds for Mr. Eckstein's

view that models with a priori specified functions have much more meaning than

models based upon empirically determined regularities for our subject of

inquiry. We certainly agree with him that an a priori specified model can be

more "orderly" if it avoids the tricky problems posed by qualitative and inter-

correlated data by an a priori selection of variables with low intercorrelations

which is restricted to those subject to direct cardinal measurement. But why

does that make the results either more meaningful or less arbitrary? The

subject of our investigations is the interrelationship among noneconomic and

economic influences in the process of economic development. The problem we

face in the derivation, for example, of our discriminant function, is that the

literatures of economics, history, sociology and anthropology have produced a

large number of reasonable, yet not well validated, theories which would justify

the substitution, on a priori grounds, of any of a dozen or more alternative

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* Klein, L.R. and A.S. Goldenberger - An Econometric Model of the
United States 1929-52 (North Holland, 1955)

** Ibid.

social and/or economic variables for the indicators currently in our discriminant function. Given this multiplicity of equally plausible competing hypotheses, we see no grounds for the view that an a priori choice among them is either less arbitrary or more meaningful than a selection made by a reasonable empirical procedure. Mr. Eckstein is not very helpful on this point. His recommendation for handling the admittedly difficult problems, inherent in our subject of inquiry, which are posed by the presence of interrelated qualitative influences is to avoid them in an "orderly" way by a priori specifications limited to influences which can be directly measured along a cardinal scale.*
Not only are we to change our approach; we are to change the subject of our inquiry as well!

V. Conclusion

We have examined the special characteristics of our data and, in particular, the major difficulties involved in conceptualizing and defining the qualitative indicators. We concluded that, for the most part, our data are probably more reliable than most of the data used in more conventional quantitative cross-section studies of developing countries in the sense that the scores on our indices are unlikely to change as grossly as quantitatively defined estimates such as GNP, investment, price inflation and fertility rates have done in the past when finally tested by intensive field research. We also concluded from a study of correlation matrices for subsamples of our data that our data are not characterized by systematic error due to the supposed tendency of expert opinion to prejudge the correlates of economic performance.

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* We believe that he would, however, be willing to accept as useful to a preliminary hypothesis-seeking exploration a qualitative indicator based on 74 field surveys in the 74 countries in our sample.

We have described in some detail the methods we are currently employing to handle, within the framework of our approach, the three major problems involved in the interpretation of our results: the problem of causality, the problem of understanding the forces for which a given variable may be proxy, and the problem of interpreting cross-section results to represent historical processes. It should, however, be stressed that the methods we recommend for handling these problems can only achieve their purpose if they are applied to data which represent reasonably well the full range of country characteristics likely to influence the capacity of developing countries for widely based economic growth.

In conclusion, we firmly believe that the empirical approach to scientific inquiry forms an extremely useful complement to the usual structured techniques of the economist for the study of the process of economic development. We concurrently reject the view that, in the investigation of the complex inter-actions among noneconomic and economic influences in development, a priori models are likely to produce much more meaningful results than models based upon empirically determined regularities. The multiplicity of plausible hypotheses regarding "causes" of variations in the capacity of low-income countries to perform economically is so great and the body of validated knowledge so small that a priori choices among candidate variables are inevitably arbitrary and tend to reflect the disciplinary preferences of the investigator. We do not deny, and indeed are ourselves convinced, that models with a priori specified functions are very important for the analysis and understanding of particular subsets of interactions about which a reasonable amount is known. (These subsets are usually encompassed by a single discipline such as economics). We only propose strongly that alternative empirical

procedures may be more fruitful for the initial exploration of those wider

interactions involved in economic development which, by crossing disciplinary

lines, involve relationships about which very much less is known.

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