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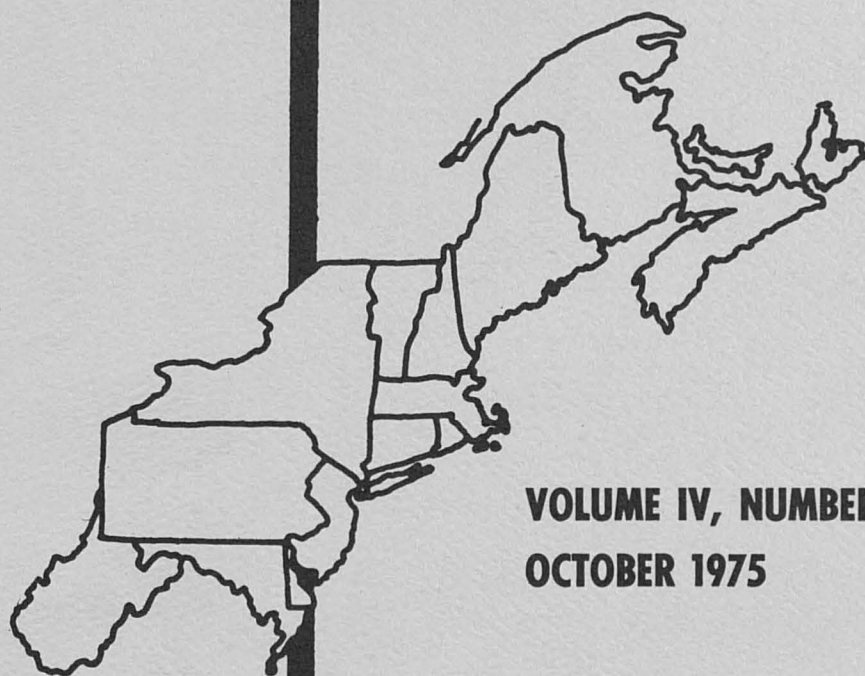
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NATURAL RESOURCES AS RELATED TO COMMUNITY DEVELOPMENT
--A PRELIMINARY ANALYSIS--

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Introduction

Natural resources play a role in economic development, but the
exact nature and importance of that role is a matter of dispute. The
spectacular development of natural resource poor Japan compared with a,
say, relatively well endowed Argentina certainly indicates that the lack
of resources need not unduly hinder development while their abundance
does not insure rapid growth. Much of the difference lies, undoubtedly,
with the human and institutional factors.

Lewis (3, p. 28) contends that in modern growth theory development,
at least of manufacturing industries, is not resource dependent because,
in part, resources can be transported. Schultz (4, p. 48) has shown
that land (natural resources) is relatively less important in the more
developed counties than in the LDC's, but does not deny a role for such
resources while pointing out the dynamic relationships between new forms
of reproducible resources, investment in human resources, and natural
resources. Castle (1, p. 109) held that resources may be utilized by a
community for development and that the community's endowment will, to
some extent, influence the types of economic activities that may be
pursued.

Despite the considerable amount of discussion relatively little em-
pirical evidence, except of the general Japan type, has been used to
relate natural resource endowments to such development measures as
income and employment levels and changes. Most aggregative production
function studies have ignored natural resources or have lumped them with
capital in a dichotomous classification. The exceptions are some
agricultural firm functions which include land as a separate category
and a few cross sectional studies which have included a land or land
quality variable for intercountry studies. Generally, significant
relationships have been found where such variables were included.

This paper reports on the results of a preliminary study using
statistical procedures to examine the links between natural resources
and changes in income and employment in West Virginia. Finding that
positive (or negative) relationships exist will not, of course,

establish causation. Additional micro data and studies will be required
to indicate the dynamics of the interrelationships which result in more
(less) effective utilization of an area's natural resources. It is in
this sense that the study is preliminary; no attempt has been made to go
to that second stage although the intention is to use the results to
guide such studies.

Hypotheses, Procedures, and Data

The basic assumption to be tested in this phase of the study was that
natural resource endowments are positively related to economic development
variables such as levels and changes in employment and income. Employ-
ment should be increased by exploitation of the resources of an area and
the increased employment and resource sales will both tend to cause higher
total and possibly per capita incomes. Incomes in a well endowed area
should be higher than in a less well-endowed area, pari passu, because
the cost of transporting the resources would be smaller.

The statistical procedures used to test the hypothesis of a linkage
between the natural resource endowment of an area and its economic
development are multiple linear regression using the least squares
approach and discriminant analysis. The former to determine if
statistically significant relationships exist between income or employ-
ment and selected natural resources for counties in West Virginia.
Discriminant analysis was used to see if counties classified as to
income or employment changes would be different with respect to their
natural resource endowment, i.e., if the natural resources can be used
to adequately predict the income or employment status of a county. In
addition, the "nonconforming" counties can then be used in the proposed
second stage of the study.

Data for study was derived from various secondary sources such as
Census of Population, Soil Conservation Service publications, the State
of West Virginia Blue Book, etc. County data were the basis with the
most recent available at time the study started used. Employment and
income levels and changes were derived from Census data for the years
from 1940 through 1970. The natural resource categories used were crop-
land, expressed as a percentage of the total land of the county, forest-
land, recoverable coal reserves, and location of a navagable river in
the county, expressed as a 0,1 dummy variable.

Results of Analyses

The statistical analyses used indicated that there are significant
relationships between natural resources and levels or changes in such
indicators of economic activity as income and employment. While
causation should not be inferred from the data and techniques used, the
results clearly indicate that the supposition of no relationship between
natural resource's endowments and economic development cannot be accepted
for West Virginia counties.

Regression models were run using three different dependent variables; average per capita income in 1970, percentage change in employment from 1960 to 1970, and percentage change in per capita income from 1960 to 1970. Since the percentages of cropland and forestland were highly intercorrelated (negatively) the percentage of cropland was used as an independent variable along with recoverable coal reserves and location on a navagable river.

The results, shown in Table 1, indicated statistically significant relationships between the level of per capita income in 1970 and both the proportion of cropland and location on a navagable river. An increase of one percent in the cropland area of a county is associated with an increase of about $21 in per capita income while location on a navagable river is associated with an average $511 higher income per person in the county. Recoverable coal reserves were not statistically significantly associated with income level differences.

Table 1
Results of Regression Analyses

Dependent Variable	Regression Coefficient	T Value of Coefficient	Probability t
Per Capita Income Model (R^2 = .501)			
Percentage of Cropland	21.066	3.24	.002
Recoverable Coal Reserves	0.00002	0.61	.548
Location on Navagable River	511.308	5.89	.0001
Percentage Change in Income Model (R^2 = .336)			
Percentage of Cropland	0.557	0.99	.674
Recoverable Coal Reserves	−0.0000001	−3.60	.001
Location on Navagable River	−0.212	−2.84	.006
Percentage Change in Employment Model (R^2 = .247)			
Percentage of Cropland	0.671	2.50	.014
Recoverable Coal Reserves	−0.00000001	−0.55	.586
Location on Navagable River	0.075	2.11	.037

The relationship of the percentage change in income between 1960 and 1970 was statistically significant with location on a navagable river and with recoverable coal reserves. Location on a river meant a 21 percent lower increase in per capita income from 1960 to 1970 while large recoverable coal reserves also were associated with lower percentage increases in income. While the counties located on navagable rivers have

higher per capita incomes the increases have been relatively smaller.
The decade from 1960 to 1970 was when oil and gas were still being sub-
stituted for coal as energy sources and thus counties with coal reserves
tended to be the more economically depressed in West Virginia.

The model using employment changes from 1960 to 1970 as the depen-
dent variable resulted in statistically significant relationships between
proportion of cropland and location on a navagable river. Both were
positive so that employment tended to increase more rapidly in the
counties with more cropland and those on rivers. Coal reserves were not
statistically related to employment changes during that decade since
much of the decline in employment in coal occurred during the previous
10 years.

The R^2s for the regression equation ranged from .50 for the per
capita income equation to under .25 for model with percentage change in
employment as the dependent variable. The unexplained variance was due,
no doubt, to the omission of contributory variables, either natural
resource or other variables. Inclusion of selected human (labor) and
capital variables in a second version of the per capita income model
resulted in an increase in the R^2 to .86.[1] The intercorrelation between
certain of the natural resources and human resource variables, however,
was sufficiently large to cause bias in the regression coefficients.
This was especially true for education and population per square mile
in relation to both percentage of cropland and location on a river
(r's = .25 to .60); although education and population also were inter-
related (r = .58), cropland and river location were not closely
interrelated (r = .12).

However, the positive correlations between the human and resource
variables tend to support the hypothesis that there are linkages between
resources and development. That because there are advantages to
locating where certain resources exist such areas tend to have higher
employment and incomes than do less well endowed areas. Cropland and
navagable rivers, for example, are not transportable so that the extent
such resources are useful, they are advantageous to the areas where they
exist.

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[1]This equation included the three natural resource variables, three
human resource variables (population per square mile, average number of
years of schooling, and percentage of urban population), and four
capital infra-structure variables (miles of primary road, miles of rail-
road, housing units, and existence of an airport). Schooling was the
most important explanatory variable, but most of the other regression
coefficients were not statistically significant due to the large error
terms which resulted from the intercorrelations of the independent
variables.

The Discriminant Analysis

The same three dependent variables used for the regression models were used to classify the counties of the state into those above and below the state averages with respect to per capita income, changes in income and changes in employment for use in the discriminant analysis.[2] The means of the natural resource variables for the state and each subdivision are given in Table 2. In all cases the means of the above average counties were greater for the cropland and navagable river variables but less for forestland and recoverable reserve variables. The differences are consistent with the findings of the regression analysis.

The use of the four natural resource variables to predict the group (above or below average) to which particular counties belonged gave mixed results.[3] When the counties were classified on the basis of per capita income, eleven were wrongly assigned on the basis of the resources—eight below average counties were predicted to be in the above average group and three from the above to the below average group. When the change in income was used to classify the discriminant analysis it resulted in 15 changes; six from below to above and nine from above to below. There were 20 changes when employment change was the classification variable.

While the majority of counties would be correctly classified with respect to developmental variables based on their resource endowments these were by no means perfect predictors. The results do tend to confirm that there are linkages between resource endowments and development, but that these are not automatic. To examine some related factors, capital infrastructure variables such as roads, railroads, and airports

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[2] The discriminant analysis used for this study was for the purpose of determining on the basis of the various classifications whether or not the resource variables could be used to classify a county above or below average in income and employment levels or changes. The procedure, explained by Rao (6), used was that in the SAS package (5). In this procedure a discriminant function was not obtained since there was no intention to use the procedure for predicting for some other set of counties. The results can be used as evidence of linkage between resources and development and to show exceptions. Those counties which do not conform can be used to help analyze why development does not occur in well endowed areas or why it does in less endowed areas.

[3] Although it could be argued that only the same three variables used for the regression model should be included in the discriminant analysis, the division into groups lessened the effects of the intercorrelations, while the purpose also is different - regression coefficients are not estimated.

and human (labor force) related variables were included in the discrimi-
nant functions. Inclusion of the capital infrastructure variables did
not noticeably improve the predictive capacity of the models but inclusion
of the human related variables did, especially for the income level and
employment change classifications. Only three counties were not correctly
predicted by the model for the 1970 per capita income classification and
five for the model using employment changes. Education (quality of labor)
and population per square mile (quantity) seemed to be the major contribu-
ting variables to the improved classification, as they were in the
regression models.

Table 2
Means of Resources for State and County Groups
Classified by State Averages

State-All Counties

Variable	No. Counties	Mean
Percentage Cropland	55	29.75
Percentage Forestland	55	66.65
On Navagable River (%)	55	30.90
Coal Reserves (Miltontown)	55	1.05

Counties Classified by 1970 Per Capita Income

	Above Average Counties		Below Average Counties	
Percentage Cropland	16	43.75	39	32.98
Percentage Forestland	16	58.35	39	70.06
On Navagable River (%)	16	62.50	39	17.94
Coal Reserves (Miltontown)	16	0.95	39	1.09

Counties Classified by Change in Per Capita Income

	Above Average Counties		Below Average Counties	
Percentage Cropland	36	36.72	19	34.97
Percentage Forestland	36	62.73	19	74.08
On Navagable River (%)	36	25.00	19	42.10
Coal Reserves (Miltontown)	36	0.69	19	1.74

Counties Classified by Change in Employment

	Above Average Counties		Below Average Counties	
Percentage Cropland	29	39.46	26	32.38
Percentage Forestland	29	64.34	26	69.38
On Navagable River (%)	29	44.82	26	15.38
Coal Reserves (Miltontown)	29	0.82	26	1.30

Conclusions

The results of the statistical analyses used in this study tend to confirm that natural resource endowments do contribute positively to variables associated with economic development--income and employment. Percentage of cropland and location on a navagable river were positively associated with higher levels and greater changes in either income or employment. These along with coal reserves and percentage of forestland provided a fairly good basis for predicting whether a county should be included in the above or below average categories with respect to income or employment.

Recoverable coal reserves of a county did not appear to contribute appreciably to the income of a county and was negatively associated with employment changes. The data used for the study was from 1970 and earlier years, prior to the energy crisis and increased coal prices. It is probable that the findings relative to coal reserves would be reversed by use of more current data. This hypothesis will be tested as soon as the data to do so is available.

The failure of resource endowments to predict more perfectly can be attributed to other factors which contribute to development--particularly to human resource related factors. Inclusion of labor quantity and quality related variables resulted in a much improved discriminant model. While superior levels of those factors tended to be associated with those counties having better resource endowments such linkages were not always so. That some relatively resource poor counties did better than some better endowed ones appears to be due to the superior position vis-a-vis human factors.

Capital infrastructure did not appear to be particularly related to either superior income or employment. The infrastructure of the state, however, for the study year was relatively old and there was relatively few differences between counties. The interstate system was not very advanced nor had it been built long enough to have a significant impact. The rapid building of new roads since 1968 also could alter the impact of the capital infrastructure.

The results of this study provide only a preliminary analysis of the linkages between resources and the development variables, income and employment. Such linkages do exist but they are not perfect as, even casual, observation of the real world indicates. Human related factors, including institutions are important, perhaps the more important determinants. Resources must, however, be considered and as they become relatively more scarce and as transportation costs increase relative to other factors (due to energy requirements and costs) it is important to consider such factors as location and relative efficiency when attempting to affect economic activity.

This is, as indicated, a preliminary study and much more work needs to be done to establish more firmly the nature and importance of the linkages between resources and development. Although casual observation

gives the impression that natural resource endowments are not the deter-
minants of development, this study tends to refute that common sense
conclusion. No single study can be taken as proof but it does point to
the desirability to reconsider some of the assumptions currently held
about economic development, many of which resulted from what was a
largely irrational, from the nature of the earth's resources, headlong
growth at all costs policy of both developing and developed regions.

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