Shifting Patterns in Developmental Rank Ordering: A Case Study of the Districts of Sind Province

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The primary objective of this paper is to observe the changing patterns in regional development and to highlight some of the major underlying phenomena. Our examination of changes in rank ordering over a short period of time reveals that only moderately developed districts have altered their position in either upward or downward direction. Larkana district moved from sixth to fourth rank, while Tharparkar district regressed considerably from fourth to eighth rank. The exercise will facilitate policy-makers in allocating development resources in districts where the deficiencies are evidently serious. It will also be helpful in locating research areas to determine particular bottlenecks to development in districts which shifted downward in rank ordering.

I. INTRODUCTION

The decade of the 70s has witnessed efforts by various national and provincial governments in Pakistan to reduce regional disparities in the level of development. A number of explicit spatial policies have been pursued towards this objective. These have included, on the one hand, a range of fiscal and monetary incentives[1] to industrial investment in backward areas and mandatory restrictions,[2] on the other hand,

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[1] To promote balanced regional development, general and/or region specific incentives are granted. For instance, complete exemption from customs duty is available on import of certain machinery and equipment in Shikarpur, Jacobabad, Tharparkar and Dadu (excluding Kotri). Industries in Hyderabad, Kotri and Karachi division, cannot avail this facility. In order to provide for timely credit in adequate quantities to different regions, mandatory credit targets have been given to the commercial banks. Tax holiday for industries in least developed areas is another example of region specific incentives.

[2] In Sind, there is a general ban on any new unit in Karachi, Dhabeji and Gharo, unless it can either only be established at these locations (ship-building and repairs, ship-breaking, sea sault, canning and preservation of sea food) or has downstream links with major investments like Steel Mill (engineering workshops) or has a localized market (ice and cold storage, bakeries) or represents the application of complex, large-scale technology (petrochemicals).

on the establishment of new units in certain industries in the developed metropolitan regions of the country like Karachi and Lahore. In addition, there has been a dimension of regional equity in the allocation of public expenditures on physical and social infrastructure. The changed sectoral emphasis, with higher priority on rural development, is likely also to have had some favourable consequences on the spatial distribution of national income and welfare.

The basic question that arises is the extent of progress that has been achieved as a result of these policies in reducing regional imbalances in the level of development at the district level in Pakistan. It is the objective of this paper to identify the shifting pattern in the development rank ordering over the 70s in one province of the country, viz, Sind. This is a province which has traditionally been characterized by fairly sharp differences among districts in the level of development with the largest city of the country, Karachi, dominating economic activity in the province and the rest of the province being essentially rural and relatively underdeveloped, except for a few pockets of development in districts like Hyderabad and Sukkur.

The basic conceptual view of development adopted in this paper is to see it as the end result of interaction between various technological, economic, social and institutional factors. As such a series of indicators have been used to indirectly measure territorial levels of development [see Torgerson, Warren S. (1958)]. These indicators primarily relate to development inputs and can be used as tools for regional planning.

The paper has been organized as follows. Section II describes the particular indicators used for evolving the spatial and inter-temporal ranking of the districts of Sind in terms of level of development. Section III discusses the methodology used for combining the various indicators into one summary measure of the level of development. Section IV presents the results of the empirical analysis. In Section V, we highlight the major implications of the findings and indicate some of the limitations of the exercise. Finally, the Appendix to the paper describes the various data sources for the different indicators and includes the background tables to the study.

II. CHOICE OF DEVELOPMENT INDICATORS

A number of studies have been undertaken in the past to rank districts of Pakistan in terms of level of development. Helbock and Naqvi (1976) used a multidimensional approach to determine the relative level of development at the district level for the 60s. Pasha and Hasan (1984) have attempted a similar analysis for the 70s. Khan and Iqbal (1982) have used the most recent data from the Agricultural Census of 1980, to quantify the spatial variation in the level of development of rural areas of the country in terms of access of villages to basic inputs and services.

All the above studies have, however, constructed development rankings at one moment in time. In this paper, given a consistent set of development indicators and

data sources, an attempt is made to show how districts have changed their rank orderings over a period of ten years, from the early 70s to the early 80s.

Indicators that have been included in the study relate to measures of economic potential and achieved levels of income and wealth; mechanization and modernization of the rural sector, especially agriculture; housing standards and access to basic residential services; development of transport and communications; and availability of health and educational facilities. The individual indicators chosen are described below. Sources of data for the different indicators are described in Appendix (Table A-1).

Income and Wealth

Various indicators have been used for deriving the income and wealth position of a district. These indicators correspond to the traditional measures of the level of development. For the rural economy, *agricultural value added per capita (AGVAD)* is the basic indicator. It includes value added in major and minor crops, fishing and forestry. The method of computing the value added is, more or less, the same as adopted in national income accounts. Another important indicator of income and wealth in rural areas is *live-stock per capita (LSTOCK)*. Different types of livestock have been aggregated by assigning weights. The *extent of commercialization of agriculture (CCROPS)* has also been used as a proxy for the relative modernization and prosperity of a rural area. It represents the proportion of total cropped area being used for the cultivation of cash crops like cotton, sugar-cane, rice, etc.

For the urban component of a district, *per capita manufacturing value added (MVAD)* has been used as an indicator of income levels. Due to the paucity of data, only value added in the large-scale industrial sector has been considered. Therefore, this measure may create distortions in the case of districts which have a relatively high presence of small-scale establishments.

An overall measure, albeit crude, of wealth levels included in the study is the *number of bank branches per 10,000 persons (Banks)*. The assumption is that there is a direct correlation between the number of branches and the volume of bank deposits in a district. This assumption may at least partially be violated in the case of districts which are geographically large and access to banking services for the dispersed population may imply, other things being equal, a bigger network of branches.

Modernization of Agriculture

There is some debate as to whether mechanization of agriculture confers net social benefits. On the one hand, it contributes to higher yields and greater farm income leading to a rise in the standard of living while, on the other hand, there is evidence that the use of tractors and other farm implements had led to tenant evictions, labour displacement and more skewed distribution of land holdings. However, an indicator of the extent of mechanization of agriculture in the form of

tractors per 1000 acres of cropped area (TRACT) has been used in this paper to capture the process of modernization in the countryside. In addition, the extent of use of fertilizer, measured as *consumption of fertilizer as proportion of cropped area (FERT)*, and access to canal irrigation systems and tube-wells, in terms of *irrigated area as proportion of cropped area (IRRI)*, have also been used as indicators of modernization in farming practices.

Housing Conditions

Improvement in housing conditions is one of the important consequences of socio-economic development. Possible indicators in this sector include the proportion of households without homes, the proportion in 'Pucca' dwellings, access to toilets by type, water connections, electricity and gas, etc. Again availability of data has restricted the choice to three indicators, viz, proportion of households using electricity (ELECT), gas (GAS) and with inside water connection (WATER)

Communications

Number of *Radio sets (RADIO) per 1000 population, Television sets (TV) and number of Post offices (POST) per 100,000 population* have been taken as indicators of the access to media and development of communication facilities. Data on number of residential telephone connections (TELEP) were not directly available, hence these have been estimated in a manner described in the Appendix (Table A-4).

Development of the transportation network of a district has been seen in terms of *metalled road mileage (MROAD) and unmetalled road mileage (UMROAD) per 100 square miles of geographical area*. With regard to the availability of transport vehicles, the use of a summary measure, viz., passenger load carrying capacity per capita, was first suggested by Pasha and Hasan (1984). The same approach, with some modification, has been used in this paper. The aggregate measure has been broken up into two indicators primarily to indicate availability of transport for lower and upper income groups in a district. For the former, by using appropriate weights, the number of *scooters, motorcycles, taxis, autorickshaws and buses per 1000 urban population (PASSEN)* has been determined. For the latter, the measure is *cars, jeeps and station wagons per 1000 urban population (CARS)*.

Health

A number of indicators of health conditions are discussed in the literature. However, district-wise statistics on indicators such as life expectancy at birth, infant mortality rate, maternal mortality rate, etc. are currently not available. Hence, indicators of inputs rather than outputs of health services were used to explain the development in this sector. These are, first, the *number of beds in hospitals, dispensaries and rural health centres (BEDS)* and, second, the number of *doctors per 10,000 population (DOCTORS)*.

Education

One of the basic indicators of development is the literacy rate. However, this indicator could not be included in the analysis because of the difference in the definition of literacy in the population censuses of 1972 and 1981. Therefore, instead of a stock measure of the development of the education sector, indicators of flow of output were used. Gross *enrollment* as proportion of population in the relevant age group are defined for *primary* (PENR), *middle level* (MENR), *higher secondary* (HENR) and *intermediate and degree college* level (IDENR).

Further *Teacher-school* and *Teacher-student* ratios have been included to depict the quality of education. In both types of ratios, three levels viz., Primary (PTSC and PTST), Secondary and Matric (HTSC and HTST) and Inter Degree (IDTSC and IDTST) have been considered.

Altogether, the total number of indicators included in the study is 31. There are five indicators of income and wealth, three of modernization of agriculture, three of housing conditions, eight of transport and communications, two of health and ten of education.[3]

III. METHODOLOGY FOR RANKING DISTRICTS

The simplest numerical procedure in establishing ranks of districts is the summation across indicators of standardized scores in each indicator. This technique is referred to as the *Z*-sum technique, and is described as follows:

$$(Z\text{-sum})_j = \sum_{i=1}^{n} \left[\frac{X_{ij} - \bar{X}_i}{S_i} \right] \qquad \cdots \qquad \cdots \qquad (1)$$

where

n = Number of indicators;
$\bar{X}_i$ = Mean value of *i*th indicator;
S_i = Standard deviation of *i*th indicator; and
X_{ij} = Value of *i*th indicator in *j*th district.

The higher the *Z*-sum for a particular district the more developed it is in relation to other districts. The basic problem with this technique is that it assigns equal weights to all indicators.

[3] An exercise to verify the sensitivity of ranks to the number of indicators in each sector yielded almost similar rank ordering. We ranked districts after standardizing for the number of indicators using *Z*-score in each sector (for instance, *Z*-sum in income and welath divided by 5 plus *Z*-sum in Housing divided by 3 and so on). The rank correlation coefficient in overall *Z*-sum (standardized for number of indicators by sector) and overall *Z*-sum (without standardizing sectors) was 0.97 for the year 1980-81, while it was 0.92 for 1971-72.

The concept of *Taxonomic distance* is also used for the purpose of ranking of countries or territorial units on the basis of selected indicators. This procedure establishes the difference between an 'ideal' unit and the observed unit. For our purpose, an 'ideal' district is one which has 'best' value for a particular indicator. After standardizing indicators, taxonomic distance is obtained using the following formula:

$$(TD)_j = [\sum_{i=1}^{n} (Z_{ij} - \widetilde{Z}_i)^2]^{1/2} \quad \ldots \quad \ldots \quad (2)$$

where

Z_{ij} = Standardized value of ith indicator in jth district; and

$\widetilde{Z}_i$ = Highest standardized value of ith indicator among all districts.

The most developed district is one which has the minimum taxonomic distance. This technique also attaches equal weights to all indicators. In addition, the contribution to *TD* by a particular indicator can be increased if its maximum value, $\widetilde{Z}_{ij}$, is very large in relation to the values for other districts. Therefore, this technique is sensitive to the presence of outliers.[4] In fact, in the context of Sind, Karachi district has very large magnitudes for some indicators in relation to other districts. Therefore, this district has been dropped from the analysis in order to avoid biases in the derivation of taxonomic distances.

Another common and popular multivariate method for indexing level of socio-economic development is the technique of factor analysis.[5] This technique proceeds by clustering indicators which are correlated most into factors such that the latter is a linear combination of the former. In addition, it attempts to create factors which have minimum correlation among each other. Weights are assigned to each factor on the basis of eigen values, and in this manner the overall factor score for a district is computed.

Helbock and Naqavi (1976) and Pasha and Hasan (1984) have both used the Z-sum technique and factor analysis for ranking districts. Khan and Iqbal (1982) have, however, relied on the approach of taxonomic distances. In this study, the relatively simple techniques of Z-sum and taxonomic distances have both been used. The two procedures lead to almost identical ranks for the different districts in both time periods, thereby demonstrating the robustness of the results.

Due to the nature of the data set, factor analysis could not be used for ranking the districts. Bum (1982) has shown that spurious results may be obtained if the number of indicators is equal to or greater than the number of spatial units in the

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[4] The technique of Z-sum is also sensitive (although less as compared with taxonomic distance) in case of outlier which effects the magnitude of the mean and standard deviation.

[5] For detailed discussion, [see Adelman and Morris (1972)].

analysis. The reason for this is fairly obvious. If there are more variables than observations, the relevant co-variance matrix will be singular and its inverse will not exist. Zerby and Khan (1984) have provided an empirical illustration of this problem. In this study, with 31 indicators and ten districts only, the factor analysis technique could not, therefore, be applied.

IV. EMPIRICAL FINDINGS

Table 1 gives the magnitude of the Z-sum and Taxonomic distance in 1971-72 and 1980-81 for the ten districts of Sind included in the study. There appears to be considerable stability in the rankings of the most and least developed districts. Hyderabad, Sukkur and Khairpur have remained the three top districts of Sind (excluding Karachi) while Jacobabad and Thatta continue to be the most backward districts. There has been some change in ranking only among the intermediate districts. Larkana has demonstrated the greatest improvement followed by Dadu. On the other hand, Tharparkar has slipped considerably in its rank. Nawabshah and Sanghar have retained their relative position.

The robustness of the results is confirmed[6] by the fact that the correlation in ranks according to the two techniques is very high in both years. In 1971-72 the rank correlation coefficient was 0.99 and in 1980-81, 0.96.

Table 1

Magnitude of Z-sum and Taxonomic Distances

Districts	1971-72				1980-81			
	Z-sum	Rank	Taxonomic Distances	Rank	Z-sum	Rank	Taxonomic Distance	Rank
Khairpur	2.19	4	12.72	3	2.68	3	12.40	3
Jacobabad	−10.65	9	14.37	9	−16.77	10	15.13	9
Sukkur	10.72	2	10.89	2	15.06	2	10.74	2
Nawabshah	−7.78	7	13.70	7	−5.94	6	13.60	7
Larkana	−6.51	6	13.42	6	−1.56	5	12.73	4
Sanghar	−4.21	5	13.26	5	−0.04	4	13.00	5
Tharparkar	3.35	3	13.12	4	−9.05	8	14.14	8
Dadu	−8.30	8	13.79	8	−6.54	7	13.50	6
Hyderabad	35.23	1	8.08	1	34.68	1	8.11	1
Thatta	−14.04	10	15.15	10	−12.60	9	15.30	10

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[6] Because of this robustness, we will present the remaining results based on taxonomic distance technique.

Another important conclusion from Table 1 is that despite the various policy measures adopted, as mentioned earlier, regional disparities in the province of Sind have not tended to decline in the 70s. The evidence, at best, is ambiguous with respect to the change in the gap between the most and least developed districts. This is revealed by examining the change in taxonomic distances for each district over the period. Taxonomic distances have increased (implying reduction in the gap) somewhat for the two most developed districts, Hyderabad and Sukkur. However, they have increased significantly (implying increase in gap) for the two most backward districts, Thatta and Jacobabad. It is clear that a significant breakthrough has not yet been achieved in bringing the various districts of Sind closer to each other in terms of the level of development.[7]

To answer the question of regional disparities, explicitly, it is hypothesized that change in Z-score in each district for each variable is a function of base year's magnitude of Z-score. Using this regression specification,[8] 31 coefficients are estimated. The sign, magnitude and level of significance of β's are used to explain the changes in regional disparities over the time.

The important conclusions from this exercise are, first, all publicly provided municipal services — electricity, water and gas — have shown increase in disparity between most privileged and less privileged districts of Sind. This assertion is obtained from positive and significant coefficients (see Appendix, Table A-5). Second, inverse and significant coefficient of unmetalled road indicates that disparity has decreased in this development activity. Third, all negative coefficients in education has confirmed a general success of Government in terms of decreasing disparity among districts of Sind especially in primary education. Fourth, disparity among districts in modernization and mechanization of agriculture has, by and large, not altered. Fifth, it seems that disparities have decreased, to some extent, in per capita physicians availability. Finally, there appears no change in disparity in manufacturing value added. Thus it implies that fiscal and monetary incentives have not worked, properly, to decrease regional disparity in industrial investment.

Table 2 presents the sectoral ranks of each district in the two periods, it is possible from this table to determine the reasons for an apparent decline or improvement in a district's position. For example, the significant improvement in Larkana's

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[7]For the year 1971-72 the gap, according to mean taxonomic distances, between most and less developed districts emerges as 5.28 and for 1980-81 it comes to 5.75.

[8]The following specification is used:

$$\Delta Z_{ij} = \alpha + \beta Z_{ij}$$

where Z_{ij} is Z-score (with two periods being merged into one common data set) of district i for indicator j. Positive β implies that regional disparity has increased, negative β indicates reduced disparity and insignificant refers to the situation where no change in disparity among districts has observed.

Table 2

Overall and Sectoral Rank Ordering by Districts
(According to Taxonomic Distance)

Districts	Overall		Income and Wealth		Modernization of Agriculture		Housing Conditions		Communications		Health		Education	
	71-72	80-81	71-72	80-81	71-72	80-81	71-72	80-81	71-72	80-81	71-72	80-81	71-72	80-81
Khairpur	3	3	8	6	5	1	7	3	9	6	4	5	1	4
Jacobabad	9	9	9	10	10	9	5	8	7	9	7	9	9	9
Sukkur	2	2	3	2	7	6	2	2	2	2	3	6	3	1
Nawabshah	7	7	10	7	3	4	9	4	5	8	10	10	5	7
Larkana	6	4	3	3	9	5	4	6	3	3	9	2	6	6
Sanghar	5	5	1	1	4	2	3	5	6	5	8	7	7	8
Tharparkar	4	4	8	8	1	10	6	9	4	4	5	8	8	5
Dadu	8	8	9	9	8	8	8	7	8	7	2	3	4	3
Hyderabad	1	1	2	4	2	3	1	1	1	1	1	1	2	2
Thatta	10	10	4	5	6	7	10	10	10	10	6	4	10	10
	0.85*		0.29*		0.26*		0.59*		0.85*		0.53*		0.83*	

Note: *These figures are rank correlation coefficients between two rank ordering in 71-72 and in 80-81.

status during the 70s can be attributed to a dramatic improvement (seventh to third) in the productivity of the district due partly to the rapid pace of mechanization and modernization of its agriculture (ninth to fifth). Simultaneously, there has been considerable expansion in social infrastructure, especially health (ninth to second).

The major deterioration in Tharparkar's position is due, first, to relatively slow growth in income and wealth (fifth to eighth) probably caused largely by the complete reversal (first to tenth) of the position of the district with respect to the use of agricultural inputs.[9] In addition, Tharparkar has witnessed a worsening of its rank in housing conditions (sixth to ninth) and health services (first to eighth).

Table 3 provides average sectoral growth rates for each district. An examination of data reveals that high growth in Dadu and Thatta is, mainly, because of substantive increase in per capita manufacturing value added. Significant improvement in Larkana's position in modernization and mechanization of agriculture and in health is the result of highest growth rates in both sectors. However, the district of Larkana has shown a decline in transport and communications facilities. In District Sukkur high growth in housing conditions and manufacturing value added per capita compensates for a significant decline in the sector of communications and health. High growth rate in Khairpur district (second highest) is due, first, to major improvement in road facilities (especially in unmetalled roads) and relatively greater improvement in housing conditions. The district of Nawabshah, Sanghar and Hyderabad have shown a moderate growth in virtually all sectors, while Tharparkar and Jacobabad have remained at the bottom in most development activities.

It is also possible from Table 3 to get an indication of which sector demands priority in future development allocations. All indicators of education have shown negative or relatively negligible growth in each district of Sind. In health, the situation is perhaps, even worse. All districts have shown significant declines in the availability of doctors with the exception of Larkana. Transport and road facilities also have shown retardation with a few exception. It is clear that development activities have not kept pace, by and large, with the growth of population.

Table 4 gives the rank correlation coefficients between sectoral ranks of the districts and the overall ranking for the two periods. A key conclusion is the relatively low correlation between income and wealth rankings and the overall status in terms of the level of development. This is consistent with the results of other studies [see Pasha and Hasan (1984)] and indicates that the use of per capita income only can distort the picture of development significantly. The highest correlation with the

[9] The coverage of cropped area for district Tharparkar in two censuses (1972 and 1981) is not the same. The latter was extended to some parts of Tharparkars (sub-division Mithi) which could not be covered in 1972 census. This extended area, largely, consists of unirrigated cropped area. Due to this extension, Tharparkar has shown a significant decline in the extent of irrigated area.

Table 3

Average Sectoral Growth Rates by Districts

(Percent)

Districts	Overall	Income and Wealth*	Modernization of Agriculture	Housing Condition	Communication**	Health	Education
Khairpur	4.2	0.0	13.6	15.8	6.2	-0.9	-0.4
Jacobabad	1.5	-3.8	21.2	9.9	-3.3	-4.6	0.3
Sukkur	2.9	5.5	6.2	18.7	-3.8	-4.5	2.0
Nawabshah	2.7	3.5	11.0	17.5	-5.2	-0.1	1.3
Larkana	3.9	1.6	22.0	13.7	-6.2	16.8	1.1
Sanghar	2.1	1.5	11.8	9.7	-2.4	-1.1	1.1
Tharparkar	1.6	1.1	-2.9	7.0	3.2	-3.9	1.6
Dadu	5.2	6.6	15.5	13.9	4.3	-2.2	0.8
Hyderabad	2.8	1.9	5.7	13.6	1.9	-0.2	0.4
Thatta	3.7	8.0	9.3	11.1	-1.5	1.5	1.6

Notes: *Agricultural and Manufacturing value added are in constant prices.
       **Excluded TV – Because of low or zero base in most of the districts.

Table 4

*Rank Correlation Coefficients between Overall
and Sectoral Ranks*

Sectors	1971-72	1980-81
Income and Wealth	0.32	0.58
Modernization of Agriculture	0.50	0.64
Housing Conditions	0.71	0.90
Communications	0.67	0.83
Health	0.48	0.50
Education	0.72	0.79

overall ranking is that of the housing, education and transport and communications indications. Therefore, the profile of backwardness in Sind appears to consist of a poor quality of housing, limited access to municipal services (water supply, gas, electricity) and restricted availability of health, educational and transport (roads) facilities.

V. CONCLUSIONS

The principal conclusion of the study is that despite the regional development policies pursued in the province of Sind during the 70s little success has been achieved in narrowing regional disparities among districts. This indicates that there is need for a fundamental re-evaluation of the nature, scope and content of these policies. Results of the study also indicate the priority sectors on which resources may have to be concentrated in future if the backward areas within the province are to be brought closer to the developed districts.

Appendix Table A-1

Sources of Data for Development Indicators

Indicators		Sources	Nature of Data Manipulation
Income and Wealth			
1. AGVAD	1.	Development Statistics of Sind	For detailed discussion of estimation procedure and computational framework, see "Regional Accounts of Sind 1970-71 to 1979-80" by Nuzhat Ahmad and Haroon Jamal, Applied Economics Research Centre (Unpublished).
	2.	Markets and Prices	
	3.	District Census Reports, 1972 & 1981	
2. LSTOCK	1.	Pakistan Census of Agriculture (Province Reports), 1972 and 1980	This indicator is constructed using the method adopted in Pasha and Hasan (1982). The weights assigned to each category of livestock are as follows:
	2.	Development Statistics of Sind	
	3.	District Census Reports 1972 & 1981	Buffalo Cow & Camel 1.0 Cattle 0.8 Goats and Sheep 0.1 Poultry 0.01
3. CCROP	1.	Pakistan Census of Agriculture (Province Reports)	Rice, Sugar-cane, Cotton Rapeseed & Mustard and Tobacco are considered as cash crops.
	2.	Development Statistics of Sind	
4. MVAD	1.	Census of Manufacturing Industries	District-wise manufacturing value added is obtained directly from the appropriate census of manufacturing Industries.
	2.	District Census Reports 1972 & 1981	
5. BANKS	1.	Banking Statistics of Pakistan 1971-72 and 1980-81	Directly available.
	2.	District Census Reports 1972 & 1981	

Continued –

Appendix Table A-1 – (Continued)

Indicators	Sources	Nature of Data Manipulation
Modernization of Agriculture		
6. IRRI	1. Development Statistics of Sind	Directly available.
7. FERT		
8. TRACT	2. Pakistan Census of Agriculture (Province Reports)	
Housing Conditions		
9. ELECT	1. Pasha and Hasan (1984)	Direct district-wise data on these indicators are available for the year 1980-81 in district-wise Housing Census reports but an estimate was needed for the year 1971-72. Fortunately Pasha and Hasan (1984) estimated using Population Census figures of 1971-72 and Housing, Economic and Demographic Survey, 1973. For detail see Pasha and Hasan (1984, p. 186).
10. WATER	2. District-wise Housing Census Reports (1981)	
11. GAS		
Communications		
12. RADIO	1. Development Statistics of Sind	Directly available.
13. TV	2. District-wise Census Reports	
14. POST		
15. TELEP	1. Pasha and Hasan (1984)	The direct data on number of residential telephone connections were not available, hence an estimate was needed. For the year 1971-72 the related figure were obtained from Pasha and Hasan (1984, p. 190). District-wise Census reports of 1981 provide the total number of telephone connections including manufacturing concerns,
	2. District-wise Census Reports, 1972 and 1981	

Appendix Table A-1 – (Continued)

		therefore, to avoid double counting, these figures were adjusted by allowing 5 to 10 percent deduction, keeping manufacturing value added of districts in view.
16. MROAD	1. District-wise Census Reports, 1972 and 1981	Directly available.
17. UMROAD		
18. PASSEN	1. Development Statistics of Sind	Directly available.
19. CARS	2. District-wise Census Reports	
Health		
20. BEDS	1. Development Statistics of Sind	Directly available.
	2. District-wise Census Reports	
21. DOCTORS	1. Pasha and Hasan (1984)	No published data on number of doctors are available. For the year 1971-72 number of doctors per 10,000 of population was obtained from Pasha and Hasan (1984). District-wise number of doctors for the year 1982 are available in an unpublished paper by N. A. Abbasi "An Analytical Evaluation of Personal Health Care Services, Organization and Management: Sind Regional Plan Organization". Karachi, 1983.
	2. District-wise Census Reports	
Education		
22. PENR	1. Development Statistics of Sind	All data are obtained directly. Enrollment ratio are calculated as percentage of the following age groups:
23. MENR		
24. HENR		
25. IDENR	2. District-wise Census Reports	
26. PTSC		5–9 years for PENR
27. PTST		10–14 years for MENR
28. HTSC		15–19 years for HENR
29. HTST		20–24 years for IDENR
30. IDTSC		
31. IDTST		

Appendix Table A-2

Taxonomic Distance by Districts

		Khairpur	Jacobabad	Sukkur	Nawabshah	Larkana	Sanghar	Tharparkar	Dadu	Hyderabad	Thatta
Total	1971-72	12.72	14.37	10.89	13.70	13.42	13.26	13.12	13.79	8.08	15.15
	1980-81	12.40	15.13	10.74	13.60	12.73	13.00	14.14	13.50	8.11	15.30
Income and	1971-72	4.87	3.04	2.82	5.18	4.35	3.58	3.48	5.17	3.04	3.38
Wealth	1980-81	4.73	5.65	4.59	5.32	4.64	3.68	5.39	5.52	4.69	4.72
Modernization	1971-72	2.31	4.79	3.45	2.11	4.34	2.30	0.54	3.95	0.86	2.94
of Agriculture	1980-81	1.25	4.15	3.60	2.33	3.30	2.09	5.03	4.14	2.13	3.82
Housing	1971-72	5.38	5.28	3.23	5.60	5.12	4.16	5.28	5.56	0.0	6.15
Conditions	1980-81	4.57	5.02	2.05	4.58	4.70	4.59	5.40	4.99	0.47	5.84
Communi-	1971-72	7.62	7.56	5.30	7.10	6.30	7.50	6.90	7.50	3.90	8.30
cations	1980-81	6.80	7.70	5.00	7.30	6.50	6.76	6.70	7.20	2.10	8.60
Health	1971-72	3.98	4.24	3.75	4.71	4.70	4.48	4.14	3.27	0.0	4.23
	1980-81	4.08	4.53	4.26	4.55	2.98	4.46	4.48	3.54	0.0	3.57
Education	1971-72	5.48	8.34	6.78	7.22	7.36	8.02	8.23	6.97	6.33	8.81
	1980-81	6.86	8.45	5.85	7.58	7.35	7.97	7.12	6.70	5.88	8.59

Appendix Table A-3

Z-sum Score by Districts

		Khairpur	Jacobabad	Sukkur	Nawabshah	Larkana	Sanghar	Tharparkar	Dadu	Hyderabad	Thatta
Total	1971-72	2.19	−10.65	10.72	−7.78	−6.51	−4.21	3.35	−8.30	35.23	−14.04
	1980-81	2.68	−16.77	15.06	−5.94	−1.56	0.04	−9.05	−6.54	34.68	−12.60
Income and	1971-72	−1.12	3.11	1.71	−3.38	−1.69	0.74	1.95	−2.92	2.42	−0.83
Wealth	1980-81	0.04	−2.26	1.53	−1.78	−0.17	3.07	−0.66	−1.26	0.79	0.69
Modernization	1971-72	1.15	−4.28	−1.49	1.44	−3.12	1.44	3.76	−2.34	3.21	0.25
of Agriculture	1980-81	3.48	−2.26	−0.47	2.40	−0.79	2.34	−3.47	−1.88	−1.62	−0.96
Housing	1971-72	−1.42	−1.23	2.35	−1.79	−0.95	0.84	−1.22	−1.73	7.90	−2.75
Conditions	1980-81	−0.70	−1.47	4.40	−0.74	−0.86	−0.77	−2.18	−1.43	6.70	−2.94
Communica-	1971-72	−3.31	−2.4	5.6	−1.5	.6	−3.14	2.4	−3.1	11.0	−5.8
tions	1980-81	−1.2	−5.1	4.4	−1.9	.2	− .03	−.9	−2.3	13.7	−6.9
Health	1971-72	−0.32	−0.74	−0.01	−1.41	−1.32	−1.08	−0.52	9.88	5.25	−0.72
	1980-81	−0.62	−1.22	−0.89	−1.27	1.41	−1.17	−1.22	0.28	5.12	−0.42
Education	1971-72	7.21	−5.09	2.62	−1.09	−0.05	−2.81	−3.01	0.95	5.48	−4.22
	1980-81	1.72	−4.46	6.11	−2.66	−1.36	−3.45	−0.64	0.06	6.74	2.06

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Appendix Table A-4

Mean and Standard Deviation of Development Indicators

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	Indicators	1971-72	1980-81
I.	**Income and Wealth**		
1.	AGVAD	331.00	834.33
	(Agricultural Value Added in Constant Rupees per Rural Person)	(75.80)	(355.88)
2.	LSTOCK	0.50	0.43
	(Equivalent Number of Livestock per Rural Person)	(0.07)	(0.07)
3.	CCROP	35.87	42.20
	[Extent of Commercialization of Agriculture (Percent)]	(6.67)	(11.67)
4.	MVAD	230.68	1861.18
	(Manufacturing Value Added in Constant Rupees per Capita-Urban)	(107.31)	(2133.70)
5.	BANKS	3.11	5.77
	(Bank Branches per 100 Thousand of Population)	(0.68)	(0.96)
II.	**Modernization of Agriculture**		
6.	IRRI	84.26	83.06
	(Irrigated Area as a Percent of Cropped Area)	(15.04)	(18.25)
7.	FERT	0.01	0.02
	(Use of Fertilizer in Nutrient Tonnes per Acre of Cropped Area)	(0.01)	(0.01)
8.	TRACT	0.38	1.40
	(Tractors per 1000 Acre of Cropped Area)	(0.24)	(0.55)

Appendix Table A-4 – *(Continued)*

	Indicators	1971-72	1980-81
III.	**Housing Conditions**		
9.	ELECT	10.71	25.09
	(Percentage of Dwelling Units with Electricity)	(4.18)	(15.32)
10.	GAS	0.91	4.54
	(Percentage of Houses with Gas Connection)	(0.98)	(4.99)
11.	WATER	5.59	10.50
	(Percentage of Dwelling Units with Inside Water Connection)	(3.42)	(6.66)
IV.	**Communications**		
12.	RADIO	13.67	15.27
	(Radio Sets per Thousand Population)	(9.21)	(8.04)
13.	TV	6.20	303.15
	(Television Set per 100 Thousand Population)	(11.89)	(248.21)
14.	POST	7.26	6.09
	(Post Offices per 100 Thousand Population)	(5.41)	(3.94)
15.	TELEP	4.21	1.83
	(Residential Telephone Connection per 1000 Population)	(1.80)	(0.79)
16.	MROAD	3.20	6.64
	(Miles of Metalled Roads per 100 Sq. Mile of District Area)	(1.81)	(3.80)
17.	UMROAD	8.34	11.77
	(Miles of Unmetalled Roads per 100 Sq. Mile of District Area)	(7.10)	(4.69)
18.	PASSEN	30.64	24.71
	(Passenger Load Carrying Capacity per 1000 Urban Population)	(24.82)	(30.86)
19.	CARS	2.16	1.79
	(Cars and Jeeps per 1000 Urban Population)	(1.24)	(1.73)
V.	**Health**		
20.	BEDS	2.66	5.06
	(Hospital Beds per 10 Thousand Population)	(1.58)	(2.51)

Appendix Table A-4 — *(Continued)*

Indicators	1971-72	1980-81
21. DOCTORS	1.01	0.69
(Doctors per 10 Thousand Population)	(0.58)	(0.45)
VI. Education		
22. PENR	35.0	32.0
[Primary Enrollment Rate (Percent)]	(8.0)	(5.0)
23. MENR	2.0	2.0
[Middle Enrollment Rate (Percent)]	(1.0)	(1.0)
24. HENR	9.0	13.0
[Higher Secondary or Matric Enrollment Rate (Percent)]	(3.0)	(3.0)
25. IDENR	1.0	1.0
[Inter-degree Enrollment Rate (Percent)]	(0.1)	(1.0)
26. PTSC	2.31	2.59
(Primary Teacher-school Ratio)	(0.40)	(0.44)
27. PTST	0.04	0.04
(Primary Teacher-student Ratio)	(0.01)	(0.001)
28. HTSC	14.60	16.92
(Higher Secondary and Middle Teacher-school Ratio)	(1.45)	(1.64)
29. HTST	0.06	0.04
(Higher Secondary and Middle Teacher-student Ratio)	(0.03)	(0.01)
30. IDTSC	17.49	18.04
(Inter-degree Teacher-school Ratio)	(3.46)	(2.73)
31. IDTST	0.09	0.05
(Inter-degree Teacher-student Ratio)	(0.06)	(0.02)

Appendix Table A-5

*Results of Regression Analysis**

Indicators	β-Coefficient	t-Statistics
AGVAD	0.15	0.09
LSTOCK	−0.92	−2.86
CCROP	−0.68	−1.12
MVAD	7.06	1.09
BANKS	−0.72	−1.49
IRRI	−0.65	−1.58
FERT	0.23	0.85
TRACT	−0.59	−0.74
ELECT	1.92	2.46
WATER	0.88	4.93
GAS	3.90	7.75
RADIO	−0.46	−1.89
TV	16.04	3.76
POST	−1.16	−4.63
TELEP	−0.62	−7.93
MROAD	0.43	0.79
UMROAD	−0.73	−3.43
PASSEN	−0.23	−0.67
CARS	−0.31	−0.73
BEDS	0.28	0.84
DOCTORS	−0.30	−2.58
PENR	−0.46	−2.88
MENR	−0.25	−0.82
HENR	−0.41	−1.57
IDENR	−0.34	−1.50
PTSC	−0.02	−0.08
PTST	−0.79	−4.64
MTSC	−0.56	−1.51
MTST	−0.94	−12.36
IDTSC	−0.69	−2.70
IDTST	−0.86	−11.75

Note: *Specification: $Z_{it+1} - Z_{it} = \alpha + \beta Z_{it}$ where; Z_{it} = Z-score of district i in period t.

Appendix Table A-6

*Magnitude of Development Indicators for Districts of Sind**

	Khairpur	Jacobabad	Sukkur	Nawabshah	Larkana	Sanghar	Tharparkar	Dadu	Hyderabad	Thatta
					1971-72					
AGVAD	342.870	459.850	383.630	220.020	326.650	321.400	422.220	209.040	340.570	283.770
LSTOCK	0.590	0.620	0.510	0.420	0.490	0.580	0.380	0.480	0.460	0.450
CCROP	21.910	37.260	34.080	33.940	41.370	35.320	41.020	28.610	38.140	47.080
MVAD	321.160	70.000	275.800	253.100	62.000	91.100	327.300	308.300	353.700	244.500
BANKS	2.250	3.810	3.540	2.580	2.600	3.900	3.540	2.610	4.030	2.200
IRRI	98.240	51 670	77.920	96.270	67.640	97.980	98.160	75.990	93.910	84.830
FERT	0.010	0.001	0.004	0.020	0.004	0.020	0.023	0.004	0.020	0.002
TRACT	0.490	0.130	0.320	0.310	0.070	0.240	0.640	0.140	0.770	0.680
ELECT	8.500	9.100	14.500	8.000	9.600	13.700	9.200	7.600	20.800	6.100
WATER	4.000	4.100	8.000	3.500	4.600	6.300	4.100	3.600	14.900	2.800
GAS	0.500	0.510	1.630	0.390	0.530	0.830	0.500	0.520	3.610	0.100
RADIO	16.001	9.200	16.964	6.998	12.052	5.560	33.744	7.766	25.645	2.761
TV	0.000	0.000	0.070	0.590	0.000	1.590	5.710	2.730	40.470	10.830
POST	8.080	2.120	21.810	5.980	6.510	9.380	2.850	8.440	2.930	4.540
TELEP	3.500	2.500	7.500	3.300	4.000	2.800	3.700	5.500	7.200	2.100
MROAD	1.620	3.080	2.310	3.430	3.900	4.690	0.900	1.980	7.590	2.470
UMROAD	0.640	5.120	10.970	17.630	15.000	2.440	0.500	8.850	20.700	1.490
PASSEN	5.350	23.650	48.450	19.300	39.740	17.480	86.790	3.800	52.140	9.750
CARS	2.370	3.740	2.900	1.420	1.990	0.740	3.980	0.350	3.260	0.810
BEDS	2.890	2.200	1.960	1.280	2.230	1.410	1.310	4.370	6.620	2.310
DOCTORS	0.740	0.750	1.260	0.700	0.400	0.840	1.200	0.890	2.590	0.720
PENR	40.000	31.000	49.000	27.000	40.000	37.000	23.000	40.000	36.000	24.000
MENR	4.000	2 000	2.000	2.000	2.000	1.000	2.000	1.000	3.000	1.000
HENR	11.000	7.000	4.000	8.000	10.000	13.000	9.000	8.000	14.000	3.000
IDENR	1.000	0.300	1.000	1.000	0.200	1.000	1.000	1.000	2.000	0.100
PTSC	2.650	2.130	2.560	2.570	2.160	2.120	1.600	2.440	3.020	1.840
PTST	0.050	0.030	0.030	0.040	0.040	0.040	0.060	0.040	0.040	0.050
HISC	18.290	13.930	15.160	15.790	14.590	13.790	13.370	14.250	13.430	13.360
HTST	0.050	0.060	0.140	0.050	0.040	0.050	0.050	0.050	0.050	0.090
IDTSC	14.800	13.330	18.000	17.000	17.330	13.250	17.600	24.670	22.400	16.500
IDTST	0.050	0.080	0.080	0.040	0.220	0,040	0.060	0.070	0.060	0.220

Continued –

Appendix Table A-6 – *(Continued)*

					1980-81					
AGVAD	994.120	1119.270	425.070	741.460	856.490	1701.980	782.710	530.760	699.790	491.670
LSTOCK	0.520	0.420	0.430	0.360	0.420	0.480	0.570	0.350	0.370	0.420
CCROP	27.700	44.660	62.210	39.240	50.580	40.480	18.000	43.450	50.400	45.240
MVAD	339.900	52.300	2041.800	1125.900	142.600	195.800	1335.800	5637.100	1521.300	6219.100
BANKS	6.010	3.660	6.620	5.990	5.780	6.620	5.590	4.830	7.200	5.350
IRRI	99.080	68.790	84.830	99.060	77.070	99.910	39.090	73.690	96.160	92.930
FERT	0.030	0.010	0.002	0.040	0.020	0.040	0.030	0.020	0.030	0.010
TRACT	2.600	1.050	2.000	1.320	1.340	1.470	0.680	0.690	1.640	1.250
ELECT	23.000	20.450	57.220	20.680	24.930	18.990	11.270	18.620	50.040	5.670
WATER	9.300	7.070	16.120	10.390	7.280	9.450	6.260	6.350	28.260	4.470
GAS	2.610	1.270	11.810	2.360	2.700	3.480	1.320	2.620	16.520	0.730
RADIO	14.165	10.726	29.200	6.175	11.264	17.796	18.031	6.896	29.656	8.787
TV	115.270	146.440	497.730	203.600	297.200	285.140	202.600	202.040	973.650	107.760
POST	2.240	1.380	1.220	3.540	11.310	9.110	10.320	11.520	3.990	6.290
TELEP	1.540	1.280	2.840	1.470	1.960	1.620	1.570	1.440	3.720	0.890
MROAD	10.290	4.050	4.870	10.910	8.580	5.690	1.270	3.170	13.730	3.900
UMROAD	14.130	7.490	16.200	16.680	12.830	17.800	8.380	8.590	13.390	2.240
PASSEN	7.150	13.920	42.960	5.770	3.440	0.830	47.110	20.640	104.140	1.160
CARS	1.980	1.690	3.090	0.400	0.400	0.120	1.510	1.750	6.270	0.660
BEDS	4.260	3.820	2.470	3.640	8.510	3.390	2.860	6.210	10.660	4.810
DOCTORS	0.560	0.370	0.760	0.380	0.710	0.470	0.540	0.610	1.980	0.550
PENR	37.000	20.000	39.000	30.000	35.000	34.000	28.000	34.000	36.000	26.000
MENR	5.000	2.000	2.000	3.000	2.000	2.000	3.000	3.000	2.000	1.000
HENR	13.000	9.000	16.000	12.000	15.000	15.000	12.000	11.000	18.000	7.000
IDENR	1.000	1.000	2.000	1.000	1.000	1.000	1.000	1.000	2.000	0.300
PTSC	2.460	2.300	3.020	2.770	2.560	2.370	2.040	2.730	3.590	2.100
PTST	0.040	0.040	0.030	0.030	0.040	0.040	0.040	0.040	0.030	0.040
HTSC	18.400	17.440	19.370	16.660	16.590	14.790	17.000	16.000	19.010	14.000
HTST	0.040	0.050	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.060
IDTSC	14.670	14.600	23.800	18.750	15.800	17.000	21.000	17.670	19.600	17.500
IDTST	0.040	0.070	0.040	0.040	0.050	0.050	0.050	0.070	0.040	0.090

Note: *Excluding Karachi.

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