Area-Distance, Contact Technology and Administrative Intensity in Societies*

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ABSTRACT

This paper examines the relationship between the areal expanse of societies, the development of their communication and transportation technologies and the relative size of their governments. Hypotheses derived from Hawley and from Mayhew and Levinger's (a) "Density of Interaction" model are tested with cross-sectional data on 70 nations. As predicted, the availability and development of communication and transportation technology is shown to have a positive effect on the relative size of government, independent of population size and population concentration. Areal expanse, however, is found to be negatively related with the relative size of government in nations with small populations and positively related in nations with large populations and does not confirm the prediction of a monotonic inverse relationship between area-distance and administrative intensity. System constraints and biological limitations of the human organism are offered as possible explanations of this finding.

Sociologists and ecologists have long discussed the important effects social density is presumed to have on major dimensions of social organization (cf. Durkheim; Hawley) and recently a theoretical paper by Mayhew and Levinger (a) implied that a social system's conduciveness to interaction might be estimated on the basis of three structural parameters: population size, the average distance between people, and the technology available for overcoming distance. This suggests that investigators wishing to determine the effects of social density (or "interaction density", as Mayhew and Levinger term it) on social organization might employ these structural parameters to estimate the level of social activity and then use this estimate to assess the impact of social density on selected features of social organization.

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Early indications of the utility of this approach are found in Mayhew and Levinger's (a) exploration of the implications of population size on crime rates, and Nolan's (b) examination of the effects of population size and concentration on administrative intensity in 70 nations. This paper will extend evaluation of the "structural conduciveness" approach, and its utility in explicating this aspect of organizational structure, by examining the effects of area-distance and contact technology on the relative size of governments. These two system parameters are presumed to have effects on social density which will be reflected in the relative size of the subsystems charged with monitoring and regulating system activity (i.e. governments). Hawley provides the most explicit formulation of the effects these system parameters can be expected to have on social interaction.

First noting the dampening effect distance has on contact and interaction he comments, "Human relationships, occurring as they do in a physical universe, involve the overcoming of a number of resistances which are generalized in the phrase *friction of space*" (237). Indeed, general systems theorists have argued that the effects of physical space and distance are so pervasive that they are not limited to human societies and human interaction. They act as constraints on the operation of all systems living and nonliving (Miller). Empirically, distance has been shown to have a negative effect on the level of traffic and communication between population centers (Carrothers; Olsson; Zipf) and distance has also been implicated in explanations of the rate of contact between population elements within population centers.[1] This "drag" effect of distance on interaction should reduce the volume of interaction and could consequently reduce problems of regulation and coordination for the administrative subsystem.

Second, noting the important part technology plays in mediating the effect of distance, Hawley argues that the effect of distance is contingent on the development of technology:

> That is to say, the resistances to contact are directly experienced, not in terms of linear distance, or physical obstruction, but in units of time and energy or cost involved in moving from place to place. . . . Distance, so far as it enters into human relationships, is thus *entirely relative to the available techniques for overcoming the friction of space* (237; emphasis added).

Technology's mediating effect on the drag of distance has been noted by a number of researchers (Svalastoga).

By assuming that increased interaction poses greater, and decreased interaction lesser problems of coordination and regulation for the administrative subsystem of a society we can derive the following hypotheses:

1. The greater the *average distance* between population elements the *lower* the administrative intensity of a nation.
2. The greater the development and availability of *contact technology* the *higher* the administrative intensity of a nation.

Of the two parameters, distance is anticipated to have a more complex effect on administrative intensity and should pose greater problems of interpretation and evaluation. Theoretical and interpretive complications result from the fact that although distance might reduce interaction it also increases problems of communication and coordination. Therefore its effects on administrative intensity could be counteracting, and might in some measure cancel each other out. Noell (a) attempted to distinguish between these two effects of area by comparing the effects of area on the proportionate *size* of government with the effects of area on the *complexity* of state government bureaucracies. He reasoned that duplication of services over a larger area would produce larger governments, but that those governments would be less complex. Although the coefficients are modest, his data support this contention. Area of the state is not only positively correlated with the relative size of the state governments ($r = .28$), but it is also negatively correlated with the complexity of state governments ($r = -13$).[2]

Distance is also a more complex consideration because the degree of its effect on contact and interaction is not immediately apparent, either in the literature or a priori. For while it can be shown that the average distance between random pairs of elements is a function of the root of the area over which they are assumed to be evenly distributed (Beckman), researchers dealing with the effects of distance on the interaction between population groupings have often found the effects of distance to be exponential and many have noted that the impact of distance does not appear to be uniform over a large range of the variable (Carroll; Ikle; Price; all cited in Carrothers).

Data and Methods

The measure of administrative intensity to be used in this study is the percent of total population employed in government. This figure is analogous to the administrative ratio that has been used as an index of administrative intensity in organization research.[3] There has been disagreement as to whether government employment or the percent of the labor force employed in administrative positions provides the more accurate assessment of administration at the societal level (Kasarda, b; Noell, b) but other research (Nolan, b) has shown that differences in disputants' findings (Kasarda, a; Noell, a) are not merely a result of their having used different indicators, and it can be argued that government employment is at least one reasonable indicator of the size of the administrative component of a nation (Lenski and Lenski). Cross-sectional data on government were obtained from secondary sources for 70 nations.[4] The major limitation of the data set is the exclusion of most communist or socialist nations. This is a result of the fact that government employment is not comparably reported for these nations in secondary sources. The lack of probability sampling and exclusion of communist and (many) socialist nations do not necessarily invalidate the inferences drawn from the data but they do limit the generalizability of the findings.

Information on the total energy consumed in kilograms coal equivalent (United Nations, Table 137) was collected in order to provide a method of controlling for general technological development, and data on three area-based measures were used to index area-distance: total area, area regressed on population, and "avdist" a mathematically generated prediction of the average distance between people, under some simplifying assumptions. The formula used to compute avdist is a constant, .52, times the square root of the area of the system. Under the assumption that people are uniformly distributed over the areal expanse of the society, this formula will generate the *average distance between random pairs in the system.* It can be mathematically demonstrated with this formula that if one holds physical density constant (as indexed by the population/area ratio) and increases the area over which elements are assumed to be evenly distributed, *the average distance between random pairs will increase at a decreasing rate.*[5] There are other *empirically based* formulas for predicting average distances between neighbors, etc. (Duncan), but this appears to be the only a priori prediction of the average distance between *all* possible pairs. The details of the derivation of this formula—it is based on the Pythagorean theorem—need not concern us here, but the theoretic interpretation of this number should, because this transformation provides us with an a priori prediction of the average distance between people in societies of differing area. Since area should be positively related to average distance, and its effects according to this mathematical model should be at least partially independent of population concentration, we would expect that area, or some function of it, would be negatively related with administrative intensity (ceteris paribus), even after population size and population concentration are controlled.

As an empirical check on the adequacy of this a priori prediction and the other measures of area-distance, more direct measures of population concentration from Taylor and Hudson (Tables 4.1, and 4.2 respectively) will be introduced into the analysis: (1) urban, the percent of the population residing in cities of 100,000 or more and (2) "concent," an index of the relative concentration of population over the area of the country based on the proportion of the population living in cities. The index is higher the fewer the cities and the greater the size of the largest city, relative to the total population.[6]

The correlation between the indirect and direct measures of area-distance will be examined to evaluate the adequacy of the a priori predictions, and the correlations of the different sets of indicators with government employment will be compared to further evaluate the plausibility of the original hypothesis.

Finally, in order to test the second hypothesis that contact technology conditions the effects of distance on interaction and has a positive effect on administrative intensity, telephones per capita and motor vehicles per capita will be correlated with administrative intensity.[7] If we are correct in our theorizing, and our ceteris paribus assumptions are not seriously violated (a question we will consider further in the text), these measures should provide adequate, if crude, indications of a system's conduciveness to movement and interaction.

Findings

AREA-DISTANCE

Taking our hypotheses in the order of their original presentation, we first examine the effects of area-distance on administrative intensity. The zero-order associations between area, avdist, and the relative size of government, suggest that area and distance have a *positive* rather than the predicted *negative* effect on the relative level of government employment. The respective correlations are .31 and .17 (Table 1). However, there is at least one immediate problem in interpreting these coefficients—area and avdist are positively correlated with population (r = .36 and .40, respectively) and these correlations are even higher when population is expressed as a logarithm (r = .40, .55). It becomes necessary, therefore, to take out the effects of population as a first step in interpreting the relationship between area and administration. When this is done the sign and the magnitude of the coefficients are not substantially altered. This is not surprising since it has already been demonstrated that population is not monotonically associated with government in this sample of nations (Nolan, b) indicating that linear controls may not provide adequate adjustment for the effects of population, and suggesting that the relationship between area and government should be examined separately within the subsets of nations with small populations and nations with larger populations.[8]

It is interesting that when the data are dichotomized into small and large (population) nations, the correlations are *all negative* for small population nations and they are *all positive* for large population nations (Table 2).[9] This is true not only for area and avdist, but it is also true for the residual indicator of area which is presumably free of linear dependence on population. It is necessary to further adjust for the effects of population on the relationship between area-distance and administrative intensity because the shift in the direction of the relationship with increasing population size is similar to the shift in the direction of the relationship between size and administrative intensity reported previously (Nolan, b). Introducing controls for population when the data are dichotomized into small popula-

Table 1. ZERO-ORDER AND PARTIAL CORRELATIONS OF AREA-DISTANCE MEASURES WITH THE PERCENT EMPLOYED IN GOVERNMENT CONTROLLING FOR POPULATION SIZE AND TECHNOLOGY—LARGE AND SMALL NATIONS

Percent in Government with:	Area	Avdist	Area Regressed on Population
All Nations (N = 70)			
	.31 (.004)*	.17 (.08)	.29 (.008)
Controlling for:			
Population	.30 (.007)	.14 (.123)	
Log of population	.34 (.002)	.21 (.050)	
Small Population Nations (N = 34)†			
	-.38 (.010)	-.51 (.001)	-.35 (.021)
Controlling for:			
Population	-.27 (.060)	-.37 (.020)	
Log of population	-.28 (.060)	-.37 (.020)	
Technology	-.29 (.072)		
Large Population Nations (N = 36)			
	.50 (.001)	.46 (.003)	.46 (.002)
Controlling for:			
Population	.49 (.001)	.45 (.004)	
Log of Population	.46 (.003)	.41 (.010)	
Technology‡	.31 (.027)		

*Significance figures in parentheses.

†Population cutting point 5,750,000.

‡The measure of technology used as a control is the residual when total energy consumed in kilograms coal equivalent is regressed on population.

Table 2. PARTIAL CORRELATIONS OF AREA-DISTANCE (AVDIST) WITH THE PERCENT EMPLOYED IN GOVERNMENT CONTROLLING FOR POPULATION, RELATIVE POPULATION CONCENTRATION AND URBANIZATION—LARGE AND SMALL NATIONS

Controlling for:	Concent	Urban	Concent and Poplog	Urban and Poplog
All Nations				
Correlation	.41	.04	.32	.22
Degrees of freedom*	(55)	(61)	(54)	(60)
Significance	.001	.385	.008	.040
Small Population Nations†				
Correlation	-.52	-.497	-.496	-.29
Degrees of freedom*	(20)	(26)	(19)	(25)
Significance	.007	.004	.011	.068
Large Population Nations				
Correlation	.47	.34	.37	.35
Degrees of freedom*	(32)	(32)	(31)	(31)
Significance	.003	.025	.017	.022

*The degrees of freedom change with the introduction of different control variables because of different numbers of missing cases.

†Population cutting point 5,750,000.

tion and large population nations reduces the size of the coefficients for small population nations, but the reduction is not sufficient to discredit the pattern of relationship. Area and average distance continue to be negatively associated with administrative intensity in small population nations, while they are positively associated with it in large population nations. Introducing a residual indicator of the energy consumed in the system (similar to a per capita figure) as a means of controlling for technology only slightly reduces the associations. For small population nations, the correlation between area and government becomes −.29, while in large population nations it is .31. This suggests that technological development is also not wholly responsible for the pattern of association. The specification of the relationship is, therefore, not explained by either technology or population size. Even when population concentration is controlled, the partial associations between the area-distance measures and the percent employed in government remain negative for small population nations and positive for large population nations. This would force us to conclude that while area appears to be positively related to the relative size of government for all societies, the relationship is negative for small population societies and positive for large population societies. The pattern of relationship is outwardly similar to that between population size and administrative intensity reported elsewhere (Nolan, b), but it is *fully independent of the effects of population size,* and it is also not explained by population concentration or general technological development.

This pattern of relationship could be attributed, perhaps, to the countervailing effects that area-distance was expected to have on the relative size of administration, or it could be interpreted as a result of the fact that below a certain level of population size, area does have a negative effect on government due to its lessening the level of interaction in the system, but that, after a critical level of population size is reached, increasing area forces the system to elaborate its administrative and communication systems in order to maintain system integrity. The essence of such an interpretation is that above certain levels of population size, area cannot be allowed to lower the integration of the society. A complete interpretation of the apparent effects of area-distance should be postponed, however, until the relationship between these area-distance indicators and more direct measures of population concentration are considered further.

The intercorrelations between the three indicators of area-distance explain why the results are essentially the same regardless of which indicator of area-distance is employed in the analysis. They are highly correlated, the lowest correlation is between avdist and the residual indicator of area, and that correlation is .81. The highest is .93. This is not surprising, since all of these measures are ultimately derived from the total area of the country. The correlations increase slightly when the data are dichotomized on population size. Therefore, it is safe to conclude that the several indicators, regardless of the centrality of their theoretical interpretation, are empirically interchangeable. It has already been demonstrated that the area-distance measures are correlated with population size, but it remains to be seen whether and in what ways these measures might be related to more empirical indicators of population dispersal. Given the theoretical interpretation of the avdist measure, it might be expected to be uncorrelated or perhaps negatively correlated with empirical measures of population concentration. An examination of the actual associations between these measures indicates that this is not the case. Area-distance measures are sometimes negatively correlated with the index of relative population concentration (for all systems and for small systems), but even then the correlations are not large. For large societies, the correlations are positive (Table 3).

The correlations of the area-distance measures with urbanization are moderately positive for all societies but when the data are dichotomized, they become negative for small population societies and positive for large population societies. The fact that this pattern is evidenced by the residual indicator of area-distance indicates that this non-monotonic relationship is not due to mutual dependence on, or correlation with, population. The positive correlations of the area-distance measures with urbanization found in large societies are quite large and disturbing given the interpretation of them as measures of "average distance" between population elements. Elsewhere (Nolan, b) it is shown that these measures of population concentration are positively and monotonically related to the relative size of government.

This cannot be directly interpreted as a validity check on our operational indicators *since population dispersal and "average distance" are theoretically separable dimensions,* but the information provided should temper the

Table 3. CORRELATIONS OF AREA-DISTANCE MEASURES WITH URBANIZATION AND RELATIVE POPULATION CONCENTRATION—SMALL AND LARGE NATIONS

	N	Area	Avdist	Area Regressed on Population
All Nations				
Urban	64	.31 (.006)*	.24 (.03)	.28 (.01)
Concent	58	-.05 (.36)	-.14 (.15)	-.02 (.45)
Small Population Nations†				
Urban	29	-.21 (.14)	-.24 (.108)	-.21 (.13)
Concent	23	-.22 (.15)	-.35 (.05)	-.21 (.16)
Large Population Nations				
Urban	35	.40 (.009)	.33 (.03)	.39 (.01)
Concent	35	.19 (.14)	.18 (.15)	.27 (.06)

*Significance figures in parentheses.

†Population cutting point 5,750,000.

interpretation of analyses that employ the area-distance measures to detect systemic features inimical to interaction. But the specification of the relationship between area-distance measures and administrative ratio continues to hold when these empirical measures of concentration are introduced as controls.

CONTACT TECHNOLOGY

The correlations between measures of contact technology, their logarithmic transformations, and the relative size of government, provide support for the second hypothesis (Table 4).[10] All of the indicators are positively related to the percent employed in government (Table 5), and in some cases, logarithmic transformation increases the association. When the data are dichotomized on population, the associations all remain positive. This would suggest that contact technology, unlike population and area, has a consistently positive effect on the relative size of government, which is what the second hypothesis predicted. It maintained that contact technology promoted interaction and that this would be reflected in the relative size of the administrative component of the society. Increasing ease of movement and contact would theoretically give rise to greater levels of interaction and would consequently result in greater problems of regulation and coordination for the administrative subsystem. This contention is supported by the evidence, even when population size is controlled and the relationship is examined separately within the subsets of small and large nations.

Having noted elsewhere (Nolan a, b) in regard to the effects of

Table 4. CORRELATIONS OF INDICATORS OF CONTACT TECHNOLOGY WITH THE PERCENT EMPLOYED IN GOVERNMENT

Indicator of Contact Technology*	Percent in Government	N =
Telepop	.36 (.001)†	69
Mopop	.48 (.001)	70
Teleplog	.52 (.001)	69
Moplog	.56 (.001)	70

*Telepop = telephones per capita
Mopop = motor vehicles per capita
Teleplog, Moplog = Log 10 of Telepop and Mopop
†Significance figures are in parentheses.

population on government, that the relative level of population concentration has a significant effect on the presumed level of interaction, it would be prudent to introduce population concentration into the analysis before drawing final conclusions (Table 6). When the effects of population size and population concentration are taken out by means of partial correlations, the partial associations are all positive. Telephones and motor vehicles per capita, are positively correlated with administrative intensity when controls for population, population concentration, and *both* population and population concentration are introduced. The associations increase slightly when the measures of contact technology are expressed as logarithms and then correlated with the percent employed in government. This would indicate that contact technology has a consistently positive effect on government employment even when two other theoretically important variables are controlled. The fact that the associations increase somewhat when the measures are logarithmically transformed indicates that the relationships are in some measure curvilinear, but there is no evidence that they are not monotonic.

When the data are dichotomized by population size level and partial correlations are recomputed within the subsets of small and large nations (which is necessary because partial correlation will only adjust for the *linear* [monotonic] effects of the control variables, and size level has been shown to have a nonlinear and nonmonotonic effect on government employment) the associations continue to be positive and, in some cases, logarithmic transformations increase the magnitude of the coefficients (Table 7).

Table 5. CORRELATIONS OF INDICATORS OF CONTACT TECHNOLOGY WITH THE PERCENT EMPLOYED IN GOVERNMENT—LARGE AND SMALL NATIONS

	Percent in Government	
Indicator of Contact Technology	Small Population Nations*	Large Population Nations
Telepop	.17 (.163)†	.49 (.001)
Mopop	.42 (.006)‡	.54 (.001)
Teleplog	.51 (.001)	.53 (.001)
Moplog	.56 (.001)‡	.57 (.001)
	N = 34	N = 35

*Population cutting point 5,750,000.

†Significance figures in parentheses.

‡N = 35.

Table 6. PARTIAL CORRELATIONS OF INDICATORS OF CONTACT TECHNOLOGY WITH THE PERCENT EMPLOYED IN GOVERNMENT CONTROLLING FOR POPULATION SIZE AND RELATIVE POPULATION CONCENTRATION

Indicator of Contact Technology	Controlling for: Population (poplog)	Concentration (concent)	Population and Concentration (poplog and concent)
Telepop	.36 (.003)*	.41 (.001)	.36 (.003)
Mopop	.43 (.001)	.47 (.001)	.43 (.001)
Teleplog	.48 (.001)	.48 (.001)	.45 (.001)
Moplog	.53 (.001)	.52 (.001)	.51 (.001)
	DF = 53	DF = 53	DF = 52

*Significance figures in parentheses.

Table 7. PARTIAL CORRELATION OF INDICATORS OF CONTACT TECHNOLOGY WITH THE PERCENT EMPLOYED IN GOVERNMENT CONTROLLING FOR POPULATION SIZE AND RELATIVE POPULATION CONCENTRATION—LARGE AND SMALL NATIONS

Indicator of Contact Technology	Controlling for: Population (poplog)	Concentration (concent	Population and Concentration (poplog and concent)
Small Population Nations*			
Telepop	.14 (.285)†	.10 (.334)	.15 (.273)
Mopop	.20 (.194)	.23 (.166)	.21 (.198)
Teleplog	.44 (.027)	.43 (.029)	.42 (.038)
Moplog	.42 (.032)	.46 (.020)	.39 (.048)
	DF = 18	DF = 18	DF = 17
Large Population Nations			
Telepop	.44 (.005)	.45 (.004)	.36 (.021)
Mopop	.49 (.002)	.57 (.001)	.47 (.003)
Teleplog	.48 (.002)	.29 (.050)	.15 (.199)
Moplog	.54 (.001)	.44 (.005)	.37 (.018)
	DF = 32	DF = 32	DF = 31

*Population cutting point 5,750,000.

†Significance figures in parentheses.

The degree of collinearity between measures of contact technology and measures of general technological development indicate the need for caution in interpreting the results, yet the introduction of controls for general technological development does not cause the partial associations between contact technology and the relative size of government to disappear.

In Table 8 it can be seen that the partial associations remain positive when controls for energy consumption and economic development are entered. This finding would tend to support the notion that it is the facilitating effect of the contact technology that is important in affecting the relative size of government and not merely the general technological or economic development of the system. Again, however, the collinearity of the indicators warns that these should be taken as suggestive rather than conclusive evidence that this is the case.

Table 8. CORRELATIONS OF INDICATORS OF CONTACT TECHNOLOGY WITH THE PERCENT EMPLOYED IN GOVERNMENT AND THE LOG OF THE PERCENT EMPLOYED IN GOVERNMENT CONTROLLING FOR GENERAL TECHNOLOGICAL DEVELOPMENT

	Controlling for:			
	Coal*		Wealth†	
	Percent in Gov't.	Log Percent Gov't.	Percent in Gov't.	Log Percent Gov't.
Telepop	.25 (.024)‡	.31 (.006)	.23 (.032)	.29 (.009)
Mopop	.39 (.001)	.44 (.001)	.38 (.001)	.43 (.001)
Teleplog	.46 (.001)	.60 (.001)	.45 (.001)	.60 (.001)
Moplog	.52 (.001)	.63 (.001)	.51 (.001)	.63 (.001)
	DF = 63			

*Coal = Total energy consumed in kilograms coal equivalent regressed on population.

†Wealth = Gross national product regressed on population.

‡Significance figures in parentheses.

Discussion

The effects of contact technology are monotonic, positive, and, at least to some degree, independent of population size and population concentration. The evidence provided by even these relatively crude indicators of contact technology favors the hypothesis. The increased development and availability of contact technology appears to have a positive effect on the relative size of the administrative component of nations which is independent of population size and population concentration. This clearly supports the second hypothesis.[11]

The first hypothesis, however, is neither clearly confirmed nor clearly refuted by the data. The predicted negative relationship between area-distance and the relative level of administrative employment was only found in societies with relatively small populations (i.e., less than 5.75 million). In more highly populated societies a positive relationship was found. This pattern of relationship between area-distance and the percent employed in government persists when population size, population concentration, urbanization, and general technological development are controlled. We should keep in mind, however, in examinig the effects of the increasing "average distance" between individuals in large settlements, that there is a limit on the amount of information that the human organism can process (Miller); and consequently, there is a limit on the amount of interaction it can engage in or sustain. This, it will be recalled, led Mayhew and Levinger (a) to posit that interaction was a logistic rather than an exponential function of population size. Therefore, while it might theoretically be the case that two urban settlements of equal population densities have differing "average distances" between their population elements because they extend over differing areas—this difference may remain inconsequential if in both systems the opportunities for interaction already exceed the capacity of their component organisms to interact. The greater area of the one system would probably pose greater problems of administration, but the theoretical effect of the increasing distance between individuals on interaction would be negligible. Noell made a reasonable attempt to deal with this issue when he contrasted the effects of area on the *size* of government; with the effects of area on the *complexity* of governments. Unfortunately, a lack of data on the complexity of governments in this sample precludes use of that technique here, and it cannot be determined if this pattern of relationship obtains cross-nationally. The data therefore remain mixed in regard to the first hypothesis. Population size specifies the relationship between area-distance and administrative intensity in this data set, and the similar pattern found in Russett et al. indicates that this specification is probably not an artifact, and is not limited to data collected here. The second hypothesis is shown to be consistent with the data. Thus the structural conduciveness approach appears to have merit, and the dimensions singled out for examination here, area-distance and contact technology, would appear to have important implications for administrative intensity in nations.

Notes

1. A general discussion of the effects of propinquity on interaction is provided in Blau, Olsson, Svalastoga, and Zipf. The effect of propinquity on friendships was examined by Festinger et al. and its effect on marriage choices was explored by Bossard and Christensen.

2. Noell also maintained that this provided empirical support for one of the speculative hypotheses offered by Anderson and Warkov to explain the apparent discrepancy between their finding that administration declined with increasing hospital size, and the findings of Terrien and Mills which indicated that administration increased with increasing school population. The specification of the relationship between area-distance and administration found here might explain why these *linear* associations are so small in Noell's data.
3. Justification for use of administrative ratios in organizational research is provided in Kasarda and Nolan, Nolan (a, b), and MacMillan and Daft.
4. Data were located for: Argentina, Australia, Bahrain, Barbados, Belgium, Bolivia, Botswana, Burma, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chile, Columbia, Cyprus, Dahomey, Ecuador, Ethiopia, Finland, France, Gambia, West Germany, Ghana, India, Iraq, Ireland, Israel, Italy, Ivory Coast, Japan, Kenya, South Korea, Kuwait, Madagascar, Malaysian Federation, Malawi, Malta, Mauritania, Mexico, Morocco, Netherlands, New Zealand, Norway, Paraguay, Peru, Puerto Rico, Southern Rhodesia, Romania, Rwanda, Saudia Arabia, Senegal, Sierra Leone, Singapore, Republic of South Africa, Swaziland, Sweden, Syria, Tanzania, Togo, Trinidad and Tobago, Uganda, Upper Volta, United Kingdom, United States, Venezuela, Western Samoa, Southern Yemen, Yugoslavia, Zambia. The primary sources of data were Sachs, Paxton, Europa Publications, and Rupprecht. In addition, the statistical yearbooks of the individual nations that were held by the libraries of: Temple University, University of Pennsylvania, and the Department of Labor (Washington, D.C.) and the Library of Congress were directly consulted where language and assistance permitted. The date of the government figure then determined the relevant year for the data on the area, population, and contact technology. This matching of dates does not apply to the Urbanization, and Concentration measure taken from Taylor and Hudson, but they are, like the other independent variables measurements taken prior to the date of the government figure. The limitations of such secondary sources of data need not be reiterated here (cf. Miley and Micklin; Webb et al.).
5. Average distance between random pairs as area increases when density = 1 and area is square. (I thank Bruce Mayhew for calling this fact to my attention and for supplying me with this computer-generated example.)

Number of Points (or) Land Area	Average Distance in Kilometers	Length of a Side in Kilometers
1	0.0	1
4	1.138	2
16	2.142	4
64	4.202	8
256	8.359	16
1,026	16.693	32

Formula: A = land area in square miles or kilometers
Average distance = $\sqrt{(A)} \times (.52)$

6. Taylor and Hudson warn that there are problems of comparability with this measure requiring that caution be exercized in interpreting analyses that employ it. The respective limitations of each of these measures individually is the best argument for the use of both of them in conjunction rather than relying on either as a sole indicator of relative population concentration.
7. Two other measures of contact technology were originally gathered (road miles per area, and rail miles per area) and correlated with administrative intensity. These were admittedly less central indicators of the concept, and due to space limitations are not presented here. Results which for the most part parallel those reported here are presented in Nolan (a).
8. Apologies are offered for the awkward terminology but, as one reviewer noted, failure to clearly distinguish between large *area* and large *population* in this presentation needlessly confuses the discussion. Also, it should be noted that the residual of area regressed on population controls or adjusts for the linear relationship between population and area (Freeman and Kronenfeld) and thereby renders further controls for population superfluous in some cases.
9. This result is reinforced by the fact that an almost identical set of correlations is evidenced in the Russet et al. data when it is dichotomized on population (10,200,000).

Small population systems ($r = -.38$), large population systems ($r = .47$). Due to typographical error the correlation for large systems is erroneously reported as $-.47$ in Nolan (a, 107).

10. Similar, though attenuated, results are produced when regression methods of standardization are employed to avoid the possibility that definitional dependency (Freeman and Kronenfeld) structures in a relationship between these independent variables and administrative ratio. For example, when telephones and motor vehicles are regressed on population and then correlated with the percent employed in government the respective correlations are .27 and .28. As might be expected (Kasarda and Nolan; MacMillan), these residualized measures produce essentially the same pattern of results as do per capita measures.

11. Although it is no simple matter to determine the probable causal ordering of these variables, we have, on the basis of our theoretical orientation, assumed that contact technology is a predictor of the relative size of government. A case for the reverse ordering of causation could be made, however, citing the role of government in instituting and developing communication and transportation technologies. This question, of course, cannot be answered with cross-sectional data, but it is interesting to note that the two factors most likely to be sensitive to governmental control, Railway and Roadway development, evidence the lowest and most inconsistent relationships with the relative size of government (Nolan, a). Also, with the caveats noted in the text, we have shown that the effects of contact technology appear to be at least partially independent of general technological and economic development. This would indicate that it is the presence of the facilitating effects of the contact technology and not merely the general technological or economic development of the system that is important in affecting the relative size of government. Finally, we should be reminded that the theoretical interpretation that one applies to associations does not determine their "validity." There are no "spurious associations," only "spurious interpretations" of them (Rosenberg), and to argue that the data are consistent with other interpretations does not dispose of the associations, they remain to be explained. The existence of an alternative explanation *does not disprove an hypothesis* which is likewise consistent with the evidence, it merely offers a plausible alternative (Campbell and Stanley).

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