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GALTON'S PROBLEM IN CROSS-NATIONAL RESEARCH

By MARC HOWARD ROSS and ELIZABETH HOMER*

GALTON'S problem raises questions about the nature of explanation in cross-national research using aggregate data.[1] Are correlations between two traits or behaviors, such as economic development and political stability, to be explained by functional relationships within political systems, or in terms of diffusion and borrowing arising from interactions between countries? An explanation that relies on the effects of internal characteristics of states, such as economic development or political organization, can be contrasted with one based on the external events or pressures on a national political system. Most commonly, cross-national researchers offer interpretations of the first sort, or functional explanations, while ignoring the second type, or diffusion explanations. In this article, we first explore the logic of Galton's problem and then evaluate several empirical solutions, using data drawn from three different types of cross-national samples. In each of our solutions we consider the impact of both diffusion and function. Comparison of these solutions with previous explanations suggests that failure to consider diffusion may often have led to erroneous inferences and incorrect or incomplete theoretical interpretations.

I. THE LOGIC OF GALTON'S PROBLEM

Edward Tylor, an anthropologist, in 1889 presented a paper that examined relationships between marriage laws and descent patterns using data drawn from a cross-cultural sample.[2] He explained his find-

* We wish to thank Professors Michael Weinstein and Charles D. Elder for the extensive technical comments they provided. In addition, we wish to thank Professors Raoul Naroll, Fred Pryor, and Jennie-Keith Ross for their ideas.

[1] For a discussion of Galton's problem in cross-cultural analysis see Raoul Naroll, "Galton's Problem," in Naroll and Ronald Cohen, eds., *A Handbook of Method in Cultural Anthropology* (New York: Columbia University Press 1973), 974-89; and Raoul Naroll, Gary L. Michik, and Frada Naroll, "Hologeistic Theory Testing," in Joseph G. Jorgensen, ed., *Comparative Studies by Harold E. Driver and Essays in his Honor* (New Haven: HRAF Press 1974), 121-48, which give a good overview of the problem. For a detailed discussion of some of the methodological issues involved, see James M. Schaefer, ed., *Studies in Cultural Diffusion: Galton's Problem* (New Haven: HRAF Press 1974).

[2] Edward E. Tylor, "On a Method for Investigating the Development of Institutions Applied to the Laws of Marriage and Descent," *Journal of the Royal Anthropo-*

ings in terms of a functional relationship between the two traits. In a critique of the paper, Sir Francis Galton raised the possibility that the correlation Tylor found might have resulted from contact between the cultures in the sample, and questioned the extent to which Tylor's cases were truly independent. "It might be," he said, "that some of the tribes had derived them [the traits being studied] from a common source, so that they were duplicate copies of the same original."[3] Lack of independence presents two problems. First, it might bias the results; second, it affects statistical analyses by making the size of the sample of independent cases uncertain. Because of the influence of Galton's criticism, few anthropologists engaged in quantitative cross-cultural research for the next fifty years.[4] In recent decades, there has been a renewed interest in the sort of cross-cultural research Tylor conducted. However, as a result of the extensive concern with Galton's problem, almost all researchers in anthropology have drawn their samples in such a way as to minimize the effects of diffusion, in order to make a functional interpretation of their results less problematic.[5]

Naroll suggests that cross-unit correlations can be attributed to function, to pure borrowing, or to semi-diffusion.[6] Because of interactions among units, especially among modern nation-states, it is difficult to think of any case where a correlation between two traits or behaviors could be attributed only to processes internal to those societies, or "pure" function. Therefore, Naroll argues that explanations in cross-unit research must be based either on pure borrowing or on semi-diffusion. Pure borrowing occurs when traits or behaviors spread through contact but are not functionally linked to other traits in the borrowing society. Thus, high correlations are found in samples where contact and diffusion are high, but there will be no correlations in a more diverse sample that eliminates the effects of diffusion. For example, Naroll reports data from Klimek's studies in California which found

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logical Institute, XVIII (1889), 245-72; reprinted in Frank Moore, ed., *Readings in Cross-Cultural Methodology* (New Haven: HRAF Press 1963), 1-25.

[3] Tylor (fn. 2), 272.

[4] One exception may be found in L. T. Hobhouse, G. C. Wheeler, and M. Ginsberg, *The Material Culture and Social Institutions of the Simpler Peoples* (London: Chapman and Hall 1930).

[5] For example, George P. Murdock, *Social Structure* (New York: Macmillan 1949); John W. M. Whiting and Irvin L. Child, *Child Training and Personality* (New Haven: Yale University Press 1953); and Keith Otterbein, *The Evolution of War: A Cross-Cultural Study* (New Haven: HRAF Press 1970). For an overview of substantive findings using the cross-cultural method, see Raoul Naroll, "What Have We Learned from Cross-Cultural Surveys?" *American Anthropologist*, Vol. 72 (December 1970), 1227-88.

[6] Naroll (fn. 1), 974-75.

that patrilineal totemic clans appear exclusively in tribes which play flagolets, use carrying frames made of sticks and cords, make plate pottery, use a squared muller, and favor twins.[7] In a worldwide sample, the correlations are reduced to zero. Naroll says that the only sensible explanation for Klimek's correlations is joint diffusion. Intuitively, diffusion seems reasonable in this case because we can see no good reason why the form of clan organization ought to be systematically related to the other cultural traits Klimek observes. The problem is more serious, however, when we uncover a relationship between two characteristics that could plausibly be related functionally—such as political instability and socioeconomic development, or defense spending per capita and GNP per capita—but where we cannot *a priori* eliminate the diffusion explanation.

Semi-diffusion occurs where traits diffuse through contact, but only to cultures where there is an appropriate or requisite functional basis. As a political example, a number of writers have suggested the case of democracy, which can be successfully adopted only by nations with certain requisites, such as a highly educated population, a minimum level of wealth, and perhaps certain political traditions.[8] If such a functional basis for borrowing exists, then the correlation between traits or behaviors should still hold in a sample of units that have minimal interactions; a complete explanation for a relationship would need to rely on both function and diffusion.

Naroll and others have now devised more than nine "solutions" to Galton's problem for use in cross-cultural studies.[9] The essence of most

[7] Naroll, "Some Thoughts on Comparative Method in Cultural Anthropology," in Hubert M. Blalock Jr., and Ann B. Blalock, eds., *Methodology in Social Research* (New York: McGraw-Hill 1968), 259; and Naroll (fn. 1), 976.

[8] For example, see Seymour Martin Lipset, "Some Social Requisites of Democracy: Economic Development and Political Legitimacy," *American Political Science Review*, Vol. 53 (March 1959), 69-105.

[9] In addition to the works of Naroll cited above, see his "Two Solutions to Galton's Problem," *Philosophy of Science*, XXVIII (January 1961), 16-39; and "A Fifth Solution to Galton's Problem," *American Anthropologist*, Vol. 66 (1964), 863-67; Naroll and Roy G. D'Andrade, "Two Further Solutions to Galton's Problem," *American Anthropologist*, Vol. 65 (1963), 1053–67; George P. Murdock, "World Ethnographic Sample," *American Anthropologist*, Vol. 59 (August 1957), 664-87; David J. Strauss and Martin Orans, "Galton's Problem: A Critical Appraisal," *Current Anthropology*, XVI (December 1975), 573-94; Dean Keith Simonton, "Galton's Problem, Autocorrelation and Diffusion Coefficients," *Behavior Science Research*, X (1975), 239-48; Rolf Wirsing, "Measuring Diffusion: The Geary Method and the Dacey Method," in Schaefer (fn. 1), 197-219; and Fredrick L. Pryor, "Toward a More Simple and General Solution to Galton's Problem: The Diffusion Possibility Method," *American Ethnologist* (forthcoming). The number of proposed solutions to Galton's problem is proliferating rapidly. Keeping an accurate count of them is increasingly difficult as it is not clear which solutions ought to be considered independent inventions and which represent duplication from a common original, due to high levels of interaction within the academic community!

of these solutions is the selection of cases in a way that minimizes the effects of direct borrowing or diffusion among the units in the sample. Geographical proximity is highly correlated with interaction and presumably with diffusion; therefore units in the sample are selected from geographically separated areas. The logic of these "sampling" solutions is that function and diffusion are not juxtaposed with one another: the second is removed in order to examine the first. Vermeulen and de Ruijter contend that functional explanations are nomothetic, while diffusion or historically based explanations are ideographic.[10] Most cross-cultural research, according to them, has relied upon an ontological dualism which they criticize: "Exceptions in the nomothetic order may always be 'explained' by viewing them as disturbances due to the influence of historical factors or diffusion."[11] In a reply to Vermeulen and de Ruijter, Naroll accepts their criticism of his earlier analyses as incorrect juxtapositions of diffusion and function, and says that he now considers Galton's problem "simply as the problem of counting the number of statistical cases."[12]

Our reading of Galton's problem is somewhat different, and leads to a second type of solution. Diffusion seems to require a "sampling" solution because researchers consider diffusion as somehow getting in the way of functional or "real" explanations. The diffusion of traits or behaviors across units is not a problem to be "removed," however.[13] Diffusion can provide the basis for as general an explanation as functional relationships. The challenge is, as Przeworski and Teune point out, to replace historical particularities and place names with the general variables that they represent.[14] In this way, functional explanations emphasize intra-system processes, and diffusion explanations stress

[10] C. J. J. Vermeulen and A. de Ruijter, "Dominant Epistemological Presuppositions in the Use of the Cross-Cultural Survey Method," *Current Anthropology*, XVI (March 1975), 34.

[11] *Ibid.*, 35.

[12] Naroll, "Reply to Vermeulen and de Ruijter," *Current Anthropology*, XVI (March 1975), 42.

[13] Not all proposed solutions employ the strategy of removing diffusion effects as an initial step. Naroll's cluster test, Naroll (fn. 9, "Two Solutions . . ."), Naroll and D'Andrade's matched-pair method (fn. 9), and Driver and Chaney's test derived from the matched-pair method, all estimate the relative importance of both diffusion and function. See Harold E. Driver and Richard P. Chaney, "Cross-Cultural Sampling and Galton's Problem," in Naroll and Cohen (fn. 1), 990-1003. Interestingly, under the influence of Kroeber, cross-cultural research in anthropology for many years consisted mainly of mapping patterns of diffusion and borrowing between cultures of a single region. Richard P. Chaney, "Comparative Analysis and Retroductive Reasoning or Conclusions in Search of a Premise," *American Anthropologist*, Vol. 75 (October 1973), 1359-60.

[14] Adam Przeworski and Henry Teune, *The Logic of Comparative Social Inquiry* (New York: John Wiley 1970).

inter-system ones; however, each may have the same level of generality.

Vermeulen and de Ruijter indicate that simply to identify the presence of diffusion or other historical processes does not constitute an explanation of human behavior.[15] Instead of trying to "remove" the effects of diffusion, a solution to Galton's problem may involve the inclusion of additional variables[16] in the analysis, to give diffusion and function, or external and internal variables, the same explanatory status.[17] It also forces a specification of the nature of diffusion rather than simply an acknowledgment of its existence. Diffusion results from contact between nations, but the specific kind of contact can take a variety of forms. For example, it may involve such diverse principles as imitation, role modeling, reference-group behavior, relative deprivation, status anxiety, learning, rational evaluation of alternatives based on observation, imposition by force, or the power of new ideas. By adding additional variables representing one or more of these principles to our analysis, we can be explicit about the basis on which diffusion takes place rather than simply considering its presence or absence.[18]

GALTON'S PROBLEM IN POLITICAL RESEARCH

Galton's problem is not only of interest to anthropologists.[19] It also threatens cross-national and other cross-unit research in political science. To date, some cross-national researchers have acknowledged

[15] Vermeulen and de Ruijter (fn. 10), 49.

[16] Gillespie also sees two general types of solutions to Galton's problem in comparative political analysis: one entails incorporating into the analysis additional variables that measure the relative impact of diffusion and function; a second involves the selection of cases in such a way as to approximate independence. John V. Gillespie, "Galton's Problem and Parameter Estimation in Comparative Political Analysis," paper presented to the Annual Meeting of the Midwest Political Science Association, April 29–May 2, 1973, p. 17. Charles D. Elder, in a personal communication, has suggested labeling the two solutions a "sampling" solution and an "additional variables" solution.

[17] Although some cross-cultural researchers have paid equal attention to functional and diffusion explanations in their empirical solutions to Galton's problem (see fn. 13), Driver is the only one who has incorporated additional variables measuring diffusion into his analysis. In one study, he uses a sample of 277 ethnic units from North America to reconsider the relationship between residence rules and kin avoidance that Tylor originally investigated. He finds diffusion (what he calls geographical-historical factors) to be relatively more important than psycho-functional ones in explaining his correlations. What is of importance here is the use of variables measuring both diffusion and function in the same study, and his use of partial correlation in assessing the relative impact of each type of variable. Harold E. Driver, "Geographical-Historical *Versus* Psycho-Functional Explanations of Kin Avoidances," *Current Anthropology*, VII (April 1966), 131-60.

[18] Charles D. Elder, in a personal communication, has pointed out that the grouping of diverse phenomena under the common heading "diffusion" may mask independent processes.

[19] Naroll (fn. 1), 974; Richard E. Hildreth and Raoul Naroll, "Galton's Problem in Cross-National Studies" (mimeo), 1971.

Galton's problem, but have not coped with it empirically.[20] The few cross-national studies that evaluate the relative efficacy of diffusion and functional explanations for the same political behavior have considered specific substantive questions, but have offered no framework for analyzing the general problem.[21]

[20] Przeworski and Teune (fn. 14), 51-53, cite Naroll's articles and say that the problem is relevant to comparative political research, but offer no solutions to it. John V. Gillespie writes, "In macro-cross-national research, we must separate the variables that are the product of historical interaction of political systems from those that might be hypothesized as the internal conditions producing a given system attribute." See "An Introduction to Macro-Cross-National Research," in John V. Gillespie and Betty A. Nesvold, eds., *Macro-Quantitative Analysis: Conflict Development and Democratization* (Beverly Hills: Sage Publications 1971), 24; Allan D. Grimshaw, "Comparative Sociology: In What Ways Different from other Sociologies?" in Michael Armer and Allan D. Grimshaw, eds., *Comparative Social Research: Methodological Problems and Strategies* (New York: John Wiley Interscience 1973), 7. After quickly describing the problem, Joseph W. Elder offers no empirical solutions, only the view that, "The problems of unit comparability and unit independence promise to remain with cross-cultural research for many years." See "Problems of Cross-Cultural Methodology: Instrumentation and Interviewing in India," *ibid.*; John V. Gillespie (fn. 16). Stein Rokkan suggests that comparative research can resolve Galton's problem insofar as comparativists "build the communication-diffusion-innovation variables directly into their models and to focus their comparative analyses on units developed through the merger of smaller societies of the type studied by anthropologists." See "Cross-Cultural, Cross-Societal and Cross-National Research," in Rokkan, ed., *Main Trends of Research in the Social and Human Sciences* (Paris: Mouton/UNESCO 1970), 668. Although we agree with this assessment of what the components of a solution might be in cross-national research, we question Rokkan's assertion that this is found in the work of comparativists such as Lipset, Almond, Deutsch, Huntington, or Holt and Turner. These scholars have pointed out the potential importance of historical diffusion and communications processes, but they have hardly provided systematic solutions to treating the relative importance of internal and external determinants of national behavior. Arend Lijphart points out that Galton's problem involves the question of the independence of cases in comparative research and suggests that this indicates that researchers should use the comparative method that involves a smaller number of cases rather than statistical studies. They can then pay more attention to details that are likely to be overlooked in aggregate analysis. See Lijphart, "The Comparable-Cases Strategy in Comparative Research," *Comparative Political Studies*, VIII (July 1975), 171-72. Finally, William B. Moul presents data drawn from Banks and Textor which show high correlations between former colonial affiliation and a number of measures of modernization and political development as a way of illustrating the importance of diffusion in cross-national data. He stresses the lack of consideration of diffusion as a basis for explanation in most cross-national research on political development. See "On Getting Something for Nothing: A Note on Causal Models of Political Development," *Comparative Political Studies*, VII (July 1974), 150-55.

[21] Most cross-national research only employs intra-national data which are then correlated across nations, despite the professed theoretical interest in international relations for interactive processes which Rokkan (fn. 20) cites. For a sampling of typical cross-national research, see Gillespie and Nesvold (fn. 20); Rudolph J. Rummel, "The Dimensionality of Nations Project," in Richard Merritt and Stein Rokkan, eds., *Comparing Nations: The Use of Quantitative Data in Cross-National Research* (New Haven: Yale University Press 1966); Charles Lewis Taylor, Michael C. Hudson, and others, eds., *The World Handbook of Political and Social Indicators* (2d ed., New Haven: Yale University Press 1972); Donald G. Morrison and Hugh M. Stevenson, "Integration and Instability: Patterns of African Political Development," *American Political Science Review*, Vol. 66 (September 1972), 902-27. One fascinating study relies almost exclusively on either interactive data or data based on scores for pairs of nations, rather

One area where the relative impact of internal and external variables on behavior has been evaluated is in research on the "coup contagion" hypothesis. Coups d'états are alternatively explained by pressures within political systems and by extra-national variables measuring diffusion or contagion. In an early empirical study, Putnam found little support for a diffusion model in Latin America; socioeconomic variables (internal) were significantly related to military intervention in politics, while several measures of outside influence or modeling behavior showed no relationship with his measure of military intervention.[22] Midlarsky, also looking at Latin America, but over a longer period of time, finds evidence that coups diffuse, at least during certain time periods.[23] Furthermore, the influence of a coup on other states in the region depends in part on the status and previous record of political stability of the country where the coup occurs. Midlarsky sees no evidence of diffusion in Africa, however. Li and Thompson, using several mathematical models, find additional evidence for the hypothesis of coup contagion in some but not all regions of the world.[24] Unlike Putnam, neither Midlarsky nor Li and Thompson explicitly juxtapose functional and diffusion explanations. Putnam's study measures diffusion only in terms of the size of various outside military training programs in each state and cannot be considered a fully adequate test of the diffusion hypothesis.

Adoption of particular policies is a second dependent variable that political scientists have analyzed through comparison of functional and diffusion explanations. Collier and Messick compare explanations for the adoption of social security programs, using a sample of 59 countries.[25] Although social security programs were originally adopted in the more advanced industrial states, Collier and Messick find that the later a country adopts a social security program, the lower its level of socioeconomic development at the time. The functional explanation that stresses the role of industrialization, urbanization, and the growth of political demands by workers is only weakly supported since they find an extremely wide range of variation in their three indicators of

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than the score of a single country: Roger W. Cobb and Charles D. Elder, *International Community: A Regional and Global Approach* (New York: Holt, Rinehart & Winston 1970).

[22] Robert D. Putnam, "Toward Explaining Military Intervention in Latin American Politics," *World Politics*, xx (October 1967), 83-110.

[23] Manus Midlarsky, "Mathematical Models of Instability and a Theory of Diffusion," *International Studies Quarterly*, xvi (November 1970), 60-84.

[24] Richard P. Y. Li and William R. Thompson, "The 'Coup Contagion' Hypothesis," *Journal of Conflict Resolution*, xix (March 1975), 63-88.

[25] David Collier and Richard E. Messick, "Prerequisites Versus Diffusion: Testing Alternative Explanations of Social Security Adoption," *American Political Science Review*, Vol. 69 (December 1975), 1299-1315.

development (percentage of the labor force in agriculture, percentage in industry, and national income level) at the time of adoption. The diffusion explanation receives strong support both from a map showing the extent to which programs spread within single regions in short periods of time, and from an analysis of the bases of diffusion at different points in time and in different regions of the world.

Using data from the American states, Walker examines diffusion as a possible source of program innovations.[26] His dependent variable is the score for each state based on the date of adoption for as many as 88 different programs. He first finds that both demographic and political structure variables are significantly related to a state's level of innovation, but suggests that such an analysis tells us little about how innovations actually spread between early and late adopters. Looking at the data to identify initiation and emulation, Walker finds clearly identifiable regional pace setters and diffusion of innovations within regional clusters throughout the country. Gray, using similar data on the American states, finds an extremely good fit for an equation based on interaction in twelve different policy areas; furthermore, through separate analysis of the different policy areas, she suggests different patterns of diffusion across issue domains.[27] Finally, like Walker, Gray suggests the importance of an explanation based both on functional linkages and diffusion. The former may be more relevant in accounting for innovation, particularly in understanding the most and least innovative states, "while user interaction might better account for the order of the states falling in the middle range of innovativeness."[28]

Although these few studies using aggregate data consider both functional and diffusion explanations, they do not provide a general framework for handling Galton's problem such as those offered to anthropologists by Naroll, D'Andrade, Murdock, and others. First, the studies by Midlarsky, Collier and Messick, Walker, and Gray all rely on longitudinal or over-time data; that fact limits the applicability of their solutions for many aggregate-data analysts who, for various reasons, rely on cross-sectional data. Second, each of the studies cited above is facilitated by use of a dependent variable—coups in the one case and

[26] Jack L. Walker, "The Diffusion of Innovations Among the American States," *American Political Science Review*, Vol. 63 (September 1969), 880-99.

[27] Virginia Gray, "Innovation in the States: A Diffusion Study," *American Political Science Review*, Vol. 67 (December 1973), 1174-85; see also Jack L. Walker, "Comment: Problems in Research of the Diffusion of Policy Innovations," *American Political Science Review*, Vol. 67 (December 1974), 1186-91; Gray, "Rejoinder to 'Comment' by Jack L. Walker," *American Political Science Review*, Vol. 67 (December 1973), 1192-93.

[28] Gray (fn. 27), 1182.

specific policies in the others—whose presence or absence at a particular point in time is easily coded. Most cross-national data, however, involve continuous (or at least ordinal) variables. Third, none of these existing studies makes an effort to evaluate in a general way the relative effects of diffusion and function. Collier and Messick come the closest, although they use separate tests and do not consider both explanations simultaneously.

II. Some Empirical Solutions

The solutions presented by Naroll and his colleagues are a starting point for an empirical consideration of Galton's problem in cross-national research. Some differences between the kinds of data used in cross-cultural studies and those used in cross-national research should be briefly noted, however. First, anthropologists usually work with small cultural groups whose relative geographical isolation across culture areas reliably implies lack of contact. No such assumption can safely be made concerning even the most remote countries in the contemporary international system. Second, almost all cross-cultural research in anthropology relies upon dichotomous data where a trait is coded either absent or present, or high or low, in a particular culture. Some of the tests Naroll has devised cannot be suitably applied to the continuous data commonly used in most cross-national research. Third, many of the solutions involve samples that include only a small proportion of the total population of cultural units. In contrast, because of the relatively small number of national units, cross-national research typically includes a large proportion of the available population.

Our starting point is that all cross-national researchers need to build into their designs ways of testing for the effects of both diffusion and function, as these constitute either rival or partial explanations of their results.[29] Either might provide an adequate explanation for the cross-national distribution of any single characteristic or of the correlation between any two or more traits. Furthermore, as we shall see shortly, in many cases a superior explanation may combine both diffusion and function.

To examine Galton's problem, we have used three different data bases: (1) a regional sample of data on 27 characteristics for 32 black African

[29] Resolving Galton's problem does not necessarily make explanation of any set of findings easy. "Galton's problem is just one of the many competing hypotheses that must be eliminated in successful cross-cultural research." Colin Loftin, "Galton's Problem as Spatial Autocorrelation: Comments on Ember's Empirical Test," *Ethnology*, XI (October 1972), 432.

nations taken from Morrison and others, *Black Africa*.[30] We chose this sample because of the virtual absence of missing data and the theoretically interesting variables considered; (2) a worldwide sample of 80 nations adopted from the study on instability by Feierabend and Feierabend;[31] and (3) a much smaller world sample of nine countries chosen according to techniques that parallel Murdock's sampling method in an attempt to achieve what Przeworski and Teune call a "most different systems" design.[32] This sample, which will generally be too small for much cross-national research, does, however, represent a "sampling" solution for controlling for diffusion effects in certain cases, and shows another way of dealing with Galton's problem in cross-national data.

Measuring diffusion through "additional variables." Virtually all studies using cross-cultural data in anthropology, or the diffusion of innovations in sociology and international relations, show the importance of geographical proximity in diffusion.[33] Proximity is important because it tends to be associated with interaction, and we expect that innovations will spread when they are associated with high interaction. Such interaction is likely to be highest when two nearby countries share a common culture. To measure diffusion, then, we have modified Naroll's linked pair test.[34] We paired each nation in our sample with another

[30] Donald G. Morrison, Robert C. Mitchell, John N. Paden, and Hugh M. Stevenson, *Black Africa: A Comparative Handbook* (New York: Free Press 1972).

[31] Ivo K. Feierabend and Rosalind L. Feierabend, "Aggressive Behaviors Within Polities, 1948–1962: A Cross-National Study," in Gillespie and Nesvold (fn. 20), 141-66.

[32] Przeworski and Teune (fn. 14), 34-39.

[33] Everett M. Rogers, *Diffusion of Innovations* (New York: Free Press 1962); Everett M. Rogers and F. Floyd Shoemaker, *Communication of Innovations* (New York: Free Press 1971); Harold E. Driver, *Indians of North America* (Chicago: University of Chicago Press 1961); Harold E. Driver and Richard P. Chaney, "Cross-Cultural Sampling and Galton's Problem," in Jorgensen (fn. 1), 109-21; Steven J. Brams, "Transaction Flows in the International System," *American Political Science Review*, Vol. 60 (December 1966), 880-98.

[34] In Naroll's linked pair test, "The societies in a cross-cultural sample are aligned geographically. . . . With respect to each trait being studied, each tribe is correlated with its neighbor. . . . Thus we are getting a measure of similarity between neighbors. . . . This measure can be compared with similarly generated coefficients of correlation between substantive traits." If the correlation between neighbors' scores is significant, these effects of diffusion can be removed through the use of partial correlations "in which the influence of diffusion as measured by the linked pair method is the control factor." Naroll (fn. 1), 984-86. The partial correlation solution Naroll proposes initially (p. 986), is statistically useless, as is pointed out in Colin Loftin, "Partial Correlation as an Adjustment Procedure for Galton's Problem," *Behavior Science Research*, x (1975), 131-41; see also Strauss and Orans (fn. 9), 578. Rolf Wirsing has shown how partial correlations can be used in conjunction with the linked pair test: "Second-order Partials as a Means to Control for Diffusion," *Behavior Science Research*, x (1975), 143-59. His formula for computing the second-order partials is incorrect,

nation in the sample in three different ways: (1) Each country was paired with the geographical neighbor in the sample with which it shares the longest border. When there is no common border, it was paired with the geographically closest country in the sample. (2) To try to account not only for proximity, but also for propensity to interact, each country was paired with the geographically closest neighbor with which it shares the major language. If a country has two neighbors with the same major language, the one sharing the longer border with it was chosen. In cases where no neighbor shared the language, pairings were made on the basis of the second language spoken in either country.[35] (3) Each country in the sample was paired with the country in the sample with which it had the highest volume of trade. Other measures, such as the exchange of persons, mail flows, diplomatic exchange, and common membership in international organizations could certainly also serve as indicators of interaction and hence as indirect measures of diffusion. In fact, we would suggest that specific researchers should try to identify the most likely bases of diffusion for the substantive variables they are considering and include these in their collection of data.

To evaluate the effect of diffusion for each variable, the score for each nation is simply correlated with the score on the same characteristic for the country with which it was paired. The data in Table 1 show the correlations in several substantive areas for the African sample, and suggest that there is a good deal of diffusion across our variables. At the same time, our three measures of diffusion are not equally powerful.[36] The pairing based on the closest country with the same lan-

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however, as Wirsing neglects to square the r terms under the radical signs in the denominator (p. 151). Rather than aligning countries geographically, we have paired countries in our sample with other countries on the basis of several different criteria (see text). Hildreth and Naroll (fn. 19, p. 30), suggest that the linked pair method is not an adequate test of the relative importance of diffusion and functional association. Their comment is appropriate for a sample, but not when the entire population is included in the study, as is the case here and in much cross-national research. One unresolved problem is that if the results do show significant effects of diffusion, the actual number of independent cases will be lower than the actual sample size and the probabilities of finding a significant correlation by chance will be higher than they should be. See Naroll, Michik, and Naroll (fn. 1), 128-29.

[35] In the African sample, the pairings were made on the basis of the language spoken by the colonial power immediately prior to independence. This variable was intended to indicate the general political and cultural patterns of mutual attention that developed within the continent. Liberia and Ethiopia were not paired with any other nations because of their lack of a colonial experience. Somalia was dropped because of the uniqueness of its colonial history. Therefore, the sample size is reduced to 29 for the analyses involving this variable.

[36] The statistically significant negative correlations between the nature of a country's legal system and that of the country with which it is paired are curious. They might

Table 1

Correlations Showing Diffusion on 27 Variables in Data on Black Africa[a]

	Variable[b]	Neighbor with longest common border[c]	Neighbor with longest border sharing major language[c]	Partner in sample with most trade[c]
ELITE	Elite instability (11.2)	.16 (32)	.31* (29)	.20 (30)
COMMUNAL	Communal instability (11.3)	.19 (32)	.16 (29)	.06 (30)
TURMOIL	Domestic turmoil (11.4)	.10 (32)	.06 (29)	.20 (30)
DEATHS	Deaths in political violence (11.5)	.13 (32)	.00 (29)	—.06 (30)
DOCTORS	Inhabitants per physician (4.8)	.53**(32)	.56**(29)	—.06 (30)
GNPCAP	GNP per capita (4.3)	.37* (32)	.23 (29)	.09 (30)
RADIOS	Radios per 1000 population (6.1)	.33* (32)	.45**(29)	—.16 (30)
PAPERS	Newspaper circulation per 1000 population (6.3)	.07 (32)	.36* (29)	.17 (30)
PHONES	Telephones per 10,000 population (6.5)	.16 (32)	.39* (29)	—.06 (30)
CALORIES	Calories per capita[d] (4.11)	.63**(22)	.00 (15)	.20 (30)
LITERACY	Percent literate (5.16)	.39**(32)	.51**(29)	.28 (30)
CITYPOP	Percentage of population in cities over 20,000 (15.2)	.23 (32)	.25 (29)	.03 (30)
LEGSIZE	Size of the legislature (7.1)	.07 (32)	.30* (29)	.05 (30)
ETHNIC	Ethnic representativeness of Cabinet at independence (7.2)	—.17 (32)	.35* (29)	—.21 (30)
LOCGOV	Organization of local government administration (appointed-elected) (7.4)	—.18 (28)	.00 (24)	—.14 (27)
LEGAL	Structure of national legal system (unitary-pluralistic) (7.5)	—.56**(30)	—.47**(26)	—.19 (29)
LEGFRACT	Legislative fractionalization at independence (8.5)	.11 (32)	.48**(29)	.19 (30)
LEVHIER	Levels of hierarchy in local community organization (average across ethnic units) (16.4)	.25 (32)	.52**(29)	.17 (30)
VARHIER	Variation in nation in hierarchy levels in local community (16.4)	.50**(32)	.47**(29)	.14 (30)
TYPHIER	Type of hierarchy system in local community (average across ethnic units) (16.7)	.32* (32)	.09 (29)	.21 (30)
VARTYPE	Variation in hierarchy system in local communities (16.7)	.30 (32)	.27 (28)	—.12 (27)
GOVSPEND	Government spending per capita (9.5)	.23 (32)	.29 (29)	—.06 (30)
PCTGSPEND	Government spending as a proportion of GNP (9.4)	.40**(32)	.41**(29)	—.22 (30)
TAXES	Direct taxes as a percentage of government revenue (9.9)	—.10 (28)	.27 (24)	.20 (25)
ARMY	Armed forces manpower per 100,000 population (10.3)	.36* (32)	.45**(29)	.13 (30)
SECURITY	Internal security forces per 100,000 population (10.4)	.44**(32)	.43**(29)	.15 (30)
DEFBUD	Defense budget as a percentage of government expenditure (10.7)	.55**(32)	.63**(29)	.14 (30)

* Significant at the .05 level
** Significant at the .01 level

[a] The raw data are from Morrison et al., *Black Africa* (fn. 30).
[b] The full definition of each variable is found in Morrison; the number in parentheses refers to the number of each variable in Morrison.
[c] Size of sample in parentheses.
[d] This variable is from Taylor, Hudson, et al., *World Handbook of Political and Social Indicators* (fn. 21).

guage is the most powerful measure of diffusion: the correlations are statistically significant in 16 of the 27 situations, and in some cases are quite sizable. Simple proximity, as measured by the neighbor with the longest common border, shows 12 significant correlations, while the correlations with a country's largest trade partner in the sample are not significant at all.[37] Therefore, in subsequent analyses we used the closest neighbor with shared major language as our measure of diffusion.

In his discussion of the linked pair method, Naroll suggests that after countries are aligned in some fashion, the functional linkage between two traits can be obtained by removing the effects of diffusion through the use of partial correlation. After inspecting the correlation matrix for the African data, we chose a number of potentially interesting bivariate correlations and sought to determine the extent to which the original (supposedly functional) relationships are unchanged after the effects of diffusion are removed. Table 2 shows both the zero-order correlations and the second-order partials which remove the effects of diffusion on both substantive variables. In most cases the correlation falls; however, in a few cases the original correlation actually rises, showing that diffusion can deflate as well as inflate a correlation.[38]

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be understood in terms of several alternative hypotheses: (1) in creating a legal system, states are careful to do things differently from their neighbors, possibly because they do not want to repeat the defects in neighboring systems; (2) the correlation reflects the impact of an unspecified third variable, which, when controlled for, reduces the correlation to zero.

[37] When the colonial language alone (French or English) is correlated with each of the substantive variables, seven of the relationships are significant; thus, while colonial traditions may have had some influence in Africa, they are not as important as simple neighboring or as neighboring plus language commonality.

[38] Most research has assumed that diffusion increases the size of a correlation. See Edwin E. Erikson, "Galton's Worst: A Note on Ember's Reflection," in Schaefer (fn. 1), 63-83. A situation where diffusion lowers a correlation is less obvious intuitively. The easiest way to think about this case is to realize that two variables may diffuse somewhat independently of each other, or that only one variable may diffuse, so that changes in one will not be highly related to changes in the other. When the effect of these changes is removed through partial correlation, the relationship between the two variables may increase. The common assumption that diffusion will only raise a correlation is limited to those situations where two traits diffuse together. When the patterns of diffusion are different, the effect on the substantive correlation is not predictable. This is the case in the correlation in Table 2 between communal conflict and defense spending. The zero-order correlation is .40; the second-order partial, removing the effects of diffusion, is .73. Only one of the substantive variables, defense spending, shows high diffusion (.63); the diffusion score for communal conflict is only .16. The two diffusion measures are unrelated (.15). The other two correlations needed in computing the partials are between communal violence and the diffusion measure for defense spending (−.24), and between defense spending and the diffusion measure for communal violence (.18). There is some evidence that in cases where the correlation between the two diffusion measures is very high, the partial correlation procedure may

TABLE 2

SIMPLE CORRELATIONS AND SECOND-ORDER PARTIALS REMOVING EFFECTS OF DIFFUSION ON SELECTED CORRELATIONS IN AFRICAN SAMPLE[a]

Variables			*Zero-Order Correlations*[b]	*Second-Order Partial Correlations*[b]
DEFBUD	×	PHONES	−.32* (32)	−.11 (29)
DEFBUD	×	GOVSPEND	−.28 (32)	−.16 (29)
DEFBUD	×	LITERACY	−.45** (32)	−.05 (29)
DEFBUD	×	COMMUNAL	.40** (32)	.73** (29)
DEFBUD	×	ELITE	.31* (32)	.34* (29)
ETHNIC	×	GNPCAP	.43** (32)	.55** (29)
ETHNIC	×	LOCGOV	−.34* (32)	−.49** (29)
PCTGSPEND	×	DOCTORS	−.36* (32)	−.31 (29)
PCTGSPEND	×	TYPHIER	.37* (32)	.20 (29)
ARMY	×	CITYPOP	.30* (32)	.19 (29)
ARMY	×	ELITE	.28 (32)	.19 (29)
CITYPOP	×	GOVSPEND	.67** (32)	.65** (29)
SECURITY	×	GOVSPEND	.52** (32)	.46** (29)
LEGFRACT	×	DEATHS	.46** (32)	.47** (29)

* Significant at the .05 level
** Significant at the .01 level

[a] The data used in computing the correlations come from Morrison et al., *Black Africa* (fn. 30). For complete definitions of each variable, see the code numbers in Table 1, which refer to the variable numbers in Morrison.
[b] Size of sample in parentheses.

Seven of the twelve zero-order correlations that were statistically significant no longer are.

So far, our procedures have been no different than those suggested by Naroll and Wirsing (except that we have used the entire population rather than a sample) in their discussions of the linked pair method and the use of partial correlation. For each variable, we initially examined the correlation between each country's score and the score of the country with which it was paired to find the degree to which each variable diffuses. In the second-order partial correlation analysis, we removed the effects of diffusion in the bivariate relationships so that

be biased in favor of the diffusion explanation because it removes variance attributed to the diffusion of each variable individually as well as that which is due to their association in the neighboring country, Wirsing (fn. 34), 156. Some of the latter variance, however, may be due to functional association. To avoid this, Loftin (fn. 29), 133-35, proposes analyzing the correlation between residuals, as does Elder (personal communication). Loftin also points out that diffusion may lead to underestimation of the standard error because samples appear more homogeneous than the population from which they are drawn (fn. 29), 429.

the correlation between the two variables might be explained in functional terms.

Regression Analysis. The foregoing procedure can be understood more generally under the framework of regression analysis, as Loftin and Ward point out.[39] In the following equation,

$$Y_i = a + bX_i + E_i \tag{1}$$

Y_i is the ith observation of the dependent variable Y; X_i is the ith observation of the independent variable X; a and b are constants representing the intercept and the slope of the linear regression; and E_i is the ith error term or disturbance variable of E which represents all factors influencing the dependent variable other than the independent variable. In equation (1), diffusion variables are not explicitly part of the model. They can be added quite easily, however, as Loftin and Ward show.[40] The partial correlation solution may be stated in regression terms as:

$$Y_i = a + bX_i + cX_j + dY_j + E_i \tag{2}$$

where X_j and Y_j are the variables measuring diffusion of X and Y (such as the score of the geographically closest neighbor sharing the same language).

Viewing Galton's problem in terms of a regression model has several advantages. First, we can state our assumptions about the relationships between the variables explicitly. Second, we are able to use multiple regression to examine the relative impact of diffusion and functional variables on any particular dependent variable, instead of trying to "remove" the effects of diffusion to analyze the results solely in functional terms. Under this approach neither the diffusion nor the functional explanation is considered somehow "better" than the other. Using the regression model, we can distinguish between three situations: (1) the independent variable is significantly related to the dependent variable, while the diffusion variables are not; (2) the diffusion variables are significantly related to the dependent variable while the substantive ones are not; and (3) both the substantive and diffusion variables are significantly related to the dependent variable and the results allow us to evaluate the relative impact of each.

When certain assumptions of the regression model are not met, either the partial correlation or the multiple regression solutions may

[39] Colin Loftin and Sally K. Ward, "An Evaluation of Wirsing's Adjustment Procedure for the Effects of Galton's Problem," *Behavior Science Research* (forthcoming).
[40] *Ibid.*

be biased. In particular, when the disturbance variable (E_i) is correlated with any of the independent variables, the estimates of the regression coefficients may be biased.[41] This fact is not at all trivial in dealing with Galton's problem because we might expect to find situations where the disturbance term is affected by a variable that also affects one of the independent variables. (We might say that the same variable affects the diffusion of each in a parallel manner.) Where this seems to be taking place, one solution is to specify additional independent variables that are then explicitly brought into the model. The inclusion of two additional variables, X_j and Y_j, in equation (2) above is a first step toward doing this. If we have reason to believe that there may be several bases of diffusion in any situation, additional independent variables should be specified until the disturbance variable is again normally distributed and uncorrelated with any of the independent variables.

Using the African data, we ran two sorts of regressions. The first involved only a single substantive variable and two diffusion variables (one for the dependent and one for the independent variable); the second involved as many as four substantive variables plus a diffusion variable for each one. The multiple regressions were first calculated using all possible independent variables. When the results showed the contribution of one or more variables to be insignificant, these variables were dropped and the regression recalculated, so that the only variables retained in the final equations presented in Table 3 are those where the F-ratio is 2.00 or larger.[42] The data in Table 3 show the variation in the effects of function and diffusion; the selected results presented here clearly indicate all three types of outcomes described above. Because of space limitations, we will discuss only one regression of

[41] *Ibid.*

[42] In the presence of multicollinearity, or high correlation among the independent variables, the variances (or standard errors) of the estimated coefficients will be relatively high. Though the estimates are unbiased, they are imprecise, so that the hypothesis that the estimated coefficients do not differ from zero often cannot be rejected. Large standard errors and nonsignificant relationships may be due to other causes as well as to multicollinearity. When multicollinearity is present, one available strategy is to combine highly correlated variables in a single index and estimate their joint effects. In short, without additional information there is little that can be done about the problem. Jan Kmenta, *Elements of Econometrics* (New York: Macmillan 1971), 390. Rockwell discusses various criteria that have been proposed to indicate the presence of multicollinearity and suggests using the Haitovsky test of the singularity of the matrix. When a matrix is significantly nonsingular, multicollinearity can be rejected as a problem. Richard C. Rockwell, "Assessment of Multicollinearity: The Haitovsky Test of the Determinant," *Sociological Methods and Research*, III (February 1975), 308-20.

each type from Table 3 and suggest in only the broadest manner the directions a satisfactory explanation might take.

FUNCTIONAL EXPLANATION IS ADEQUATE

(1) The simplest case, and the rarest in our data, occurs when variation in a dependent variable is accounted for by an intra-system variable, suggesting a functional explanation. That is the sort of finding generally offered in cross-national research. For example, as is shown in Table 3, the number of deaths in domestic political violence is negatively related to the level of government spending as a proportion of GNP, and unrelated to the neighbor's political violence or level of government spending. The functional explanation for this finding might be similar to that offered by the Feierabends: that in systems where the provision of social services is low, frustration builds up and subsequent politically based aggression is likely to be high.

EXTERNAL (DIFFUSION) VARIABLES ARE IMPORTANT

(2) The second group of regressions in Table 3 represents situations where the diffusion variables enter into the equations, but the substantive variables are unimportant. Here we are pushed to propose explanations that involve inter-system processes. It would not, however, be appropriate to argue that intra-system processes can be ignored here: any complete explanation would have to suggest how and why the inter-system processes produce certain internal effects. The identification of diffusion, then, is not an explanation in itself, only a start toward developing one. Further, we should identify general processes of diffusion rather than consider all diffusion as simply historical accident and unsystematic in character.[43]

In African nations, the size of the defense budget as a proportion of government expenditure is predicted by a diffusion variable: the size of the neighbor's defense budget as a proportion of his government spending. Similarly, the proportion of the population serving in the army is best predicted by the proportion of the neighbor's population in the army. Interestingly, in both cases, the substantive variables measuring government expenditure and development (as indexed by the population living in cities) are not statistically significant. It seems that the forces determining a country's defense policies are external to

[43] Vermeulen and de Ruijter (fn. 10) are right in suggesting that most cross-cultural studies have tended to treat diffusion in this manner, but we wish to stress that explanations that include diffusion processes may be just as nomothetic as functional explanations.

TABLE 3

SELECTED MULTIPLE REGRESSION TO EVALUATE THE RELATIVE CONTRIBUTION OF INTERNAL (FUNCTIONAL) AND EXTERNAL (DIFFUSION) VARIABLES IN AFRICAN SAMPLE[a]

Dependent Variable	*Independent Variables in Regression Equation*	*Regression Coefficient*	*Beta*	*Standard Error*		*Independent Variables Not Entering Equation (F-level below 2.00)*
(1) Intra-system (function) variables are the best predictors of the dependent variable:						
DEATHS	PCTGSPEND	−.20	−.43	.08	$R = .43$	*N*DEATHS[b]
	intercept	6.61			$R^2 = .18$	*N*PCTGSPEND
GOVSPEND	CITYPOP	2.43	.67	.52	$R = .67$	*N*CITYPOP
	intercept	4.70			$R^2 = .45$	*N*GOVSPEND
DEATHS	LEGFRACT	.05	.46	.02	$R = .46$	GOVSPEND
	intercept	1.53			$R^2 = .21$	LITERACY
						*N*DEATHS
						*N*LEGFRACT
						*N*GOVSPEND
						*N*LITERACY
(2) Inter-system (diffusion) variables are the best predictors of the dependent variable:						
DEFBUD	*N*DEFBUD	.67	.63	.16	$R = .63$	GOVSPEND
	intercept	3.14			$R^2 = .40$	*N*GOVSPEND
ARMY	*N*ARMY	.74	.45	.28	$R = .45$	CITYPOP
	intercept	43.27			$R^2 = .19$	*N*CITYPOP
PCTGSPEND	*N*PCTGSPEND	.46	.41	.20	$R = .41$	LITERACY
	intercept	8.84			$R^2 = .17$	*N*LITERACY

(3) Both intra-system (function) and inter-system (diffusion) variables enter the equation:

LEGFRACT	*N*LEGFRACT	.52	.44	.23	$R = .58$	*N*LITERACY
	LITERACY	.65	.34	.39	$R^2 = .34$	GOVSPEND
	intercept	6.89				*N*GOVSPEND
						LEGAL
						*N*LEGAL
ETHNIC	*N*ETHNIC	.72	.75	.13	$R = .87$	*N*LITERACY
	*N*LOCGOV	20.29	.60	4.72	$R^2 = .76$	
	GNPCAP	.23	.55	.05		
	LITERACY	− .61	− .30	.26		
	LOCGOV	− 10.28	− .29	4.72		
	*N*GNPCAP	− .12	− .27	.06		
	intercept	− 11.51				
SECURITY	*N*CITYPOP	3.11	.47	1.00	$R = .80$	*N*SECURITY
	RADIOS	.56	.36	.21	$R^2 = .64$	PCTGSPEND
	CITYPOP	2.23	.35	.91		*N*PCTGSPEND
	*N*ARMY	− .32	− .37	.16		*N*RADIOS
	ARMY	.16	.31	.08		
	intercept	29.42				

[a] The data are from Morrison et al., *Black Africa* (fn. 30). For complete definitions of each variable, see the code numbers in Table 1 which refer to the variable numbers in Morrison.

[b] An *N* preceding the name of the variable refers to the measure of diffusion for that variable, the score received by the country each state is paired with in terms of geographical and cultural proximity.

the country, as arms-race theory would predict. African states are sensitive to the arms expenditures and military buildups of neighboring states that are culturally similar. Internal variables, such as level of resources and development, are less effective predictors of defense outlays and army size.

BOTH INTERNAL AND EXTERNAL VARIABLES ARE INVOLVED

(3) The third section of Table 3 shows situations where both substantive and diffusion variables enter into the regression equation. Here a complete explanation must consider both. It must account for both the intra-system pressures represented by the substantive variable(s) and the inter-system pressures created by the processes of diffusion as in situation (2) above. Diffusion and function are not incompatible with each other here, but do represent two different sorts of processes in a political system, which need to be combined into a single explanation.

A relatively simple example is the case where the degree of legislative fractionalization (representation of many parties) at independence is related to two variables: the degree of fractionalization of the neighbor's legislature at independence (diffusion), and the country's own literacy rate (function). The fractionalization of a neighbor's legislature may reflect the working of norms concerning the representation of minorities or minority views among mutually responsive neighbors. The association between literacy and legislative fractionalization suggests that the institutionalization of political diversity may be more widely held in states where there is a greater spread of education and democratic norms, as Lerner and others have hypothesized.

These examples show the importance of including both external (diffusion) and internal (function) variables in cross-national studies. In several cases, the results indicate that conclusions based only on internal variables—the most common feature of cross-national political research today—are inadequate. Frequently, diffusion processes are also at work, and explanations must consequently take them into account. In some cases, they will not be particularly important, as is shown in our first group of regressions.[44] Our point is only that they need to be considered among the plausible rival hypotheses that can explain a set of findings. To illustrate further how such an analysis might be done, we will now re-examine data from a well-known cross-national study which failed to include any diffusion variables.

[44] Cobb and Elder report a similar finding when they show that various forms of interaction between European states, such as mail flows, student exchange, and trade are virtually unrelated to the development of positive attitudes toward states for whom the interaction levels are high (fn. 21), 96-99.

Diffusion versus function in explaining instability. Feierabend and Feierabend have found a positive relationship between 8 indicators of socioeconomic development and political stability in a sample of 84 nations.[45] They suggest a functional explanation: that greater political stability is achieved in the more developed countries because the level of systematic frustration and subsequent aggression (in the form of political violence and extra-legal activity of various sorts) is lower. An alternative explanation for instability, based on processes of diffusion, suggests that the correlation is due to modeling behavior in neighboring states, most of whom tend to have relatively similar levels of development. A more sophisticated explanation might combine the two to argue that instability diffuses selectively and only to countries with certain requisite conditions. To test these competing explanations, we have reanalyzed the data used in the Feierabends' study.[46] We first paired each country in the sample with its geographically closest neighbor sharing the same major language.[47] As the Feierabends report, and as our reanalysis of their data shows, there is a significant positive relationship between socioeconomic development and political stability.[48] However, Table 4 also shows significant effects of diffusion for each variable, as a country's score is highly correlated with the score of the country with which it is paired on the same variable. Interestingly, the diffusion scores are higher for the socioeconomic variables than for the measure of instability.

To remove the effects of diffusion, we then calculated the second-order partial correlations between instability and each of the socioeconomic variables. The results presented in Table 4 (column 3) show a sharp *decrease* in all the correlations that were originally significant. Only the correlations between instability and newspaper circulation per capita, telephones per capita, and literacy rate remain significant, although the absolute value of the correlations decreases. Clearly, the effects of diffusion make the status of a functional explanation incomplete and highly tenuous. A complete account would have to include

[45] Feierabend and Feierabend (fn. 31), 154.

[46] The list of the 84 nations used in the study and the instability scores for each is provided in Feierabend and Feierabend (fn. 31), 146. The data for the measures of socioeconomic development are from Bruce M. Russett and others, *World Handbook of Political and Social Indicators* (New Haven: Yale University Press 1964).

[47] When no neighbor in the sample spoke the same language, pairing was made on the basis of second-language speakers.

[48] The Feierabends report their findings using dichotomized data and chi square tests (fn. 31), 154. We have treated the data as at least ordinal in nature and present Pearson correlations. Only in the case of persons per physician does the significance of the results differ. When we use Spearman rank-order correlations, there are no differences at all with their results at the zero-order (Table 5).

TABLE 4

INSTABILITY AND SOCIOECONOMIC DEVELOPMENT, SIMPLE CORRELATIONS AND SECOND-ORDER PARTIALS

	Zero-Order Correlations		*Second-Order Partial Correlations*
	Score on Variable by Score for Closest Neighbor Sharing Major Language[a]	*Instability*[a]	*to Remove Diffusion in Correlation with Instability*[a]
Instability	.19* (81)	1.00 (81)	—
Newspaper circulation	.74** (81)	— .49** (82)	— .32** (81)
Calories per day	.73** (80)	— .30** (81)	— .04 (80)
Doctors per capita	.70** (75)	.02 (80)	.05 (75)
Telephones per capita	.78** (75)	— .49** (79)	— .31** (75)
Literacy rate	.86** (81)	— .34** (82)	— .23* (81)
Radios per capita	.76** (77)	— .32** (80)	— .10 (77)
Percentage urban population	.55** (77)	— .25** (79)	— .11 (77)
GNP per capita	.86** (81)	— .43** (82)	— .18 (81)

* Significant at the .05 level
** Significant at the .01 level

[a] Size of sample in parentheses.

the effects of both diffusion and function. To juxtapose the two types of variables more systematically, we ran a series of regressions using three independent variables each time: one of the seven substantive variables (excluding doctors where the simple *r* was insignificant), a neighbor's score on the same substantive variable, and a neighbor's instability score. The results, which are certainly suggested from the simple correlations, show that in four of the cases the substantive variable is the most important one in the regression equation; in the other three, the most important variable is one of the diffusion measures. From these results, we again see that both diffusion and functional processes are needed to account for political instability. The exclusive focus on internal (functional) variables in the Feierabends' research, as in most other cross-national analyses, is a failure in part because it does not consider the real effects that Galton foresaw more than three-quarters of a century ago.

Diffusion in the "most different systems" design: A "sampling" solution. Following the lead of Murdock[49] and Przeworski and Teune,[50] we developed a third sample to control for diffusion so that the resulting correlations might be interpreted in functional terms. Murdock identifies 60 ethnographic regions in the world; he suggests that researchers doing cross-cultural investigations select randomly within each region, and that no sample include more than one culture from each area. The same logic is behind the "most different systems" design advocated by Przeworski and Teune. This design maximizes variance in the dependent variable and then tries to identify the independent variables that account for it. By including only units from different areas in the sample, the effects of diffusion are limited, if not eliminated, and any resulting relationships can be more easily interpreted in terms of intra-systemic effects.[51]

We initially had some doubt about whether this strategy made any sense at all in an international system where the possibilities and realities of interaction, and hence diffusion, between even two distant countries are far greater than the chances of diffusion in an ethnographic sample.[52] Nonetheless, we became persuaded that the endeavor was at least interesting enough to try, although we are not fully certain about how the results ought to be interpreted. As a basis for sampling, we began with Russett's study which empirically identifies eight major trade regions in the world.[53] One country from each region was included in our sample; we added an African state, since Africa is underrepresented in his data.[54]

The substantive problem is the same one we just examined using the worldwide sample: the relationship between political instability and

[49] Murdock (fn. 9).

[50] Przeworski and Teune (fn. 14), 34-39.

[51] Vermeulen and de Ruijter advocate a strategy of "stratified random sampling in which the different strata represent different levels of the independent variable under study" (fn. 10), 37. This strategy has some common elements with the "most different systems" design.

[52] Naroll is cautious and does not rule out the possibility of diffusion between even the two most remote cultures in his samples, but there does seem to be more face validity to this design in cross-cultural than in cross-national research as a way of ruling out diffusion effects.

[53] Bruce M. Russett, "Delineating International Regions," in J. David Singer, ed., *Quantitative International Politics* (New York: Free Press 1968), 317-52.

[54] We first aimed at getting a core country in each of Russett's regions. In order to try to maximize regional differences and minimize diffusion effects, it was replaced, however, if it was also in another of Russett's regions. In addition, we wanted states for which there would be no missing data. In adding an African country, we selected what seemed to be the most representative one for which the Feierabends' instability score existed. The countries included in the final sample are: El Salvador, South Korea, Thailand, Colombia, Lebanon, Turkey, Norway, Argentina, and Ghana.

levels of socioeconomic development. Table 5 presents the correlations that can be compared to those in the larger worldwide sample used by the Feierabends. Instead of finding all eight relationships significant, we now find that *none* are. Furthermore, this is not just an artifact of the smaller sample size which requires a higher correlation to achieve significance. Of the eight correlations that were significant and no longer are, six are smaller in this "most different systems" sample, and one of the two that is larger is in the opposite direction than predicted by the Feierabends' theory.[55] Although the Feierabends' sample is based

TABLE 5

INSTABILITY BY SOCIOECONOMIC DEVELOPMENT, FEIERABENDS' AND "MOST DIFFERENT SYSTEMS" SAMPLES COMPARED; SPEARMAN RANK-ORDER CORRELATIONS

	Feierabends' Sample[a]	*Most Different Systems Sample*[a]
Newspaper circulation	— .37**(82)	.29 (9)
Calories per day	— .29**(81)	.17 (9)
Doctors per capita	.24**(80)	.33 (9)
Telephones per capita	— .36**(79)	.19 (9)
Literacy rate	— .41**(82)	— .07 (9)
Radios per capita	— .35**(80)	— .07 (9)
Percentage urban population	— .22* (79)	.26 (9)
GNP per capita	— .37**(82)	— .14 (9)

* Significant at the .05 level
** Significant at the .01 level

[a] Size of sample in parentheses.

on almost nine times as many cases, the smaller sample based on Russett's trade regions may be considered more useful because the effects of diffusion, which are quite important in the Feierabends' data, have been partially removed. We would expect this sort of reversal to occur in other cross-national studies as well. We selected the Feierabends' data as an example because they allowed for a relatively clear examination of our methodological point: that diffusion effects need to be estimated empirically along with the intra-system process,

[55] Table 5 presents the Spearman rank-order correlations for both the Feierabends' and the "most different systems" samples. Because the smaller sample severely violated the assumptions of normality, the Pearson r should not be used. The correlation coefficients are actually not very different, however. Only the relationships between instability and telephones per capita and GNP per capita are statistically significant for the "most different systems" sample when the Pearson r is used.

as in the previous examples, or else controlled for, as in the "most different systems" design.

Although the "most different systems" sampling design does show the strong diffusion effects in the worldwide data, we think it is inferior to the "additional variables" design which uses partial correlation and regression. First, it is not safe to contend that in a sample drawn from contemporary states in the international system we have effectively ruled out diffusion effects, as Murdock and Naroll have been able to do using cross-cultural samples. Their research strategies rely heavily on geographical proximity as a basis of diffusion, but in the international system diffusion may take place on other grounds as well.[56] Second, this design is inferior because it makes difficult the development of an explanation that can include both diffusion and functional processes. Here we first "rule out" diffusion and then look at function. Instead, as Vermeulen and de Ruijter argue, we need to integrate both into a single explanation.

III. Conclusions

Most approaches to Galton's problem have attempted first to eliminate effects of diffusion and then to consider the remaining relationship between two variables as an effect of function. Our approach to Galton's problem is somewhat different: in most of the solutions we discuss, we have attempted to test for the effects of diffusion and function simultaneously, to compare their relative strengths, and, where necessary, to propose that explanations ought to be based on both processes. The ways in which states were paired in our tests for diffusion were based on both theoretical reasonableness and the availability of data. Creative researchers will surely develop additional measures of diffusion, some of which may have a general utility, such as those used here, and some of which may be relevant to particular traits or behaviors. In addition, we expect to see new techniques for evaluating diffusion and functional effects.

One method recently developed in anthropology may be adapted to continuous data. This strategy attempts to measure diffusion in several directions at once through use of a matrix rather than through pairing a country with only one other.[57] When using interactional data such as

[56] The effect of geographical proximity in the international system is not quite clear. See, for example, the discussion in Cobb and Elder (fn. 21), 26-28, 88-90; Mohr (fn. 20).

[57] Rolf Wirsing (fn. 9) presents techniques that are variations on methods used by geographers. Pryor (fn. 9) calculates a diffusion possibility matrix in which each unit (culture, nation) receives a score based on the degree to which it shares traits likely

diplomatic exchange or trade, the matrix method may provide a more sophisticated measure of the pattern of diffusion in the international system than the measures used here. Ultimately, good diffusion measures may be difficult to develop, particularly for the spread of behavior or traits that are not material in origin. For example, the rise of independence movements after World War II, first in Asia and then in Africa, and the spread of student discontent in the late 1960's in both the developed and the underdeveloped countries, seem clear examples of diffusion. They are not particularly well explained simply by pressures within nations. Geographical proximity, common language, trade, mail flows, diplomatic exchanges, and other commonly used measures of diffusion would probably not be good indicators in these instances. Additional measures of diffusion must be developed if cases like these are to be understood.[58]

The measures of diffusion used here and by Naroll place the heaviest emphasis on geographical proximity. As a result, our tests for diffusion may be overly severe in certain situations in that they identify a correlation as resulting from diffusion when that is not the case. This error is most likely to occur when the variables under study are systematically related to ecological or environmental conditions which do in fact cluster throughout the world. For example, since soil types and weather conditions are clustered geographically, variables that are likely to be related to them, such as farming technologies, will also be likely to cluster. On the basis of the correlation alone, clustering is not necessarily evidence for diffusion.[59] If our tests for diffusion are

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to promote diffusion, such as closeness or common language, with each other unit in the sample. He then offers a variety of tests that calculate the degree to which the diffusion possibility scores are related to the actual distribution of the substantive traits under study. Michael Weinstein has suggested to us that each country in the sample might receive a diffusion score for each variable based on the scores for all other countries in the sample, weighted by their similarity in terms of cultural traits, their proximity, or any other plausible ways in which the trait at hand might have diffused.

[58] Our discussion is relevant primarily for cross-sectional data. When time-series data are available, techniques such as those used by Midlarsky (fn. 23) or Gray (fn. 27) should be particularly useful in identifying, if not explaining, how diffusion works.

[59] Naroll makes this point in his first article on Galton's problem (fn. 9, "Two Solutions . . ."), 30-31. Vermeulen and de Ruijter argue, however, that Naroll and others are guilty of categorizing ecological and geographical clustering of traits as diffusion (fn. 10), 34. This problem might be handled empirically by including variables that measure these traits in the analysis. Unless the correlations among the independent variables are extremely high, the researcher can then test the alternative hypotheses. Erikson offers the suggestion that certain types of variables are more likely than others to diffuse and to create higher and lower risks of incurring Galton's problem (fn. 38), 78-81. For a further discussion of differential diffusion rates across substantive areas, see Stanley Witkowski, "Galton's Opportunity: The Hologeistic

overly severe in the case of ecological and environmental variables, they probably are not severe enough here because we had to pair each country with a single partner and thus could not account for either indirect influence or multiple sources working simultaneously. As mentioned above, a matrix-type method such as that developed by Wirsing or Pryor might be more appropriate to handle this problem.

A final question raised by Galton's problem is that of the statistical consequence of analyzing samples where the cases are not independent. Do neighboring nations having similar scores on a number of traits represent independent units that should all be included in a sample? Anthropologists doing cross-cultural work have generally answered this question in the negative.[60] Political scientists engaged in cross-national research have used other criteria for sample selection, such as membership in the United Nations or the availability of data. If cross-national researchers were to accept the verdict of most anthropologists, the question of appropriate sampling units would need to be resolved.[61] For most practical purposes, a sample as small as the one we drew on the basis of Russett's trade regions is impractical. Possibly a general answer is not called for, but sampling units can be defined on the basis of substantive variables under study. The most radical solution suggests that all cross-national—and possibly much other cross-unit—research is inappropriate because of the lack of independence of cases.[62] Although this last position strikes us as extreme for the moment, we would welcome discussion of it among people involved in cross-unit research. As Naroll points out, the same problems that confront an-

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Study of Historical Processes," in Schaefer (fn. 1), 84-112. The independence of different processes of diffusion is seen in the correlation matrix of the diffusion measures in the African sample, where the variation in both the magnitude and, in a few cases, the direction of the diffusion is large.

[60] Several authors have suggested techniques which try to correct for diffusion through the estimation of an adjusted sample size which is lower than the actual *N*. See Strauss and Orans (fn. 9), and Simonton (fn. 9).

[61] Not all anthropologists consider Galton's problem important. For example, see Vermeulen and de Ruijter's quote (fn. 51). Melvin Ember also suggests that random sampling is all that is needed, even if some of the units in the sample happen to be in close contact with each other. See "An Empirical Test of Galton's Problem," *Ethnology*, x (January 1971), 98-106. Loftin's (fn. 29) and Erikson's (fn. 38) responses to Ember show the weakness of this position.

[62] Several anthropologists have suggested that the most important problem is the nature of the units under study in cross-cultural research and the degree to which they can be compared. Known as Flower's problem, this question is beyond the scope of this paper. See Barbara Frankel, "Reply Comment on Vermeulen and de Ruijter," *Current Anthropology*, xvi (March 1975), 39; J. A. Barnes, "Comment on Strauss and Orans," *Current Anthropology*, xvi (December 1975), 585.

thropologists are present in cross-unit work in the other social sciences. Our purposes in selecting cross-national data to illustrate Galton's problem are first, to demonstrate its relevance, and second, to suggest some uncomplicated empirical methods for estimating the relative importance of diffusion and function.