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A SPATIALLY-VARYING PARAMETER MODEL OF AFDC PARTICIPATION: EMPIRICAL ANALYSIS USING THE EXPANSION METHOD*

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Spatial variation in the importance of determinants of participation in the Aid to Families with Dependent Children program (AFDC) is investigated for the U.S. Casetti's Expansion Method is applied to the two-dimensional space domain by making the model's parameters a function of state x–y centroids. The spatially-varying parameter model suggests that the black population's association with participation is lowest in the Southeast and Northwest and greatest in the Southwest and Northeast. **Key Words: AFDC, Expansion Method, parameter variation, trend surface, welfare.**

Public assistance is a significant feature of American society, including a large number of people and a substantial commitment of resources. In discussions of public assistance, or "welfare," one important ingredient is the mechanisms influencing participation. Much attention has been directed toward understanding the explosive growth of public assistance rolls in the U.S. as well as the equally interesting issue of what determines geographic variations in program use. Answers to these questions have policy significance because public officials need to know factors influencing participation to better understand and predict possible changes resulting from alterations in program supply or demand.

The common approach to identifying the determinants of welfare program participation is to specify a model in which substantive variables are tested vis-à-vis others in a multivariate framework. This process allows identification of important relations and may be used to assess likely program impacts if conditions alter. Most of these models make the assumption that the factors influencing participation remain equally important for different areas of the country. In other words, while variables in these analyses may assume different values, the extent to which they are related is usually held constant for all places studied.

The assumption that the processes are identical in all areas may ignore a spatial dimension to the understanding of participation variations. Although research *could* reveal that the relation between program use and its correlates does not vary over space, this should not constitute a premise upon which analyses are conducted. Instead, the possibility that in some areas of the U.S. certain processes operate more strongly than in others is a justifiable research question. Answers may provide clues to participation and its determinants and may lead to improved analyses which reflect localized adherence of the model.

Examined here are participation variations in Aid to Families with Dependent Children (AFDC), a large, state-supported and administered program with substantial disparities in implementation, effectiveness, provision, and use [*24, 25, 26*]. A model is developed to investigate whether the determinants of participation variations at the state level differ in their association over space.

The research question posed above emanates from Casetti's Expansion Method, which is both a methodological tool for testing the variation in relationships in different contexts, and a research paradigm directing questions concerning the differential operation of these relationships. Here the Expansion Method suggests a concern for spatial variation in the associations between welfare program participation and its determinants, a feature generally neglected heretofore.

The major perspectives guiding past research are discussed below as is a rationale for analyzing the spatial operation of participation determinants. The methodological aspects of the research are then presented, including a discussion of the use of the Expansion Method to

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detect parameter variation in the two-dimensional space domain. The spatially-varying parameter model is presented in the fourth section and followed by conclusions.

Welfare Participation Determinants in a Spatial Context

Analyses of welfare institutions and their impacts are conducted within two broad theoretical perspectives [13, 14]. The first is an orthodox developmental/modernization perspective, in which program variations are seen to be the result of the supply and demand for state services. In this perspective equilibrium shifts are a response to demographic changes, economic dislocations, and the ability and willingness of the state to provide services [1, 2, 13, 14]. The second, a radical political class struggle perspective, views welfare institutions within the context of advanced capitalism, operated by the state in the general interest of capital, creating conditions for accumulation, and preserving social harmony [13, 14, 19].

The variables commonly identified under the first perspective conform broadly to factors influencing the supply and demand for welfare. Participants respond to a variety of forces affecting need, such as unemployment and urbanization, and to variations in program supply, such as benefit levels. Taken together, the mixture of need and local variations in welfare provision create variations in levels of participation. The radical perspective does not deny that supply and demand forces are associated with welfare variations, but argues that these are not direct causes. Instead, conditions inherent in capitalist society are thought to generate cycles of growth and depression, resulting in political disorder and insurgency, provoking the state to expand welfare provision and increase rolls [13].

Of central concern here is the fact that whatever perspective dominates empirical work, there is the implicit assumption that the parameters of quantitative models are spatially stable [e.g., 1, 11, 14, 16, 20, 23, 26]. This may result in erroneous conclusions in two ways: by incorrectly attributing importance to a determinant for some area, or by masking some process which is place specific. Allowing parameters to vary may provide information concerning participation variations and the processes thought to generate them. Quite simply, we can ask: Are there patterns to the processes?

There is empirical evidence consistent with a shift in causal mechanisms along regional lines. For example, growth in AFDC participation is more responsive to unemployment growth in the North Central and New England states than in the South and West [15]. This finding means that given equal growth in unemployment throughout the U.S., participation growth would be higher in Snowbelt than Sunbelt states.

Variations in the processes could be investigated regardless of the overriding research perspective. If variables drawn from both perspectives are incorporated into a single model and tested together, then variations in the effects of determinants may reveal that in some areas one perspective provides greater explanation than the other. One possibility is that the developmental/modernization perspective is more in concert with processes in the liberal "welfare state" in the Northeast, while the political class struggle perspective is more applicable to the South, where welfare institutions have historically operated in the interests of the power elite [19]. It may be no coincidence that the focus of the most extensive research from the radical perspective is the South [19].

While some authors have examined spatial differentials in the effects of welfare use determinants [e.g., 2, 15, 18, 22], for the most part these have been broad regional tests of parameter instability. The approach illustrated here allows for a more detailed picture of the spatial patterns of parameters. The model draws upon variables employed previously; after estimating parameters for the country the significant terms are tested for spatial parameter stability. Before presenting the model, I first describe the use of the Expansion Method to estimate spatially-varying parameters.

Spatially-Varying Parameters by the Expansion Method

A number of techniques have been used to investigate spatial variation in functional relations. One approach is re-estimating the same relations over different data sets and comparing the parameters obtained [10]. The use of dummy variables [12, 27], the jackknife technique [21], and the more general Drift Analysis of Regression Parameters [6] all fit in this category. The continuous variation of a model's parameters is outside the scope of most of these ap-

proaches; in addition, data set stratification reduces available degrees of freedom. The Expansion Method [3, 5] is instead efficient in terms of data requirements. It also facilitates and makes routine the asking of questions and testing of hypotheses concerning the manner in which substantively meaningful functional relations "perform" in wider contexts. Previous applications of the approach in spatial settings concerned variation in parameters with distance from growth poles [8, 9], central business districts [4], and other foci [7]. This research utilizes the Expansion Method to identify patterns in the association among variables in two-dimensional spatial contexts. To illustrate this approach, a description of the Expansion Method is provided, followed by the extension to the two-dimensional spatial case.

The Expansion Method systematizes the building of more complex terminal models from simple initial ones. The method redefines at least some of the parameters of an initial model as functions of other variables which may or may not appear in the initial model. The expanded parameter is then substituted back into the initial model to obtain a terminal one. When both the initial model and its expansions are intrinsically linear, the parameters of the terminal model are also intrinsically linear and capable of being estimated by OLS regression.

To illustrate the Expansion Method, let

$$z = \quad + bw \tag{1}$$

be an initial model, where z and w have been measured at a number of points in space. If we hypothesize that b varies with distance, s, from some point of interest, then we can redefine the parameter using the Expansion Method. A linear specification of the relationship can be written as:

$$b = b_0 + b_1 s \tag{2}$$

Replacing (2) into (1) we obtain the terminal model:

$$z = a + b_0 w + b_1 sw \tag{3}$$

The parameters of equation (3) can be estimated and tested for significance using a multiple regression program. If b_1 is significantly different from zero we could conclude that the relationship between z and w is a function of the distance from the point, as hypothesized.

In the above case b is hypothesized to vary in one dimension from a pre-assigned point in space. This approach has been applied in a variety of contexts. In many models of spatial processes no a priori assumptions of parameter distance-decay can be made. In these instances we require a model which allows us to estimate spatially-varying parameters in two-dimensions. Fortunately, a two-dimensional extension of the technique is easy to implement. To demonstrate, again let (1) be an initial model where z and w are measured in space. If we hypothesize that b varies over space, we can redefine b as a smooth function of the two-dimensional coordinates of the areal units or sample points. Expanding b into a second-order polynomial or "trend surface" of x and y coordinates, we obtain:

$$b = b_0 + b_1 x + b_2 y + b_3 xy + b_4 x^2 + b_5 y^2 \tag{4}$$

This results in the following terminal model:

$$z = a + b_0 w + b_1 xw + b_2 yw + b_3 xyw + b_4 x^2 w + b_5 y^2 w \tag{5}$$

Now assume that estimates of b_0 to b_5 are significantly different from zero. Replacing them back into (4) would then yield a function b(x,y) which is the spatial portrait of the parameter b. If some, but not all of the parameters b_0 to b_5 are significant, the function can be computed with only the significant terms. If only b_0 is significant, then we conclude that the parameter is spatially stable with respect to a second-order polynomial expansion. Higher order polynomials can be employed to obtain a greater degree of spatial resolution in the parameter's surface. This approach is applied to investigate spatial variation in the factors influencing participation in the AFDC program.

An Application to AFDC Participation Rates

The regressions reported below employ data for the 48 conterminous states. The dependent variable is the percentage of persons less than 18 years old receiving AFDC benefits in De-

cember, 1975. This participation rate is noted as PRAFDC. Six independent variables, also measured in 1975, were tested as explanatory factors. They are:

(1) The state unemployment rate, UNEMP, which has been consistently associated with levels of participation [11, 16, 23].

(2) The average monthly benefit level paid per family, BEN. Participants may respond to benefit levels which vary widely among states [25] and have been found associated with participation in the food stamp program [17], the general assistance program [16], and AFDC [20].

(3) The percentage of the population residing in cities over 50,000, URBAN. This variable is an indicator of access to local AFDC offices and also serves as a proxy for the anonymity provided by large urban areas. Regarding AFDC, Wohlenberg argued that "the effect of the stigma factor is greater in rural areas," while "the greater anonymity of the metropolitan setting is more conducive to seeking help than is the milieu of the small town" [25, p. 260].

(4) The state median educational level, EDUCAT. It has been argued that in states with high levels of education welfare eligibility standards might be more lenient and the social stigma associated with participation less [11, 14, 25].

(5) and (6) The percentages of the population black and of Spanish origin, BLACK and SPAN. These variables were included since these groups are disproportionately greater users of the program. Their significance in welfare participation studies is documented [17, 20].

Means and zero-order correlations of these variables are shown in Table 1. The parameters of an initial model relating these six independent variables to PRAFDC were estimated using a stepwise multiple regression program, which was terminated when variables failed to achieve a 95 percent confidence level. Of the six variables, UNEMP, BEN, and BLACK were significant (Table 2).

Consider the possibility that these variables might differentially influence state participation rates. Beginning with UNEMP, we might expect differential effects because of differences in the prevailing attitude toward welfare provision among both administrators and the eligible population, differential access of the unemployed to the provision of the program, and differences in the degree of state reliance upon AFDC relative to other welfare programs. These differences suggest that equal unemployment rates may be associated with varying AFDC participation rates.

The percent black can be differentially related to AFDC participation rates because of the considerations listed above, plus at a given level higher rates might be found where the black population is more of a political force, is located in high access urban areas, and, because of a breakdown in extended family social networks, is more reliant upon social welfare programs than kinship ties in periods of economic stress. Also in some states social welfare agencies may be more or less restrictive than in others, resulting in variations in the degree to which the black population influences state participation rates.

Finally, consider benefit levels. The parameter measures the overall responsiveness of participants to AFDC benefits. Spatial variation in it would indicate that state populations differ in their response to a given benefit level. This variation could be attributed to differences in the cost of living among regions, but benefit levels exhibit far more variation than cost of living. Wohlenberg [25] noted that cost of living varied 21 percent in 1970 among metropolitan

TABLE 1

SUMMARY STATISTICS FOR VARIABLES USED IN THE INITIAL MODEL

Variable	Mean	St. Dev.	PRAFDC Simple r
PRAFDC	10.14	3.54	—
UNEMP	8.10	2.11	.54
BEN	64.79	22.92	.04
URBAN	59.44	24.69	.34
EDUCAT	11.82	0.68	.31
BLACK	9.10	9.37	.47
SPAN	3.59	6.58	−.03

TABLE 2

REGRESSION STATISTICS FOR INITIAL MODEL

Variable	Estimate	St. Error	t-value
UNEMP	0.72277	0.17007	4.367[a]
BLACK	0.24604	0.04684	5.253[a]
BEN	0.06137	0.01904	3.224[a]
CONSTANT	−2.08731		
	Multiple R: .75	Adjusted R^2: .53	

[a] $p < 0.01$.

areas in 26 states, while benefit levels in these same states varied 234 percent. The overall effect of benefit levels is likely to override any regional variations in cost of living. Because the approach taken here is exploratory, the benefit parameter was also tested for spatial variation.

From the significant elements composing the initial model,

$$PRAFDC = a + bUNEMP + cBLACK + dBEN$$

an expansion of b, c, and d was carried out, using a third-order polynomial in the coordinates of state areal centroids:

$$b = b_0 + b_1x + b_2y + b_3xy + b_4x^2 + b_5y^2 + b_6x^2y + b_7y^2x + b_8x^3 + b_9y^3 \quad (6)$$

$$c = c_0 + c_1x + c_2y + c_3xy + c_4x^2 + c_5y^2 + c_6x^2y + c_7y^2x + c_8x^3 + c_9y^3 \quad (7)$$

$$d = d_0 + d_1x + d_2y + d_3xy + d_4x^2 + d_5y^2 + d_6x^2y + d_7y^2x + d_8x^3 + d_9y^3 \quad (8)$$

The spatially-varying parameter model was obtained by substituting these expanded parameters into the initial model. While this model may seem unwieldy, it was decided here to err on the side of a relatively high-order polynomial to capture spatial variation which could actually be quite complex. A stepwise regression program used to estimate the parameters of the model was terminated when variables not in it failed to achieve the 95 percent confidence level. Of the thirty parameters (excluding the intercept), only four were found significant (Table 3). These include the parameters for UNEMP, BLACK, and BEN, as well as the c_3 parameter, associated with the product of BLACK and the x and y coordinates. Thus, percent black was found to have a spatially-varying parameter. The significant elements c_0 and c_3 were replaced into (7) to obtain the following function of x and y:

$$c(x,y) = 0.28273 + 0.19842xy$$

TABLE 3

REGRESSION STATISTICS FOR EXPANDED MODEL

Variable	Estimate	St. Error	t-value
BEN	0.05190	0.01843	2.816[a]
UNEMP	0.73797	0.16106	4.582[a]
BLACK	0.28273	0.04679	6.053[a]
BLACK*X*Y	0.19842	0.08055	2.463[b]
CONSTANT	−1.58610		
	Multiple R: .78	Adjusted R^2: .58	

[a] $p < 0.01$.
[b] $p < 0.02$.

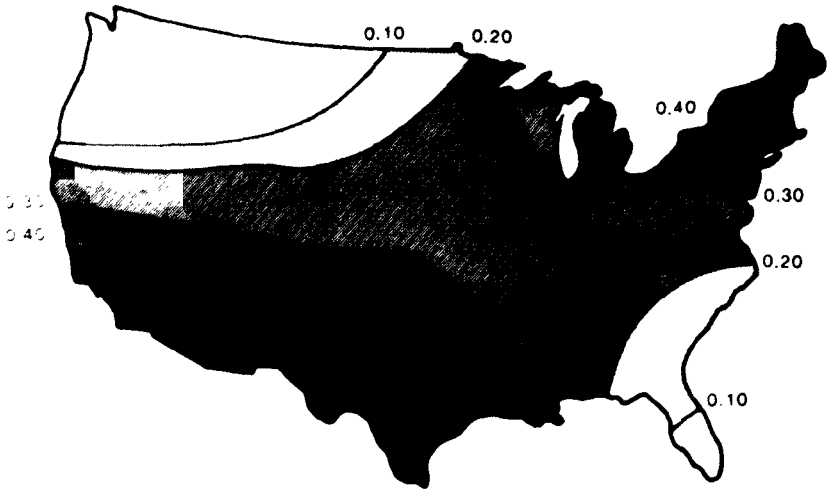

Figure 1. Spatial effect of black population upon AFDC participation.

This parameter, which represents the spatially-varying effect of BLACK upon PRAFDC, is mapped (Figure 1). The spatial form is consistent with the argument set forth above regarding the possible existence of differential responses among states to the black population. The parameter is highest in the Northeast where access to the AFDC program among predominantly urban blacks is likely to be high. In the South the parameter is less strong, possibly reflecting lower access of rural blacks or perhaps more restrictive practices by public welfare agencies. The parameter increases in the Southwest, and falls off dramatically in the Northwest and Rocky Mountain states where the black percentages are low. That the parameter is low in a number of states indicates that blacks in those states have even less impact upon PRAFDC than their small proportions would otherwise indicate.

Conclusion

The findings reported have implications for public assistance studies and for spatial analytic research in general. The results suggest that parameter stability should not be an assumption of nationwide analyses. The spatially-varying parameter model provides evidence for a "threshold effect" wherein the black population affects welfare use in a non-linear manner, with a disproportionately low impact where their numbers are small and greater impact elsewhere, particularly large metropolitan settings. Although this effect has been noted [*11, 14, 19*], its presence has not been revealed by constant parameter models. There is also support for the argument that blacks are unequally served by welfare institutions in the South, again a theme in the literature [*19*], but not a finding of the more common cross-sectional models. Because the need for public assistance is great in areas where the parameter is low, it appears that spatial inequities in program provision persist [see *24, 25*]. Redressing imbalances may prove difficult in a political climate that supports returning more fiscal and administrative responsibility for social programs to states.

The broader implication emerging from this research concerns the application of the Expansion Method to the two-dimensional space domain. This approach can lead to better models of causal processes by providing new information regarding the effects of independent variables. At a minimum the Expansion Method provides a conceptual framework that explicitly examines the operation of empirical relationships across space. This framework equips areal

association with an additional set of geographic questions by allowing researchers to consider places as not only having different levels of variables but possibly different causal mechanisms as well.

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