The Distribution of Public Services: An Exploration of Local Governmental Preferences

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A local governmental welfare function is specified to explore two of its central characteristics: the equity-productivity tradeoff and differential weights across neighborhoods. The model is estimated using service outputs (safety) in the welfare function, as opposed to publicly provided inputs (police), over neighborhoods. The equity-productivity tradeoff is found to be considerable, and not all neighborhoods are weighted equally. The estimation results raise several questions about accepted analysis of governmental behavior.

The *Serrano v. Priest* case concerning the allocation of educational expenditure in California brought the question of the nature of the distribution of local public services to the forefront of policy debate.[1] Despite considerable subsequent attention to related issues in the press and in political and judicial arenas, there has been little systematic economic analysis of important dimensions of this process. The fairly sparse related literature to date, recently surveyed by Edward Gramlich and Daniel Rubinfeld (1982), has focused on the empirical pro-poor vs. pro-rich bias of local public expenditures.

A problem with examining expenditures, however, is that what is of concern to residents is the actual level of service that is provided by local governments. The present paper therefore represents an important departure from most previous literature because we study distribution of local public service outcomes, rather than expenditure.[2] We hypothesize that local services are distributed "as if" there is a constrained maximization of a local governmental social welfare function,[3] defined over the distribution of local public services among the residents of its jurisdiction.[4] Differentiation between publicly provided inputs and final service outcomes reflects that there are two separate constraints on governmental welfare

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[1] *Serrano* v. *Priest* (1971, L.A. 29820); subsequent opinion December 30, 1976. This is the landmark case in which the California Supreme Court ruled that the school finance system was unconstitutional due to the equal protection clause in the state constitution.

[2] This distinction itself is not original with us, though a number of studies seem to ignore it.

[3] The median voter model is the usual method for specifying local governmental preferences. However, this model has some well-known disadvantages, especially in the modeling the government of a large, heterogeneous city (see Robert Inman, 1979, for a discussion of these issues). Competing theories of governmental behavior are just beginning to be developed; they essentially involve group decision-making models (Kenneth Shepsle, 1979; Craig and Inman, 1985). These group behavior models may involve an agenda-setting politician, coalition building, or logrolling concensus building. We do not provide a structural model of governmental behavior, but we model the "as if" preferences of the government to allow for distributional concern, whatever the cause. We model local governmental preferences to depend on public services outcomes. Some observers suggest that expenditures (or, for constant prices across neighborhoods, inputs) may be arguments of a local governmental welfare function. Our approach is a start towards attempting to explain the observed distribution of publicly provided inputs given local governmental preferences over the service outcomes.

[4] This process operationalizes and significantly extends the local governmental choice framework first suggested, to our knowledge, by Carl Shoup (1964). We thank the referees for bringing Shoup's contribution to our attention.

maximization. The first is a resource constraint, which determines the amount of publicly provided inputs that are available. The second is a production constraint that determines how much public service outcome is produced by a combination of the publicly provided inputs and existing neighborhood characteristics.[5]

The distinction between publicly provided inputs and service outcomes is crucial because the allocation of inputs and the distribution of outcomes across neighborhoods can be very different. The difference can be illustrated in our model because we explicitly incorporate the production function constraint that converts inputs into outcomes. The model shows that the distribution of inputs (or expenditures) may respond in the opposite direction than the distribution of public service outcomes in response to changes in neighborhood characteristics. Further, we formulate the model to incorporate systematically different welfare weights for different neighborhoods, that may depend on characteristics such as income or racial composition.[6] We estimate the key parameters of our model using the allocation of police and safety from crime across neighborhoods in Baltimore. The empirical example shows how the distribution of final service outcomes depends on the key parameters of the "as if" welfare function.

The critical attributes of the local governmental welfare function are two. The first, inequality aversion, refers to the tradeoff between equity and productivity as reflected in the curvature of the welfare surface. The degree of curvature indicates the relative tradeoff between equity and concern over maximizing aggregate city-wide output (productivity). The second attribute of the welfare function, unequal concern, pertains to weights in the governmental welfare function for the service outcomes of different neighborhoods. Such weights may differ, for example, depending on neighborhood political support for the current local governmental incumbents, or on the possible movement of some residents from the jurisdiction to the detriment of the local tax base.[7] Unequal concern is reflected in the asymmetry of the welfare surface around a 45° ray from the origin.

Local government inequality aversion and unequal concern may underlie important differences between the publicly provided input and public service outcome distributions. A pro-poor distribution of publicly provided inputs across neighborhoods, for example, may result from a number of conceptually different phenomena:

1) The objective of the city government is to maximize aggregate service outcomes over the entire city, with no concern about distribution of those outcomes. Equivalently, there is no inequality aversion and there is no unequal concern. If publicly provided inputs would have a higher marginal product in poor neighborhoods were they distributed equally, resources are distributed in a pro-poor fashion for productivity reasons alone.

2) The objective is to equalize service outcomes for each neighborhood, in which case there is an extreme case of inequality aversion, but no unequal concern. If publicly provided inputs are more productive in rich neighborhoods, a pro-poor distribution of publicly provided inputs results because concern about equity overrides productivity considerations.

3) The objective of the city is to provide greater services for poor neighborhoods so

[5] Outcomes depend on both publicly provided inputs and private resident characteristics (see D. F. Bradford, R. A. Malt and W. E. Oates, 1969). For example, crime may be less in a "safe" neighborhood than in a "dangerous" neighborhood even if both have the same level of police activity.

[6] Distributional concerns in the policy arena are much broader than simply concern over income. Inman and Rubinfeld (1979), for example, show that racial concerns are potentially important in applying the *Serrano* decision to jurisdictions in which a distribution biased towards high-income groups would not be the basis for legal complaint.

[7] The group conflict models which underlie unequal concern imply many possible reasons why distribution may matter to local governments. Our specification is not a structural model of the causes of distributional concern, but it allows an empirical test of whether the group conflict models merit further investigation.

there is unequal concern favoring the poor. Even if publicly provided inputs are more productive in rich neighborhoods, a pro-poor distribution of such inputs may result.

These alternative scenarios illustrate that the distribution of *inputs* provided by a city government does not necessarily provide insight into the government's distributional interests regarding service *outcomes*. They also highlight the tradeoff faced by city government between equity and productivity and the possibility of unequal concern about different neighborhoods.

Our general model of the welfare-maximizing local government is presented in Section I. Section II discusses explicit functional forms and their implications. Section III presents the unique data set that we use, which involves the level of safety from crime in each neighborhood of a single jurisdiction. Section IV presents the empirical results. We find in the case of the distribution of police and of safety from crime among neighborhoods in Baltimore that the local government does sacrifice some productivity in order to achieve a more equitable distribution of service outcomes, and that unequal concern is pro-poor and pro-young, but racially neutral. A brief summary and conclusion is presented in the final section.

I. The Model

We assume that the local government acts as if it maximizes a welfare function defined over service outcomes in each neighborhood of the jurisdiction. In this one-period model, the resource constraint is assumed to be fixed. Further, the political structure is assumed constant, so the form of the welfare function also is exogenous. The model is developed specifically to account for the empirical example, the distribution of police and of safety from crime across neighborhoods of a single city. Nonetheless, the model is general to any public service outcome, and can be used to explore the allocation of any publicly provided input.[8]

The welfare function of concern to the local government is

$$(1) \qquad W = W(\underline{S}, \underline{N}),$$

where $\underline{S}$ is a vector of outcomes such as safety from crime per capita in each of m neighborhoods and $\underline{N}$ is a vector of populations in each neighborhood.

The first derivatives with respect to both $\underline{S}$ and $\underline{N}$ are assumed to be positive. This welfare function is maximized subject to two constraints. First, there is a constraint on total governmental resources (R) which can be used to purchase public inputs, such as police:

$$(2) \qquad R \geq \sum_{j=1}^{m} TP_j N_j,$$

where R is the total available governmental resources (assumed to be fixed by the political process for the period of interest), $\underline{P}$ is a vector of per capita publicly provided inputs, where the jth element is the amount of the factor allocated to the jth neighborhood, and T is the price of P_j.

The second constraint specifies that production of the output, S, is dependent on the level of publicly provided inputs, P_j, and on a vector of neighborhood characteristics, $\underline{X}_j$.[9] The neighborhood characteristics in $\underline{X}_j$ are given for the period of the governmental allocation problem. Any neighborhood characteristics that adjust to the allocation of governmental resources within the time period of concern (for example, private security guards may be adjusted in response to police allocations) are not included in $\underline{X}_j$. Instead the private reaction functions for private inputs dependent on $\underline{X}_j$ and P_j are used to eliminate these inputs, so that S_j

[8] The model also is easily generalizable to a multitude of service outcomes and a multitude of publicly provided inputs. Here the one-outcome, one-input case is presented since that is the case explored in our empirical estimates. See Behrman (1986) for a multiple-input, multiple-output generalization for the intrahousehold allocation of nutrients.

[9] The neighborhood characteristics ($\underline{X}_j$) could include population or population density to capture contention effects or scale economies in the production of services. See Craig (1987b).

depends only on P_j and $\underline{X}_j$ in the following relation:[10]

$$S_j = f(P_j, \underline{X}_j), \tag{3}$$

where $\underline{X}_j$ is a vector of characteristics of the jth neighborhood that affect the outcome of interest but are not adjusted during the period.

We can obtain the first-order conditions under the assumptions that the welfare function in (1) and the production relation in (3) have the standard desirable properties for an interior maximum to occur. The intuition behind the model can be illustrated geometrically by considering the ratio of the first-order conditions for neighborhoods 1 and 2:

$$\frac{\partial W/\partial S_1}{\partial W/\partial S_2} = \frac{N_1\,\partial S_2/\partial P_2}{N_2\,\partial S_1/\partial P_1}. \tag{4}$$

The left side of (4) is the slope of the welfare function, for which W in Figure 1 indicates an iso-welfare curve.[11] The right side of (4) is the slope of the production possibility frontier, which is the convex solid line identified by S_1 and S_2. The production possibility frontier illustrates that the "price" of allocating more inputs to one neighborhood is the lost output in other neighborhoods. Welfare maximization leads to a tangency at point 1, at which point the marginal rate of substitution in the welfare function equals the marginal rate of transformation along the production possibility frontier.

In general, the slopes of the production possibility frontier for planes between different pairs of neighborhoods differ due to different values of $\underline{X}_j$ across neighborhoods (through equation (3)). Because the different pairwise planes of the production possibility frontier are tangent to the same welfare function, they trace out the curvature and location of that welfare function. For example, the dashed line in Figure 1 indicates the production possibility frontier in the plane for neighborhoods 3 and 4 with a tangency at point 2. The curvature of the welfare function can be identified by considering a series of points like 1 and 2. Note that estimation of relation (4) gives estimates of characteristics of the welfare function and not necessarily those of the production relation (3). Our analysis does account for the fact that both P_j and S_j may enter into relation (4), for which reason control for simultaneity is required.

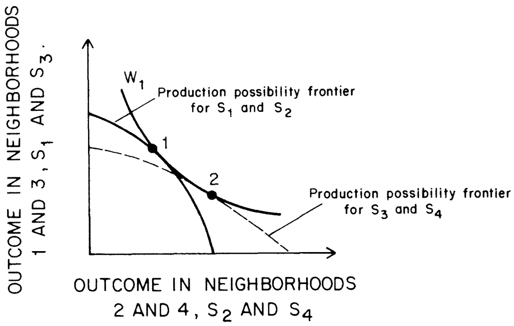

FIGURE 1. PRODUCTION POSSIBILITY FRONTIERS AND WELFARE-MAXIMIZING ALLOCATIONS

As we noted, the two critical attributes of the local governmental welfare function pertain to its curvature (inequality aversion) and to its asymmetry around a 45° ray from the origin (unequal concern). Figure 1 assumes some inequality aversion (with a curvature between the extreme linear case of focus only on productivity and the L-shaped case of focus only on equity) and equal concern. Equal concern about neighborhoods does *not* generally imply equal service outcomes across neighborhoods because the production set is not symmetrical if the distribution of $\underline{X}_j$ is not symmetrical. Figure 2 indicates a case of unequal concern in which neighborhood 2 is favored over neighborhood 1 in the sense that the weights in the welfare function are greater for neighborhood 2 than for neighborhood 1. Thus we distinguish between equal and unequal concern related to the *symmetry* of the iso-welfare curves around the 45° line and in-

[10] We are assuming a short-run allocation problem in which people do not move among neighborhoods because of the distribution of service outcomes. However, such movements could be made endogenous and dependent on S for a longer time horizon.

[11] This iso-welfare curve is drawn symmetrically around the 45° ray from the origin; it is not necessary to do so (see below).

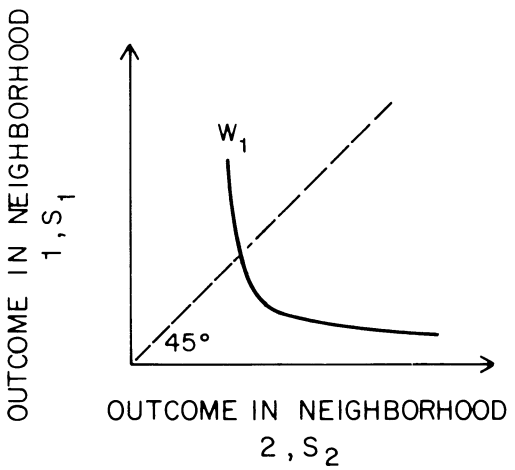

FIGURE 2. ILLUSTRATION OF UNEQUAL CONCERN ABOUT DISTRIBUTION OF THE OUTCOME

equality aversion (or the equity-productivity tradeoff) related to the *shape* of the iso-welfare curves. Both attributes of the welfare function are essential for determining the distribution of outcomes. For example, unequal concern even with pure inequality aversion (i.e., L-shaped iso-welfare curves) results in an unequal distribution of service outcomes.

II. Explicit Functional Forms and Relative vs. Absolute Inequality Aversion

This section presents explicit functional forms for the welfare function in (1), and for the production function constraint in (3). These functional forms allow estimation of the first-order conditions. From these results conclusions can be drawn as to what extent the local government trades off equity of public service outcomes for productivity (inequality aversion) and whether welfare weights differ across neighborhoods (unequal concern).

A. *Production Function Specification*

The production constraint on local governmental welfare maximization is assumed to have a partial log-linear form:

$$\ln S_j = \varepsilon \ln P_j + h(\underline{X}_j), \tag{5}$$

where ε is a production function elasticity, and h is any functional form with positive marginal productivities for $\underline{X}_j$.

The first-order condition for P_j is

$$\partial S_j / \partial P_j = \varepsilon S_j / P_j. \tag{6}$$

Since S_j depends on $\underline{X}_j$, this partial derivative depends on the neighborhood characteristics $\underline{X}_j$ and therefore changes as $\underline{X}_j$ changes, as is required for the identification of the welfare surface, even though $\underline{X}_j$ does not appear explicitly in (6).

B. *Welfare Function Specification*

We have explored two alternative specifications of the welfare function (1). One is the relatively well-known *CES* form; the other is the Kohm-Pollak (KP) specification (see Charles Blackorby and David Donaldson, 1980, and Behrman and Raaj Kumar Sah, 1984).[12] The difference in the specifications is in their treatment of the inequality aversion parameter. Empirically, we find more support for the KP specification, which is presented here. The *CES* specification is presented in the Appendix since this specification probably is more familiar and may be more appropriate than the KP form in other applications. The KP welfare function is

$$W^{KP} = \frac{1}{q} \ln \left[\sum_j \alpha_j \frac{N_j}{N} e^{qS_j} \right] \text{ for } \approx \tag{7}$$

where N is $\Sigma_j \alpha_j N_j$. The parameter q summarizes the equity-productivity tradeoff. The lower is q, the greater is governmental inequality aversion concerning the distribution of public services among neighborhoods. As $q \to 0$, the KP welfare function approaches the pure productivity sum over individual outcomes with no concern about inequality. For $q_i \to -\infty$, the KP welfare function ap-

[12] We also have considered a generalized *CES* form with displacement from the origin by a set of parameters b_j. These b_j a priori could relate to unequal concern. However, we find no empirical support for such displacements, so we do not consider them further in this paper.

proaches the L-shaped pure equity form. For values of q between these two extremes, there is an equity-productivity tradeoff.

The parameters α_j relate to equal vs. unequal concern. If there is equal concern, $\alpha_j = \alpha$ for all m neighborhoods. If there is unequal concern, α_j depends on neighborhood characteristics, such as racial composition or income level. The α_j parameters can be interpreted to control for the political influence of the jurisdiction, and therefore allow the parameter q to represent the direct equity vs. productivity tradeoff.

The representation of inequality aversion in the KP welfare function is absolute. This can be seen from calculating the shape of an isowelfare curve between neighborhoods 1 and 2:

$$(8) \qquad \left.\frac{dS_1}{dS_2}\right|_{W^{\mathrm{KP}}} = \frac{N_2\alpha_2}{N_1\alpha_1} e^{q(S_2 - S_1)}.$$

This relation says that along an iso-welfare curve it is the *absolute* difference in expected outcomes across neighborhoods (not their relative values as in the *CES* case in the Appendix) that is relevant.

The logarithm of the first-order condition for the constrained maximization of the KP welfare function (7) is

$$(9) \qquad \ln P_j = A^{\mathrm{KP}} + qS_j + \ln S_j + \ln \alpha_j$$

where

$$A^{\mathrm{KP}} = \ln\left(P\lambda \left[\sum_j \alpha_j N_j e^{qS_j}\right] \text{for} \approx / \varepsilon\right),$$

is a constant within a period, and λ is the Lagrangian multiplier for the budget constraint.

For empirical work, a stochastic term can be added to represent the fact that observed *ex post* outcomes differ from *ex ante* expected outcomes. Estimates then can be obtained of absolute inequality aversion (q) with data on outcomes and government-allocated inputs across neighborhoods. Without further assumptions or a priori information it is not possible to identify the absolute magnitudes of the components of A^{KP}. However, it is possible to identify whether the α_j reflect equal concern by substituting for α_j a relation dependent on neighborhood characteristics into (9). If neighborhood characteristics are found to influence the α_j, the hypothesis that all residents are weighted equally in the allocation process can be rejected.[13] Simultaneous estimation is required for (9) because it involved S_j and P_j, as does the production relation in (5).

III. Data: Safety from Crime and Police Allocation in Baltimore

Our empirical illustration of the model considers the allocation of police to produce safety from crime in the city of Baltimore in fiscal year 1972. The unit of observation is an individual neighborhood. The allocation of police in Baltimore is an interesting example for two reasons. First, there had been considerable local (Democratic) political stability in Baltimore at that time, with the same police chief (D. D. Pomerleau) since 1968, so the factors underlying the allocation processes probably are not masked by too much noise from adjustment processes. Second, a unique data base exists for Baltimore in 1972 which permits the estimation of our model, including the exploration of whether it is survey-reported crime or officially reported crime that matters in the allocation process.

The data base contains information on 79 (out of 240) representative residential neighborhood police beats.[14] It combines data from: 1) the *Criminal Victimization Surveys* on survey-reported crime per capita; 2) the

[13] The estimates of q are not particularly dependent on the choice of variables included in the α_j for our sample. The identification of the impact of neighborhood characteristics on α_j, however, is more problematic. See fn. 20 below.

[14] This includes all the police beats on which data were collected in the crime survey. The beats fairly represent neighborhoods in Baltimore (see Craig, 1987a, for more detail). The police beats included are not all contiguous. For this reason we have avoided the complications of including "spillover" effects on other neighborhoods in the models of Sections I and II; such an extension would be straightforward, but tedious.

TABLE 1—DATA DEFINITIONS AND DESCRIPTIVE STATISTICS[a]

Variables	Means	Standard Deviations	Ranges
Outcomes[b]			
Per capita safety from officially reported crime	1.28	.28	.04–1.55
Per capita safety from survey reported crime	.54	.14	.09–.75
Officially reported crime per capita	.32	.28	.05–1.56
Survey reported crime per capita	.26	.14	.05–.71
Inputs			
Police patrols per capita ($\times 10^{-3}$)	1.010	.880	.095–5.195
Neighborhood Characteristics Tested for Relation to Unequal Concern			
Mean household income	$6928	$2941	$2795–18179
Percent residents white	36.6	39.0	0–100
Percent residents over 65	13.1	8.4	0–35.2
Percent resident-owned housing	29.8	22.5	0–82.0
Other Instruments			
Percent households with income < $5000	44.6	23.2	0–91.1
Percent households with income > $15000	7.9	10.5	0–56.1
Percent single homes	60.8	26.7	0–100
Percent with ≥ 10 units per building	13.6	24.4	0–100
Percent married	39.1	14.3	0–69.4
Percent male	42.8	7.6	16.7–62.3
Percent between 16 and 24-years-old	21.3	7.7	0–44.4
Percent unemployed	2.4	3.6	0–21.6
Percent completed high school	85.9	16.6	19.3–100
Percent insured for loss	18.0	19.0	0–100
Percent criminals observed who are white	18.6	31.4	0–100
Percent crime victims employed	58.5	22.9	0–100
Average age of household head	38.4	6.1	25.6–53.2
Average dollar loss per crime	$246.9	$365.8	$0–3000

[a]There are 79 neighborhoods in the sample. Data are for Baltimore in fiscal year 1972.
[b]Per capita safety from crime is defined as is indicated in relation (10): per capita safety from officially reported crime is 1.6 minus officially reported crime and per capita safety from survey reported crime is 0.8 minus survey-reported crime.

Baltimore Police Department on officially reported crime per capita and the number of police per capita; and 3) census data on neighborhood characteristics.[15] Table 1 gives summary statistics of the variables that we use.

We use two outcomes: safety from survey-reported crime per capita and safety from officially reported crime per capita. One interesting fact in the study of crime is that about one-half of all crime is unreported to the police. Because a survey measure of neighborhood crime is available, these data permit examination of whether the police authorities use officially reported or survey-reported crime in making police allocation decisions. Unfortunately, the survey measure of crime has some deficiencies; in particular, it does not measure crime to nonresidents in an area, while it includes crime to residents suffered in other areas. We restrict our analysis to residential crime to minimize these problems (see Craig, 1987a, for more details).

For both outcomes, we define safety from crime[16] to be

$$S_j = \bar{C} - C_j, \tag{10}$$

[15]The data base was prepared by Robert Highsmith while he was at Towson State University. We are grateful to him for kindly making it available for this study.

[16]Some outcomes may lessen "bads" such as crime (but perhaps in other contexts, disease) rather than increase "goods." Of course, goods can be considered to be the absence of bads. Because our functional forms use logarithms, for empirical purposes we use safety from crime as defined in relation (10) as the outcome of interest.

where $\bar{C} > \max(C_j)$ and C_j is the per capita crime rate (reported or actual) in the jth neighborhood. The empirical results are not qualitatively sensitive to a range of values for $\bar{C}$. We use a value slightly above $\max(C_j)$ in the estimates that we present below.[17]

The equation of interest for estimation is (9). The problem is a simultaneous one, as not only does the allocation of police depend on safety levels, but safety levels are produced by police. Therefore, we use an instrumental variable estimator, with a list of instruments that accounts for the supply of crime, the private demand for safety, the propensity to report crime, and exogenous determinants of the probability of arrest. The instruments are derived from a simultaneous equation model of urban crime; Craig (1987a) presents the full specification. These instruments include the 4 neighborhood characteristics indicated above, plus 14 additional characteristics (see Table 1). The basic thrust of our results is not sensitive to the exact instruments used.

IV. Estimates of Inequality Aversion and Unequal Concern in Baltimore Allocation of Police Patrols

The first set of empirical results that is presented utilizes a two-output version of the model to examine whether officially reported or survey-reported crime is the more relevant decision variable in the local government welfare function. Results are then presented for both the KP and *CES* specifications of the welfare function, although we concentrate on the empirically preferred KP specification.

A. *Safety from Officially Reported vs. Survey-Reported Crime*

As noted in Section III, our sample includes data on crime as reported in police records, and survey-reported crime as indicated in the National Crime Victimization Survey. We estimate a nonlinear relation parallel to the antilog of (9), but with an extension to the two-output case with safety from officially reported crime and safety from survey-reported crime as the two weighted outcomes, in order to examine which measure of public service outcome is more relevant empirically.[18]

Since the results are robust with regard to variations in specification, we report in Table 2 the estimates for the simplest case—the basic KP model with equal concern. We find that the weights on safety from officially reported crimes are positive and significant while those for safety from survey-reported crime are negative and insignificant.

There are at least two possible explanations for finding that officially reported crime

TABLE 2—ESTIMATION OF KP WELFARE FUNCTION PARAMETERS WITH TWO OUTCOMES: OFFICIALLY REPORTED AND SURVEY-REPORTED CRIME[a]

Right-Side Variables	Parameters in Two-Outcome Extension of First-Order Condition in Relation (9)
Multiplicative Coefficient of[b]	
Safety from Officially Reported Crime	45.1[d] (14.9)
Safety from Survey-Reported Crime	−5.6 (5.4)
Inequality Aversion Parameter[c]	
Safety from Officially Reported Crime	−2.9[d] (.51)
Safety from Survey-Reported Crime	−3.0 (1.7)
R^2	.76
SEE	27.5

[a]Beneath the point estimates are the standard errors of estimates. The R^2 are pseudo R^2 calculated as one minus sum of squares of the error over the total sum of squares of the dependent variable.
[b]The first two rows give the weights on the safety from reported and survey crime terms, respectively.
[c]The third and fourth rows give the estimates for the inequality aversion parameter (i.e., q in (9)).
[d]Point estimates that are significantly nonzero at the 5 percent level.

[17]To be explicit, we use $\bar{C} = 1.6$ for per capita safety from officially reported crime and $\bar{C} = 0.8$ for per capita safety from survey-reported crime.

[18]In such an estimation the weights cannot be identified separately from the product of the equal concern parameters (α_j), the constants (A^{KP}), and the production function parameter (ε). But the significance of the product that includes the weights can be determined from the estimates.

TABLE 3—KP AND *CES* WELFARE FUNCTION PARAMETER ESTIMATES WITH AND WITHOUT EQUAL CONCERN[a]

Right-Side Variables	Absolute Inequality Aversion KP—Equation (9) Equal Concern (1)	Absolute Inequality Aversion KP—Equation (9) Unequal Concern (2)	Relative Inequality Aversion *CES*—Equation (A2) Equal Concern (3)	Relative Inequality Aversion *CES*—Equation (A2) Unequal Concern (4)
Estimates of Inequality Aversion:				
ln Safety from Crime per Capita (c for *CES*)	1.0[b]	1.0[b]	−1.6[c] (.30)	−.90[c] (.30)
Safety per Capita (q for KP)	−4.0[c] (.30)	−3.4[c] (.39)		
Determinants of Unequal Concern:				
α (or a)				
Mean household income		−.55[c] (.17)		−.66[c] (.20)
Percent residents white		−.02 (.02)		−.02 (.02)
Percent residents over 65		−.06[c] (.03)		−.08[c] (.04)
Percent resident-owned housing		−.01 (.03)		−.06[c] (.03)
Constant	4.5[c] (.38)	8.8[c] (1.3)	−.04 (.10)	6.0[c] (1.7)
R^2	.53	.67	.27	.55
SEE	24.7	17.1	48.3	25.8

[a]See fn. a, Table 2.
[b]In these estimates the coefficient of ln safety is constrained to be one as required in relation (9).
[c]See fn. d, Table 2.

empirically dominates as a determinant of the allocation process. First, the officially reported information may be the best (or only) information available to the allocator of police across neighborhoods. Even if the survey crime measure is better, the police may not have accurate information on how officially reported and actual crime diverge systematically across neighborhoods. Second, even if the allocator of police knows the pattern of actual in addition to officially reported crimes and survey-reported crime is a better measure of actual crime than is officially reported crime, attention may be focused on officially reported crimes because of the perception that they are more important in the political process.[19] If either of these explanations hold, there may be social gains in terms of control of total crime from improving the data on officially reported crime to reflect better the patterns of actual crime.

In any case, because of this evidence on the relative importance of safety from officially reported crime in the police allocation process, we focus exclusively on officially reported crime in what follows.

B. *Welfare Parameters Underlying Police Allocation*

Table 3 presents estimates of specifications with equal and with unequal concern for the first-order conditions derived from the KP (9) and *CES* (A2) welfare functions. These results are robust in three crucial respects. First, and most important, they indicate substantial governmental inequality aversion, but still with some equity-productivity tradeoff. Second, they indicate that

[19]See Craig (1987a) for additional discussion of this issue, an estimate of the causes of the propensity to report crime, and a discussion of the problems with the survey crime measure.

unequal concern prevails in the allocation decisions, so that all neighborhoods are not weighted equally in the "as if" social welfare function. Third, they suggest that police patrol allocations are more consistent with the KP absolute inequality aversion than with the *CES* relative inequality aversion local governmental welfare function (see the Appendix for the *CES* specification).

The statistically significant inequality aversion is in addition to any unequal distribution of inputs resulting from different social welfare weights for different neighborhoods. The KP results allowing for unequal concern yield an estimate of q of -3.4. This estimate is significantly less than zero, indicating aggregate outcome is not maximized. At the same time, however, there also is significant concern about productivity, as the inequality aversion parameter is significantly greater than the extreme of concern solely with equity. Results for the *CES* case are similar; the estimated value of c is significantly negative with both the equal and the unequal concern specifications.

In addition to the inequality aversion, *F*-tests reject the hypothesis of equal concern across neighborhoods.[20] As discussed in Section II, this means that public service output is weighted more heavily in the local governmental welfare function for some neighborhoods than for others. The estimates with unequal concern are robust in suggesting preferences for greater safety from crime for lower income and younger (in the sense of a smaller percentage of residents over 65) neighborhoods, but there is no significant impact of racial composition. The estimates are mixed for the percentage of resident-owned housing, with a significant negative effect in the *CES* case, but insignificant impact in the preferred KP case. Thus the preference weights seem to be pro-poor and pro-young, but neutral regarding race and probably resident-owned housing.

Some important implications of our estimates of inequality aversion and of unequal concern can be seen by solving relations (5) and (9) for the reduced form for the ratio of safety from crime:[21]

$$(11)\quad \frac{e^{h(\underline{X}_1)}}{e^{h(\underline{X}_2)}}\left(\frac{\alpha_1}{\alpha_2}\right)^{\varepsilon}=\left(\frac{S_1}{S_2}\right)^{1-\varepsilon}\frac{e^{-qS_1\varepsilon}}{e^{-qS_2\varepsilon}}.$$

Since $0<\varepsilon<1$ (because it is the elasticity of safety from crime with respect to police patrols) and q is estimated to be less than zero (see Table 3), all of the powers on the right side of relation (11) are positive; therefore, if neighborhood 1 has more of the characteristics that produce safety from crime and there is equal concern ($\alpha_1=\alpha_2$), neighborhood 1 has greater safety ($S_1>S_2$).

Relation (11) also is useful for examining the optimal allocation of safety from crime in neighborhood 1 vs. 2. The more unequal concern favors neighborhood 1 (i.e., the greater is α_1/α_2), the greater is safety from crime in neighborhood 1 relative to 2. Since the mechanism for increasing safety from crime in neighborhood 1 vs. 2 is through allocation of police patrols (given neighborhood characteristics), relation (11) also implies that the more unequal concern favors neighborhood 1, the greater the relative al-

[20] Estimation of a model that allows unequal concern may have a greater problem with identification than does estimation of a model assuming equal concern because of the introduction of neighborhood characteristics. We have noted in Sections I and II that our estimates are of first-order conditions that permit identification of certain characteristics of the welfare function and *not* of production relations, which also involve the neighborhood characteristics in $\underline{X}_j$. If the neighborhood characteristics in $\underline{X}_j$ were exactly the same as the neighborhood characteristics on which unequal concern depends, however, our first-order conditions would be identified from production relations only by the functional forms (and, as a referee has noted, some alternative production relation to that in (5) may make identification by functional form impossible). On a priori grounds we do not think that the set of neighborhood characteristics that we explore in our estimates are identical to the elements of $\underline{X}_j$ in the production relation (also see Craig, 1987a). Moreover, our estimates of the inequality aversion parameters do not change significantly if we allow unequal concern, as might be expected were we switching from estimating the first-order condition to the production function. Therefore we interpret our estimates to relate to unequal concern and not to the production process.

[21] Closed-form expressions for the ratio of police patrols and safety from crime cannot be derived for the KP case. See the Appendix for such expressions in the *CES* case.

location of police patrols to that neighborhood.

These estimates imply an allocation of police resources that partially compensates for the distribution of neighborhood characteristics that prevent crime. While there is ambiguity in the KP case about which neighborhoods have greater police patrols, relation (11) does show that the relative allocation of police is greater to neighborhoods with more crime-causing characteristics. But compensation does not offset completely the impact of neighborhood characteristics, so neighborhoods with more crime prevention characteristics are more safe than are those with relatively greater police patrols. In addition, those neighborhoods that are favored by unequal concern are allocated further police and have greater safety from crime than would be the case with equal concern.

V. Summary and Conclusions

We have presented a model which explicitly examines the distributional preferences of a local government over service outcomes. An important feature of the model is that it distinguishes inequality aversion from unequal concern in the social welfare function of a local government. The model is estimated for a particular case, the allocation of safety from crime and of police across neighborhoods in Baltimore in 1972. All the major results hold with both alternative specifications of the welfare function. These empirical results indicate a significant degree of inequality aversion, so that some aggregate production is sacrificed in order to obtain the equity goals of the local government. Further, there appears to be unequal concern so that the safety from crime outcomes are weighted differently for residents in different neighborhoods. Subject to qualifications about the conditionality of our estimates on our assumptions and data, our empirical results have potentially far-reaching implications for models of local government behavior.

First, we have shown that at least one major local government appears to have substantial concern about equity in the distribution of a local public service. The inequality-aversion parameters that we estimate are significantly negative, even after accounting for the fact that residents may be weighted unequally in the social welfare function. This suggests that the local government compensates for the distribution of characteristics across neighborhoods regarding safety, rather than reinforcing the impact of such characteristics, in its allocation of police across neighborhoods. While a structural model that would explain strong inequality aversion has not yet been developed, our contribution shows that pursuing such a research goal may yield interesting new insights into governmental behavior.

Second, we also show that in this case not all residents are weighted equally in the local welfare function. These results also merit further examination. Unequal concern may exist, for example, because residents who receive less safety from crime may receive more of other publicly provided services, such as education. Conversely, the results may reflect that certain residents are more "in favor" with the authorities, and receive more of all locally provided services. While our single-input, single-outcome estimates are not able to distinguish between these two alternatives, or from a host of other explanations, the point is that a distinction among residents apparently is being made by the government. Research with a multi-output extension of our model, if data become available, could clarify further the situation. In any case, our results imply that models which a priori assume that all residents are treated equally in the distribution of governmental services are ignoring the potentially important fact that unequal welfare weights may prevail.

Third, our empirical support in this case for both aspects of unequal service allocation by neighborhood implies potentially serious misspecification in studies of aggregate local public service demand. Models of preference aggregation may need to take heed of the fact that people pay taxes based on the city-wide amount of purchased inputs, but base their demand and voting behavior on the perceived level of neighborhood service output. The standard assumption of median voter models is that residents participate equally in service outputs and tax shares. These models calculate resident tax shares based upon their share in the cost of the aggregate level of purchased inputs. However, the framework and results presented here show that residents may share unequally in the benefit of those inputs to the extent that service outcomes differ from the allocation of inputs. Thus, residents may perceive different service levels even when they have equal tax shares, causing differences in the voting behavior of people who prima facie may appear to face the same constraints.

Appendix

The CES Welfare Function Specification

The *CES* specification of the welfare function is

$$\text{(A1)} \qquad W^{CES} = \left(\sum_j N_j a_j S_j^c \right)^{1/c}.$$

The parameter c refers to inequality aversion. Like q for the KP specification, as c is more negative, inequality aversion is greater. At the extreme with only concern about equity, c is $-\infty$; for the intermediate Cobb-Douglas case, c is zero; and for the extreme with only concern about productivity, c is one so that W^{CES} is the weighted sum of the S_j. The a_j parameters represent unequal concern, in the same manner as the α_j parameters in the KP version. Inequality aversion in the *CES* case is relative (i.e., along an iso-welfare curve it is the *relative* outcomes that matters), rather than absolute as in the KP case. Nonetheless, the estimation results are similar for the two cases (see Table 3).

Maximization of (A1) subject to the resource and production constraints yields an estimating equation from the first-order conditions that is similar to (9) for the KP case:

$$\text{(A2)} \qquad \ln P_j = A^{CES} + c \ln S_j + \ln a_j,$$

where

$$A^{CES} = \ln\left(P\lambda \Big/ \left(\varepsilon \left(\sum_j N_j a_j S_j^c \right)^{(1-c)/c} \right) \right)$$

is a constant within a period.

One advantage of the *CES* case is that closed-form expressions can be derived for the ratios of P_1/P_2 and S_1/S_2 for neighborhoods 1 and 2, analogous to equation (11) for the KP specification:

$$\text{(A3)} \qquad \frac{P_1}{P_2} = \left(\frac{a_1}{a_2}\right)^{1/(1-\varepsilon c)} \left(\frac{e^{h(\underline{X}_1)}}{e^{h(\underline{X}_2)}}\right)^{c/(1-\varepsilon c)};$$

$$\text{(A4)} \qquad \frac{S_1}{S_2} = \left(\frac{a_1}{a_2}\right)^{\varepsilon/(1-\varepsilon c)} \left(\frac{e^{h(\underline{X}_1)}}{e^{h(\underline{X}_2)}}\right)^{1/(1-\varepsilon c)}.$$

Again, the implications of these expressions are similar to those for the KP version, except there is no ambiguity; the allocation of police patrols is greater to the neighborhood with less crime prevention characteristics for our estimate of c in Table 3.

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