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NOTES

THE GEOGRAPHIC HETEROGENEITY OF PUBLIC EXPENDITURE FUNCTIONS

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I Introduction

The empirical estimation of public expenditure functions has been prominent in the quantitative public finance literature.[1] Numerous scholars have ascertained the impact of population, density, population growth, income, and intergovernmental transfers on various definitions of public expenditures. Some have focused on SMSA's, others have focused on counties; both total and disaggregated (by function) expenditures have been analyzed. The vast bulk of empirical work has used published Census data and pooled data for a particular governmental unit across a wide geographic area to perform regression analysis.

A priori, such pooling is untenable, for regressions across state boundaries implicitly assume either identical state tax institutions or relatively homogeneous institutions and homogeneous needs and preferences of each resident population. These seem unreasonable behavioral assumptions to any student of local finance. The paucity of local government statistics undoubtedly has necessitated this approach. Yet to a limited extent, researchers have been aware of systematic geographic differences in expenditure behavior as evidenced by urban-rural distinctions. We seek in this paper to analyze this geographic heterogeneity more systematically by investigating inter-regional and inter-state differences in local expenditures. We ascribe such likely differences among regions to differing needs and preferences and ascribe such differences among states within a region to differing fiscal institutions.

To show that such inter-region heterogeneity exists, we examine regional expenditure functions and test the null hypothesis that expenditure determinants operate in the same fashion for each region. To show that intra-region heterogeneity exists, we examine state expenditure functions and test the null hypothesis that expenditure determinants operate in the same fashion for states within the same region. Section II presents the expenditure model to be used, hypothesis testing technique, and data base. Section III presents the empirical results, and section IV concludes.

II Model, Technique, and Data Base

In a recent issue of this *Review*,[2] Henderson derived and estimated an expenditure function of the form:

$$G = \beta_1 + \beta_2 Y + \beta_3 R + \beta_4 P + \epsilon \qquad (1)$$

where G is per capita general local government expenditures, Y is per capita income, R is per capita intergovernmental transfers, P is local population, ϵ is a random disturbance term, and β the vector of unknown reduced-form parameters. He estimated (1) for two groups of governmental units: the 100 most populous (urban) counties and the remaining (rural) 3000 counties in the United States.

To test for heterogeneity, we test for the equality of regression coefficients [3] of regional versions of (1). Our null hypothesis, H_0, is that $\beta_{R1} = \beta_{R2}$, i.e., that the vector of reduced-form parameters in region 1 equals the vector of parameters in region 2. Denoting the residual sum of squares of a regression as SS, we may test H_0 by computing the following F statistic:

$$F_{k,i+j-2k} = \frac{[SS_{1+2} - (SS_1 + SS_2)]/k}{(SS_1 + SS_2)/(i+j-2k)} \qquad (2)$$

where k is the number of parameters estimated, i is the number of counties in region 1 and j is the number of counties in region 2. If $F_{k,\,i+j-2k} > F_{\alpha}$[4] we reject H_0 and infer that expenditure behavior is significantly different in the two regions. An identical procedure is used to test for interstate heterogeneity.

We shall estimate (1) using 1962 data from the

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[1] Bahl (1968) lists and reviews 66 such studies as of November, 1968.

[2] James M. Henderson, "Local Government Expenditures: A Social Welfare Analysis," this REVIEW, 50 (May, 1968), 156–163.

[3] This test is developed by Gregory C. Chow, "Tests of Equality between Sets of Coefficients in Two Linear Regressions," *Econometrica*, 28 (July, 1960), 591–605.

[4] We set α equal to 0.01 to minimize Type I error.

County and City Data Book, 1967.[5] All raw data refers to 1962 except for population and income which were adjusted to 1962 by assuming constant rates of change as suggested by the 1960–1965 population increase.[6] The basic governmental unit is the county which contains aggregations of all units through the county level of government. We define an urban county to be one with more than 100,000 population in 1962, in consonance with the Census definition of a "State Economic Area." [7] We estimate (1) first for the four Census regions and test the six possible regional hypotheses of equality for urban and rural expenditure equations. Within each region, urban and rural state pairs are created by first ranking states on the basis of density, population, and median family income and then pairing the states most similar in average rank. States with less than ten counties in the urban or rural category were excluded from the state pairing tests on statistical grounds.[8]

III Test Results

Table 1 presents the F tests of the six regional hypotheses.[9] Note that we first test both urban and rural counties together for each pair of regions. We reject all but one null hypothesis at the 99 per cent confidence level. In only one case, the urban North Central vs. the urban South, do we find no significant difference in expenditure behavior.

Table 1. — Homogeneity Tests of Expenditure Functions

	H_0	Group	F
1	NE = NC	Urban and Rural	67.20[a]
	NE = NC	Urban	7.50[a]
	NE = NC	Rural	12.32[a]
2	NE = S	Urban and Rural	88.77[a]
	NE = S	Urban	7.46[a]
	NE = S	Rural	49.79[a]
3	NE = W	Urban and Rural	25.37[a]
	NE = W	Urban	10.47[a]
	NE = W	Rural	6.67[a]
4	NC = S	Urban and Rural	227.60[a]
	NC = S	Urban	1.83
	NC = S	Rural	281.20[a]
5	NC = W	Urban and Rural	29.17[a]
	NC = W	Urban	3.34[a]
	NC = W	Rural	33.79[a]
6	S = W	Urban and Rural	154.18[a]
	S = W	Urban	3.77[a]
	S = W	Rural	137.91[a]

[a] Reject H_0 at 99 per cent confidence level.

The inter-regional differences are highlighted by examining the regression equations themselves. Table 2 presents the regional expenditure equations. When we compare urban counties in the Northeast with urban counties in the North Central region, we find substantially different expenditure responses to changes in all three variables. With the regions pooled, we find that a dollar more of personal per capita income elicits eleven cents more in local expenditures. In the Northeast, slightly less than eleven cents (10.8 cents) would be spent, while in the North Central region, slightly more than six cents (6.4 cents) on the dollar would be spent. Even more divergent results obtain when we focus on the effect of a marginal dollar of intergovernmental transfers. The pooled results suggest that 1.84 dollar beyond the original dollar will be spent; in the Northeast 1.96 dollar more will be spent; and in the North Central region, expenditures are stimulated by only thirty-eight cents beyond the dollar. All of these comparisons are made with statistically significant regression coefficients. The reader will find many other dramatic differentials in table 2 that clearly document regional heterogeneity in expenditure patterns.

We turn now to investigate heterogeneity in pub-

[5] U.S. Bureau of the Census. *County and City Data Book, 1967*. (Washington, D.C.: U.S. Government Printing Office, 1967).

[6] Denoting the 1960–1965 percentage change in county population as CHG, we define 1962 county population as: $P_{62} = P_{60}(1 + CHG)^{2/5}$.
We obtain 1962 per capita income by multiplying 1959 aggregate income times $(1 + CHG)^{3/5}$ and then dividing this by P_{62}.

[7] *County and City Data Book, op. cit.*, xiv.

[8] That is, we are estimating four parameters in the expenditure equation and have chosen six degrees of freedom as the minimum we wish to utilize. Unfortunately, there are few states with ten or more urban counties that are in a region with another such state. Of course, all four regions have at least ten urban counties.

[9] The states in each region are:

North East (NE)	North Central (NC)	South (S)	West (W)
Connecticut	Illinois	Virginia	Arizona
Maine	Indiana	Alabama	Colorado
Massachusetts	Michigan	Arkansas	Idaho
New Hampshire	Ohio	Florida	Montana
Rhode Island	Wisconsin	Georgia	Nevada
Vermont	Iowa	Louisiana	New Mexico
Delaware	Kansas	Mississippi	Utah
New Jersey	Minnesota	North Carolina	Wyoming
New York	Missouri	South Carolina	California
Pennsylvania	Nebraska	Texas	Oregon
	North Dakota	Kentucky	Washington
	South Dakota	Maryland	
		Oklahoma	
		Tennessee	
		West Virginia	

TABLE 2. — REGIONAL EXPENDITURE EQUATIONS

Regional Group	Urban-Rural	Constant $\hat{\beta}_1$	Population $\hat{\beta}_2$	Income Per Capita $\hat{\beta}_3$	Inter-governmental Revenue Per Capita $\hat{\beta}_4$	R^2
NE	Urban	−182.459	.00040	.10852	2.96840	
			(.00020)	(.02065)	(.15304)	.86
NC	Urban	1.335	.00010	.06400	1.37942	
			(—)	(.01226)	(.16352)	.56
NE + NC	Urban	−170.298	.00010	.11081	2.83783	
			(.00010)	(.01354)	(.11566)	.82
NE	Rural	−106.839	−.00055	.14322	1.26513	
			(.00017)	(.01995)	(.09102)	.67
NC	Rural	82.656	.00067	.05310	.89667	
			(.00008)	(.00432)	(.04116)	.40
NE + NC	Rural	73.199	.00066	.05617	.96264	
			(.00007)	(.00429)	(.03788)	.43
S	Urban	19.293	.00004	.05137	1.11752	
			(.00002)	(.01313)	(.26853)	.34
NE + S	Urban	−120.218	.00005	.08088	2.78401	
			(.00001)	(.01265)	(.12813)	.79
S	Rural	97.459	—	−.00043	.66325	
				(.00114)	(.06674)	.25
NE + S	Rural	106.832	−.00020	.00786	.79172	
			(.00006)	(.00126)	(.04467)	.14
W	Urban	−96.527	—	.08146	2.16404	
				(.01528)	(.18705)	.80
NE + W	Urban	−38.589	.00001	.07522	1.70069	
			(—)	(.00919)	(.08855)	.78
W	Rural	138.687	−.00035	.00092	1.24185	
			(.00019)	(.00037)	(.06898)	.48
NE + W	Rural	133.577	−.00044	.00093	1.26986	
			(.00013)	(.00037)	(.05656)	.51
NC + S	Urban	.642	.00010	.06475	1.25909	
			(.00010)	(.00810)	(.15595)	.47
NC + S	Rural	106.832	−.00020	.00786	.79172	
			(.00006)	(.00126)	(.04467)	.14
NC + W	Urban	−38.589	.00001	.07522	1.70069	
			(—)	(.00969)	(.08855)	.78
NC + W	Rural	135.849	−.00031	.00096	1.15084	
			(.00008)	(.00027)	(.3472)	.46
S + W	Urban	−27.233	−.00001	.06545	1.73999	
			(.00001)	(.00993)	(.12501)	.73
S + W	Rural	60.401	−.00007	.00077	1.44680	
			(.00008)	(.00030)	(.04375)	.40

Standard error is in parentheses. A dash indicates a value smaller than 0.00001.

lic expenditure behavior within each Census region. Table 3 presents the *F* test results for the state pairs. In the North Central region, we find substantial urban and rural homogeneity, and in the Northeast rural homogeneity; however, strong within region differences appear for the urban Northeast, the entire South, and the entire West. Thus, urban Michigan and urban Ohio are quite similar in urban expenditure functions; rural New York, Pennsylvania, Maine, Vermont, Illinois, Ohio, Michigan, Wisconsin, and Minnesota are similar as well.

TABLE 3. — HOMOGENEITY TESTS OF STATES PAIRED within Census Regions

State Pairs H_0	Region	Urban-Rural	$\hat{F}$
New York = New Jersey	NE	Urban	25.37[a]
Massachusetts = Pennsylvania	NE	Urban	4.06[a]
Illinois = Ohio	NC	Urban	9.73[a]
Michigan = Ohio	NC	Urban	.71
Florida = Texas	S	Urban	5.33[a]
New York = Pennsylvania	NE	Rural	1.90
Maine = Vermont	NE	Rural	.40
Illinois = Ohio	NC	Rural	.13
Indiana = Michigan	NC	Rural	2.55
Wisconsin = Minnesota	NC	Rural	2.08
Iowa = Kansas	NC	Rural	3.60[a]
Nebraska = South Dakota	NC	Rural	3.59[a]
North Dakota = South Dakota	NC	Rural	7.25[a]
Virginia = Alabama	S	Rural	1.45
Florida = Texas	S	Rural	4.29[a]
Georgia = Louisiana	S	Rural	12.19[a]
North Carolina = Tennessee	S	Rural	2.85
Alabama = South Carolina	S	Rural	7.24[a]
Mississippi = Oklahoma	S	Rural	28.94[a]
North Carolina = Arkansas	S	Rural	38.11[a]
California = Washington	W	Rural	29.72[a]
Colorado = Oregon	W	Rural	1.75
Arizona = Utah	W	Rural	.92
Nevada = New Mexico	W	Rural	15.96[a]
Idaho = Montana	W	Rural	7.79[a]
Montana = Wyoming	W	Rural	17.75[a]

[a] Reject H_0 at 99 per cent confidence level.

IV Conclusions

It is not surprising that regional differences exist in local public expenditure behavior. Certainly Southern communities have little need for snow removal, while North Central and Northeast communities certainly do. Such differences in need will create differences in expenditure patterns. More importantly, state tax sharing institutions vary enormously as do the ways in which a locale provides public services. States may provide the service or the community may be forced to purchase it out of local or local plus shared state tax revenues. In either case, reported expenditure figures may be misleading regarding the actual basket of public goods a community consumes. Such aggregation bias, as it were, compounds as one regresses across geographic regions and in many instances across states within a region.

While wont to suggest a purely institutional approach to the explanation of public expenditure behavior, our results do indicate the need for caution in such studies. If the purpose of such a study is to predict future local expenditure levels, then we have shown that such prediction should be substantially improved by accounting for geographic heterogeneity. If the purpose of such studies is to define the important determinants of local expenditures, then we have shown that region must be included in the analysis, for omission of geographic considerations will lead to serious specification error.

In terms of immediate public policy, it should be reiterated that local response to intergovernmental transfers, the precursor to systematic Federal revenue sharing, varies dramatically by region and within region, let alone by an urban-rural breakdown. Hence, evaluations of alternative revenue-sharing strategies which attempt to account for the stimulative effects of transfers must account for this substantial regional variation in behavior at the outset.

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