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Local governments in Michigan, as municipal corporations authorized by their respective charters, provide basic services like police protection, fire control, emergency services, roads, water and sewer, parks and recreation, public improvements, planning and zoning, and general administrative services to the residents in their jurisdictions. Expenditures for these services are partly a matter of service level and quality. A local government of a given size may provide its own police patrol while another may rely on county sheriff's department respond to calls. Per capita expenditures will differ accordingly even for the same sized places. But size may also influence service demand. For example, a small government may have demand only for elementary police services while a larger unit with congestion and regional malls drawing a diverse population may require more extensive and comprehensive services. Expenditures can also be related to economies of scale in providing a given level and quality of service. For example, emergency central dispatch represents a lump fixed investment and the cost per capita falls as population increases up to a point and then may increase again as management becomes complex. Thus, per capita expenditures are the results of a host of factors including the rate of population growth and its distribution (density, relation to other centers of population, and land use).

Several studies based on a single year cross-sectional data have offered population growth as the most significant factor that explains variations in local government expenditures. However, a preliminary observation of historical data of population and expenditures of the fast growing communities in Michigan that have comparable population size does not confirm this claim. This observation warrants further studies that use rich and extensive data that could help in finding the other variables that are significant in impacting expenditures of local governments. This paper extends the literature by longitudinal data and further isolates the various factors that explain the variations in expenditures and attempts to understand the relationship between mix of land use, population settlement patterns, and public service expenditures of local governments in the State of Michigan and to draw some policy implications for expenditures associated with

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alternative patterns of populations settlement and land development. The impacts of selected explanatory variables including total population, population density, population growth rate, and state equalized value of different types of properties (agricultural, residential, commercial, and industrial) on expenditures were investigated in the context of two types of government (city or township), population size groups (large or small), and geographic location (Southeast Michigan or the rest of the state).

There are significant variations in the per capita expenditures of comparable communities ranging from $34 to $1,029 in constant 1995 dollars. Cities and townships classified by population sizes have different expenditure patterns. While cities with smaller population size spend $120 per person more than cities with larger population size, townships with larger population size spend $126 per person more than smaller townships. Furthermore, cities spend considerably more ($305 per person) than townships and communities located in Southeast Michigan spend more ($143 per person for cities and $62 for townships) than those in the rest of the state (See Tables 1 & 2). What are the factors that explain these variations?

Table 1: Characteristics of Fast Growing Cities in Michigan 1981 – 1995

Variables	*Large*	*Small*	*SE Michigan*	*Rest of State*	*All*
Per Capita Expenditure	402	522	527	393	479
Total Population	71,573	16,030	36,440	34,155	35,633
Annual Pop Growth Rate	1.9	2.0	2.2	1.5	2.0
Pop Density	2,119	1,235	1,613	1,425	1,547
Per Capita Property Value	23,084	20,602	23,580	17,625	21,478

Table 2: Characteristics of Fast Growing Townships in Michigan, 1981 – 1995

Variables	*Large*	*Small*	*SE Michigan*	*Rest of State*	*All*
Per Capita Expenditure	287	161	206	144	174
Total Population	67,523	19,768	33,986	16,048	24,708
Annual Pop Growth Rate	1.6	1.8	2.0	1.6	1.8
Pop Density	2,193	658	1,144	511	816
Per Capita Property Value	20,277	18,220	18,933	17,966	18,432

The Model

In order to specify the decision model of local governments it is assumed that local governments respond to service demand generated by their environment and are subject to the underlying cost function. The efficiency of public service providers for a given quality and quantity of the services provided was not included in the model because they are very difficult to measure and there are no data that could be used for such a purpose.

The econometric technique used to analyze the data is the *Fixed Effects* regression model. The basic assumptions considered in the model relate to the heterogeneity, stochastic relationship, and residuals of the explanatory variables. Heterogeneity across the observation units was considered to be essential because the constant term, α_i, of the regression equation is expected to vary across units of observation. The expenditure data showed that the relationship between the expenditures and the independent variables were not fixed, exact, or deterministic. Since the study was conducted under a non-experimental and uncontrolled environment, it was necessary to assume that the relationship between the explanatory variables and the dependent variable are stochastic in nature. The estimation of the unknown parameters in the equation is assumed to largely depend on the nature of the error terms (residuals). Error terms could arise in this study from one or two factors. Some variables (like demography and politics, for instance) that may have systematic or irregular influences on expenditures were not included in the model. This omission could constitute specification error that leads to inaccurate estimation of the economic relationship between expenditures and the independent variables. Furthermore, the fact that public service expenditures are decided by people and that people randomly make different decisions under identical circumstances makes it difficult to specify a model that accounts for such a behavior**.** Therefore, the *Fixed Effects* regression technique is selected to use a complex statistical analysis that could capture and account for such specification errors that are inherent to studies using extensive panel data like this one.

The basic framework of the model was given by

$$y_{it} = \alpha + \beta x_{it} + v_i + \varepsilon_{it} \qquad (1)$$

where: y_{it} = per capita public service expenditures of unit *i* at time *t*
x_{it} = vector of all independent (explanatory) variables (of unit *i* at time *t)*
α = constant (intercept)
β = estimated coefficients of the independent variable
v = unit-specific residual (differs between *i* units but constant for any particular unit)
ε = "usual" residual (with mean 0, uncorrelated with itself, uncorrelated with *v*, and homoscedastic)

From equation (1) it follows that

$$\bar{y}_i = \alpha + \bar{x}_i \beta + v_i + \varepsilon_i \qquad (2)$$

where: $\bar{y}_i$, $\bar{x}_i$, and ε_i are within-group means of y_{it}, x_{it}, and ε_{it}.
Subtracting equation (2) from (1), we obtain

$$y_{it} - \bar{y}_i = (x_{it} - \bar{x}_i)\beta + (\varepsilon_{it} - \bar{\varepsilon})_i \qquad (3)$$

Equation (3) is the most common form of the *Fixed Effects* estimator. But, in this formula, α remains unestimated. Therefore, with further mathematical manipulation, it follows from equation (1) that

$$\hat{y} = \hat{x}\beta + \bar{v} + \hat{\varepsilon} \qquad (4)$$

where $\hat{y}$, $\hat{x}$, $\bar{v}$, and $\hat{\varepsilon}$ are the grand averages of y_{it}, $x_{it,,}$ v_i, and ε_{it} and the computation of the grand averages follows the formula,

$$\hat{y} = \{(\sum_{i=1}^{n}\sum_{t=1}^{Ti} y_{it}) / N\}$$

N is the number of observation. Summing equation (3) and (4), we obtain

$$y_{it} - \bar{y}_i + \hat{y} = \alpha + (x_{it} - \bar{x} + \hat{x})\beta + (\varepsilon_{it} - \bar{\varepsilon}_i + \bar{v}) + \hat{\varepsilon} \quad (5)$$

Then, the *Fixed Effects* with-in regression estimates the above equation under the constraint v = 0. That means, it estimates

$$y_{it} - \bar{y}_i + \hat{y} = \alpha + (x_{it} - \bar{x} + \hat{x})\beta + noise$$

The Data

The study covered the 15-year period between 1981 and 1995. Communities with a population greater than 5,000 and which had grown by at least 1,000 people between 1981 and 1990 were defined as fast growing local governments. Sixty-nine local governments, 17 cities and 52 townships qualify as fast growing communities in Michigan. While all the seventeen cities were included in the study, a sample of twenty-nine townships representing geographic distribution and population sizes were purposefully selected

Data were gathered from US Census population figures, Office of the State Demographer in the Michigan Department of Budget and Management, Comprehensive Annual Financial Reports (1981 to 1995) of the forty-six local governments, State Tax Commission of Michigan Department of Treasury (1981 to 1995), Department of State Police and Fire Marshal Division, County Road Commissions, and interviews.

Data adjustment included netting out of all expenditures to avoid double counting, adjusting to 1995 constant dollars to account for inflation, and amortizing all capital investments over a thirty-year life to spread out the payments (debt service). If this is not done, government spending may appear different just because of the timing of capital expenditure within the 15-year period.

The expenditure data include all expenditures relating to most of the major service categories like general government, public safety, public works, recreation and culture, capital outlay, and debt service. The state-equalized value of properties includes the estimated values of agricultural, residential, commercial, and industrial properties.

Estimation Results

The overall regression estimates, which are the estimated per capita public service expenditures equation for all cities and townships respectively were found to be:

$$y_{it} = 659.3 - (.01)x_1 + (953.7)x_2 - (734.8)x_3 + (.016)x_4 + (.12)x_5$$

and

$$y_{it} = -38 + (.002)x_1 + (56.5)x_2 - (28.1)x_3 + (.05)x_4 + (.09)x_5$$

where y_{it} = per capita expenditures
x_1 = total population
x_2 = population growth rate
x_3 = residential property as % of total property value
x_4 = per capita total property value
x_5 = population density

The significance of most of the independent variables considered in this study, excepting the total property value variable, vary across groups of communities. Variables that are statistically significant in expenditures of cities are not significant in expenditures of townships. Likewise, variables that are significant in expenditures of cities in Southeast Michigan are not significant in the expenditures of cities in the rest of the state. A variable that has a positive association with expenditures of cities may have an inverse relationship with expenditures of townships; and the variable that was inversely related to expenditures of townships in Southeast Michigan may be positively associated with expenditures of townships in the rest of the state. In sum, the ranking of the significance of the independent variables (or their ability to explain expenditures of local governments) vary by types of government, population size, and geographic location of the communities (Tables 3 &4). The relatively large R^2 suggest that the model is quite successful in accounting for the variations in expenditure. The unexplained variation is probably due to political decision on quality level holding other variables constant.

Table 3: ***Fixed Effects*** **Regression Results, Cities**

	Large		Small		SE Michigan		Rest of State		All	
Variable	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Total Population	-0.01	-1.8	-0.02	-4.0	-0.01	-4.7	0.00	0.2	-0.01	-4.8
Pop Growth Rate	-103	-0.3	2003	2.7	1407	2.0	2.5	0.0	953.7	1.8
Residential Property	-169	-1.4	-621	-5.5	-753	-6.7	-326	-1.1	-735	-7.8
Total Property	0.01	7.7	0.02	10.6	0.02	9.5	0.01	5.2	0.17	11.1
Population Density	0.51	1.9	0.02	0.3	0.14	2.0	-0.09	-0.4	0.122	2.0
Constant	221	2.0	533	7.6	679	8.3	409	1.7	659.3	9.5
Adj R^2		0.77		0.74		0.72		0.54		0.68

Table 4: ***Fixed Effects*** **Regression Results, Townships**

	Large		Small		SE Michigan		Rest of State		All	
Variable	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio	Coeff	t-ratio
Total Population	-0.02	-1.6	0.00	1.1	0.01	2.7	-0.03	-3.9	0.002	0.9
Pop. Growth Rate	-15	-0.0	96	0.7	-193	-1.2	369	1.9	56.5	0.4
Residential Property	-77	-0.4	-35	-0.8	134	2.3	-117	-1.7	-28.1	-0.7
Total Property	0.01	4.8	0.01	14.9	0.00	8.3	0.01	10.9	0.006	17.4
Population Density	0.63	2.1	0.09	1.1	-0.01	-0.1	1.1	4.3	0.093	1.3
Constant	26	0.1	-31	-1.0	-178	-3.9	9	0.2	-38.04	-1.2
Adj R^2		0.92		0.69		0.78		0.71		0.72

Total Property

The most important factor that explained the variations in the expenditure patterns of all classes of communities was the per capita value of total property. The state equalized values of industrial and commercial properties (collectively called business properties) have positive association with expenditures. Business properties affect expenditures in two ways: (1) they create expanded tax base for communities. More tax revenues generated from these properties and business related activities make more expenditures on public services possible; and (2) new business developments may require new and improved public services and infrastructures that may replace or duplicate the existing ones. In general, the state-equalized value of total property was statistically significant in the expenditure model and its estimated coefficient was very large such that any change in its value will be followed by significant change in expenditures of local governments. If a government has a large tax base it has both the revenue and demands (needs) to spend more.

Mix of Land Use

Mix of land use can significantly affect the demand for public services. For example, residential property value as percent of total property value was found to be inversely related with expenditures of most of the communities. That means, new residential developments may not require as much new infrastructure of public services as business developments[**]. It was also observed that most of the communities with high ratio of residential property value have very low per capita expenditures (less than $200 per person). This may be due to big houses on large acreage (lots) which translates to low demand for public services. It should be noted, however, that the regression results for townships indicated that the residential property variable and expenditures of townships in Southeast Michigan were positively associated. It is very likely that the difference between types of residential properties in Southeast Michigan and the rest of the state could be a reason for the positive association of the variable with expenditures in the estimated equation. The existence of more multi-family multi-story residential properties in the

[** *] The model does not include school expenditure because school districts and territorial boundaries of local governments are not the same. The result of this analysis could probably be different if we were to consider school expenditure in that it is one of the major expenditure categories of residential communities.

region may contribute to increasing expenditures in certain types of public services. For instance, high rise multi-family dwellings and office buildings in Southeast Michigan require an aerial fire truck equipped with more high cost and sophisticated equipment which may not be needed in single family residential properties that characterize many of the communities outside of Southeast Michigan.

Population

The population variable impacts expenditures of cities and townships differently. Expenditures decrease in cities and increase in townships as total population grows. It should be noted that cities are required by their municipal charters to produce and provide all major public services to their residents, whereas townships could get by with services from the county and any other service provider. Public service expenditures include the flow of all financial outlays for service provisions and maintenance of the infrastructures. Communities that produce and provide their own public services incur considerable overhead costs to maintain existing service infrastructures. These expenditures are considered as fixed costs in their public service production function. In smaller population size cities the per capita cost of producing certain units of public services will be higher because there are fewer people among whom the fixed costs could be distributed. But, as population increases, the per capita expenditures would decrease since there will be more people to share the cost.

In the case of townships, however, increasing and discontinuous jumps in expenditures are observed as population increases. This is because increases in population are followed by increases in demand for better quality and quantity of services. More populated townships may begin producing their own public services such as police and fire protection. Then, they will have higher associated expenditures compared to the less populated townships that may contract such services from other units of governments or may do with whatever general level of service is provided by the county government.

Population Density

Population density, while statistically significant for cities, was found to be not significant for townships. Nonetheless, care must be taken in interpreting impact of this variable. First of all, the computation of density itself has a serious problem. Dividing the total population by the total land area of a local government does not tell how the population is distributed across the landscape of that city or township. Two communities with equal population size and land area may have a different distribution of settlement. One may distribute its residents evenly on all the land under its jurisdiction and the other may only confine its residents to a certain portion of its area, but at a higher density for the built-up area. These different types of population distribution will have different impacts on expenditures because constructing and maintaining service infrastructures over the entire land area or over a limited high density section will have different expenditure requirements.

Density was found to be negatively associated with expenditures of cities outside of Southeast Michigan and Townships in Southeast Michigan. But, it has positive association when all cities and townships were classified by types of government. A negative coefficient in the former case indicates that increasing population density will decrease expenditures of local

governments because of economies of scale. Cities outside of Southeast Michigan, although small in population size, have full infrastructures and services. These communities are very likely to reduce their per capita expenditures if they are able to increase their population density because per unit cost of services could decrease as the rate of out put increases. The more people along a mile of water or sewer pipeline, the lower the cost per person. The positive association between density and expenditures of cities in Southeast Michigan could be seen from a settlement congestion angle. All the larger cities in the study groups are located in Southeast Michigan. It is likely that most of these large cities may have passed over the threshold for economies of scale and are experiencing high costs associated with congestion in some service categories. For example, the conditions of road, police, and fire services in Southeast Michigan are very different from those in the rest of the state. Frequency of calls for police protection and fire emergencies require many patrol officers and fire fighters on duty, more police vehicles, jails, and fire trucks. All these are costs associated with congestion resulting in a positive correlation between population density and expenditures.

Population Growth Rate

The population growth rate variable over the 15-year period was found to be statistically not significant for both cities and townships when they all are grouped in their respective types of government. However, on a regional basis, cities in Southeast Michigan and smaller population size group indicated that the variable was statistically significant and the sign of the estimated coefficient was positive. The positive correlation is indicating that it is the rate at which the population grows that contributes to the increase in expenditures rather than the actual number of residents (since actual population size is inversely related with expenditures). This is because faster population growth will be accompanied with increasing demands for expansion of services and infrastructures. The faster the population grows, the higher the service expenditures will be.

Conclusion

Many people in Michigan are concerned about land use and population settlement patterns. The Michigan Society of Planning Officials has conducted a series of studies and conferences dealing with the impacts of land development and settlement. Two major studies by academics (Burchell, 1997; Schmid, 1997) were recently commissioned by Southeast Michigan Council of Governments (SEMCOG).

According to the empirical results, whether communities were grouped by their respective types of governments or different sub-classes of population size and geographic location, the most significant factor that explained public service expenditures was the per capita value of total properties. It appears that communities that have wealth to tax do so and spend the revenue. At the same time, wealthier communities demand more and higher quality services. No one would advocate becoming poor or rejecting high valued land use just to hold expenditures down. To the contrary, communities try to attract high valued land uses. They offer reduced taxes now to get more wealth in the future.

Michigan has created eleven tax-free Renaissance Zones (six urban, three rural, and two military bases) located throughout the State where businesses and residents pay virtually no taxes up to fifteen years. Such measures are expected to attract more commercial and industrial

developments that could utilize existing infrastructures and achieve economies of scale. While an increase in tax base will increase spending, it may help to keep the tax burden of the established residents lower in the future than it might otherwise be. Therefore, the statistical significance of total property does not warrant land use regulations as a policy instrument to hold expenditures down. What matters is not the level of expenditures but the ability of residents to pay for the services they demand.

Most of the communities with high per capita expenditures are the smaller cities. Because of the lumpy nature of many of the services, underutilization of the existing public service infrastructures results in high public service expenditures. Consistent with the findings of Burchell (1997) and Schmid (1997), such a population-expenditure relationship implies that more people could be added to the existing smaller communities and spending per capita would decrease. A small city following a dense settlement policy has two things going for it that can reduce expenditures. (1) If small cities were to grow to achieve economies of scale they need not contribute to sprawl since sprawl refers to low density development (not growth in population). (2) City population is negatively correlated with expenditures. If there is a policy aiming to increase the number of residents of the existing smaller size communities, the savings that could be obtained from the joint impact of increased population and a dense new residential development could be substantial.

Settlement follows jobs. Currently most of the jobs in the state are concentrated in cities and townships of Southeast Michigan where per capita expenditures are the highest. The projected future job growth is also in Southeast Michigan. This trend could be expected to raise per capita expenditures in the region. But if some of the growth could be redirected to other parts of the state (especially small cities) the future increase in per capita expenditure in Southeast Michigan could be less. At the same time, the rest of the state would enjoy a decrease in per capita expenditure because of economies of scale. Growth in the rest of the sate could benefit Southeast Michigan by removing some of the pressure for increased spending. Regions in the rest of the state need new and coordinated growth strategies that will redirect businesses and settlement into their areas. But, such strategies are unlikely to materialize if growth efforts are not coordinated at regional or state levels and if communities in Southeast Michigan can not see that it is also to their advantage.

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