A spatially determined public service cost function: Incorporating political jurisdiction and reputation

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Abstract

We develop a spatial model of a public service cost, which follows standard theory but also the agency manager decision framework, and the spatial structure of the built environment and service conditions. In order to develop the public service cost function, we extend Tiebout model of government service provision by individual choice to allowing public officials to respond to citizen preferences by setting and adjusting service levels within a jurisdiction. Public goods are then delivered as per capacity or volume consideration, with signaling coming from citizen pressures, or Hirschman and his notion of "voice". Following Akerlof, the managers' reputation is then governed by perceptions of voice in the community. The manager's reputation can have as substantial effect on individual decision making as market forces. The focus of the investigation is the cost of policing services for a county government in the USA. Signaling from citizens to agency managers about service levels is operationalized in the model with an index used to establish the reputation costs to the local government service provider. Reputation links citizen pressures, production inputs and level of service outputs. The structure of the built environment is operationalized with an index which captures the spatial distribution of fixed elements in the built environment by land use. Inclusion of the index in the cost function offers the opportunity to determine the contribution of specific locations to the total cost of providing a public service and thus a means of ascertaining the spatial component of development costs.

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1 Introduction

Research on the determinants of state and local government spending on services goes back nearly 100 years. Much of this work attempts to capture the economic and social influence of changes in the spatial structure of the built environment with emphasis on public services expenditures (e.g. Lyon 1942, Branch 1951, Gaffney 1964, Downing 1977, Ladd 1992, Hortas-Rico and Solé-Ollé 2010). The methods used in early regression and correlation models relied on proxies for urban form such as population, population density and urbanization (per cent population that lives within urban areas). Results most often suggest low density developments distant from nodes of service provision are more expensive to service than proximate, high density developments (e.g. Hirsch 1968, Lyon 1942). A smaller but nevertheless substantial body of studies associates increasing public service costs with increasing congestion (e.g. Wood and Almendinger 1961). A large number of studies indicate both circumstances depending upon service type and specific conditions of the study area (e.g. Brazer 1959, Ladd 1992). The notion common to these works is that urban form is consistently indicated as a potentially significant determinant of public service expenditures. Investigation of the specifics of the relationships between urban form and public services costs therefore stands out as a promising opportunity for research.

Addressing the relationship between urban form and the cost of public services

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is complicated by the gap between underlying theory and empirical work. Specific criticisms include the lack of rigorous theory (Hirsch 1970), a lack of grounding in the theory of choice (Borcherding and Deacon 1972) and ignoring factor prices when explaining public service expenditures (Fortune 1983). Public service costs are determined by service quality, service quantity, input prices, service conditions and state of technology (Hirsch 1970). There are few state and local government cost functions in the literature due to the difficulty in finding data on input prices and output measures (Hirsch 1970).

This paper addresses the relationship between urban form and costs of public services by incorporating a representation of the political and social structures around public service decision-making. Goals of this study include addressing governments need for accurate assessments and projections of the fiscal consequences of development. This includes addressing the frequently asserted notion that limited community budgets for public services may become stressed in the face of development beyond the urban fringe. This paper extends the body of research around government service cost modelling by presenting a theoretically robust public service cost function and the spatial component of public service cost via spatially explicit model of public services provision. We examine the cost of public safety as driven by input prices, output quantities, signalling from citizens to agency managers, urban form and other socioeconomic and demographic characteristics. The empirical work presented here addresses policing services in Laramie County, Wyoming USA. Policing services were chosen based on previous research (Lieske et al. 2012) indicating that the provision of this service is at least in some cases sensitive to urban form.

2 Theoretical framework for a public service cost function

The foundation of this work follows two longstanding avenues of public service modeling: A theory of the firm approach to public enterprise modeling and the Tiebout Model (Tiebout 1956) of competition between communities. The first draws on Hirsh (1970), Borcherding and Deacon (1972) and later work by Behrman and Craig (1987) and Heikkila and Craig (1991) that treats the public enterprise as a firm. Both public agencies and firms compete in private input markets in order to secure the factors needed to provide goods and services and may or may not compete in output markets. However, costs do not function identically in public and private markets. Borcherding and Deacon (1972) model public enterprises using a production function for service output and then employ a cost minimization framework to develop marginal cost functions.

$$\begin{aligned} &\underset{x}{\text{minimize}}\ C = \sum_{i=1}^{k} r_i x_i \\ &\text{subject to } y \leq f(X) \end{aligned} \tag{1}$$

where
C represents cost
y represents the output of the firm
f represents the function that maps input to outputs
X is a vector of inputs, with x_i as a specific input
r_i represent input prices

We posit that public service cost modeling must reflect differing market structures and resource allocation regimes for public as opposed to private goods. Privately provided goods and services are provided in accordance with market price signals for outputs and inputs. Public services are delivered as per capacity or volume consideration, with signaling coming from demographic and/or development pressures The traditional representation of the decision framework of the firm, formally presented in (1) does not account for locally specific information that can drive what a firm uses as inputs or produces as outputs. In a traditional private enterprise a manager chooses input quantities subject to input prices to attain a given level of production. In a public enterprise managers are constrained to geographic limits (e.g. within a county or outside a city) as well as the unique pattern of development (urban form) within a jurisdiction As such spatial characteristics become important.

Borcherding and Deacon (1972), Heikkila and Craig (1991) and Heikkila (2000) identify the importance of more spatially differentiated explanatory variables, neighbourhood characteristics, as well as socioeconomic and demographic attributes in modeling local public services. Borcherding and Deacon (1972) argue that while input prices are important determinants of level of service, urbanization and land area can also explain levels of inputs. This follows a considerable line of research beginning with Davenport (1926), Bartholomew (1940), Lyons (1942), Isard (1951), and Hirsch (1968) which relate urban form to public service costs and the role that dimensions of the input process itself play in costs. Hirsch (1968) indicates the cost of overcoming spatial distances and their alternatives deserves careful investigation (p. 522-523). Heikkila (2000) and Lieske et al. (2012) explicitly argue for space

as an explanatory variable related to public service production inputs and outputs. These works articulate the argument of including the composition of space in the built environment along with labor and capital in economic analysis.

We expand the arguments of Borcherding and Deacon (1972) in (2) but follow similar mathematical structure to incorporate urban form "s". Variables "s" and "n" represent unique local characteristics that affect the use and level of inputs as well as, potentially, input prices. For example, expectations by urban residents may be different from rural residents. One could expand this to include a variety of cultural differences between regions and population centers also. Equation (2) then is a broader framework that incorporates these notions of geographical distinction.

$$\begin{aligned} \underset{x}{\text{minimize}} \quad & C = \sum_{i=1}^{k} r_i x_i \\ \text{subject to} \quad & y \leq f(X; s, N) \end{aligned} \tag{2}$$

where
s is an index representing urban form
N is a vector of socioeconomic and demographic characteristics of the study area
X, y are defined previously

The relationship between the specific local characteristics and cost depend upon the variables used. In this case variable "s" represents the spatial distribution of the built environment. The definition of urban form implemented here, the spatial distribution of fixed elements in the built environment, is based on Anderson et al.

(1996) slightly altered to focus attention on the relationship between the built environment and the cost of public services. The idea of urban form incorporates land use, density, transport networks as well as communication infrastructures (Anderson et al. 1996). Discussions in the literature of decentralization, population density, housing density, distance from metropolitan center, property value, size of government area and urbanization are all germane to urban form. For the spatial variable "s" prior research suggests high levels of dispersion as well as congestion decrease the marginal productivity of inputs. The relationships of "s" and "n" depend upon the exact metric used, but in this case, s and n are assumed to relate to C defined by (3):

$$\frac{\mathrm{d}C}{\mathrm{d}s} \neq 0; \frac{\mathrm{d}C}{\mathrm{d}n} \neq 0 \tag{3}$$

The lagrangian is represented by (4) where λ is the langrangian multiplier.

$$minC = \sum_{i=1}^{k} r_i x_i - \lambda[y - f(X; s, n)] \tag{4}$$

Calculating first order conditions and then solving for input demand for each input (5) ultimately creating a dual cost function with spatial variables (6).

$$x_i = f(r_i, y; s, n) \forall i \tag{5}$$

and

$$C(r, y; s, n) = C(r, y(x); s, n) \tag{6}$$

The preceding discussion informs the need for accounting for local characteristics and conditions. However, it says nothing about either decisions made on the demand side nor the supply side. In our second view of public service provision, we bring in the Tiebout model (1956) of competition between communities. The traditional approach in this model assumes that public managers are passive players and residents react to differences in public service provision by selecting the community which most matches their preferences for public goods and services provision, or simply voting with one's feet. Perkins (1977) describes the Tiebout model results as political ordering resulting from individual preferences. These results lead to individual maximization and the emergence of collective rationality. Bergstrom and Goodman (1973) add detail by noting first that quantity decisions are made collectively and, second, that costs of publicly supplied goods and services are divided among the members of the community. Bergstrom and Goodman (1973) introduce the notion of quality of service outputs as a component of this decision process. Quantity and quality decisions as well as the distribution of costs are made in aggregate by a heterogeneous collection of individuals with differing amounts of wealth and heterogeneous preferences. So it is the voters that make the choice and the quality and level of service is incidental to voter decisions.

Empirical tests of a pure Tiebout model have produced mixed results. Complications arise in single versus multiple jurisdictions (Kollman et al. 1997), the relationship between political institutions and public service provision (Romer and Rosenthal 1979), as well as the assumptions behind general modelling of public service provision as a private activity (Bewley 1981). Hirsch (1970) noted that the Tiebout model does not offer an identifiable political process for policy making. Both Kollman et al. (1997) and Bewley (1981) challenge the notion that the institutional structures around a public agency lead to private good solutions that are necessarily optimal. Kollman et al. (1997) evaluate the Tiebout hypothesis in a multijurisdictional framework with alternative voting systems. The authors evaluate a hypothetical system where political parties compete based upon different institutional rules and alternative jurisdictions. In this theoretical framework agents can choose jurisdictions under alternative institutional rules: democratic referenda, direct competition, and proportional representation. Tiebout model results would occur if the sorting across the jurisdictions were welfare increasing and stable. The authors found that for the most part the Tiebout model results occurred. However, the more heterogeneous the agents, the more likely migration to low valued areas occured. This diverges from Tiebout model results.

The need to incorporate citizen preferences for public goods and urban form in a public service model suggest something different from agency as firm. In a standard neoclassical formulation private goods are provided in accordance with market price signals for outputs and inputs. In reality produced public goods are delivered as per capacity or volume consideration, with signaling coming from political and social

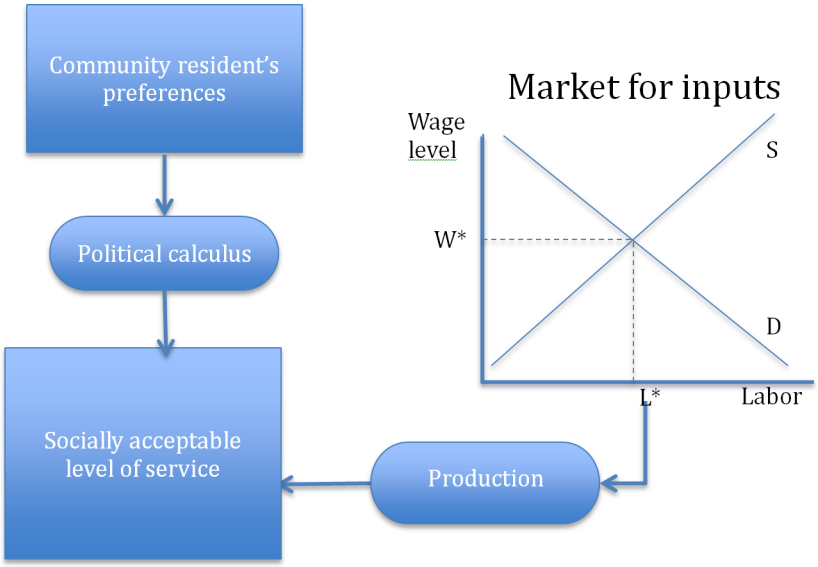
processes driven by demographic and/or spatially defined development pressures. This suggests that a broader interpretation of the Tiebout model structure is needed.

In our extension of the Tiebout model we assume a proactive decision-making role for managers. Managers react to their perceptions of the median voter for making public service decisions (Deacon, 1978, Hirsch 1970). In our proposed theoretical framework the manager actively defines service level based upon perceived expectations of residents on what the acceptable level of public service may be. Her decision actively incorporates political information into the level of service.

In the case of a public enterprise such as policing services, we argue that managers engage in optimizing inputs for a perceived level of output. That perceived level is what managers might view is politically acceptable or preferable. Public enterprise managers then "play" in the market on the input side but use a political calculus to identify an optimal level of service of which the inputs into the process are used, Figure 1. This political calculus would likely be unique to the community or region modeled. The manager then has to coordinate between market discipline on the input side and political and social queues on the service production side.

In this extension of the Teibout Model we account for a more proactive decision-making process by managers. Two lines of theory motivate this extension of the Tiebout model: Hirschman (1970) and Akerlof (1980). Hirschman argues that consumers do not always utilize exit from a market or in our case voting with one's feet as a response to inadequate quality or quantity. They use voice or political tools to make changes in their local governments provision of public service. They can use both voice and exit, where exit occurs when voice is not effective and loyalty to the

Figure 1: Relationship between input markets and output politics in a local public enterprise.



community is a non-issue. Given that public agency managers are elected officials, or appointed by elected officials, voice can be an effective approach in making service changes. Agency managers listen to the public for monitoring quality issues in the provision of public services. That means that staffing and management are subject to how the local publics use voice as much or more than exit.

Hirschman's framework provides a rationale for our modeling approach of public service costs. We posit that citizens may express their dissatisfaction (or satisfaction) with public service levels by moving (Tiebout 1956), or by complaining and encouraging a change in policy or management objectives in public agency. The citizen who reacts publicly is expressing V or voice, which represents an effort on the part of a citizen to change a government policy, represented in (7). Voice is defined

in this analysis in (7)

$$V = f(U), \frac{\partial V}{\partial U} < 0 \tag{7}$$

where

V is voice or effort changing polices,

U is resident's utility, and

f is mapping utility into voice space.

The more residents' utility falls the more voice is used. Hirschman argues that at some threshold people exit the market or service district. But until departure, effort is expended through voicing opinions about management to change the policy regime. Complaints increase as utility associated with a public service decreases.

As voice increases confidence in the public service manager declines. This can affect the reputation of the elected manager or the manager's elected supervisors. So in the second line of theory, Akerlof (1980) presents social custom where reputation can affect both buyer and seller decisions. Voice in and of itself does not explain a change in service output or quality. The reason managers listen to voice is because the political process can punish managers for ignoring voice, or conversely, can help get managers re-hired or re-elected if they listen to voice. A managers reputation then is governed by perceptions of voice in the community. Customs that may be disadvantageous to the individual may persist if sanctions or the threat thereof exist (Akerlof 1980). These social rules or codes of behavior can govern levels of

resource use and output as much as market discipline may. Akerlof (1980) draws from anthropological theory on this argument that customs or cultural heuristics can have as significant of an effect on individual decision making as market forces. Gudeman (2008) and other more contemporary anthropologists label these heuristics as reciprocity and mutuality relationships.

In the backdrop of a unique set of spatial and neighborhood characteristics the political and cultural factors play into how public managers make decisions. Reputation, "Γ", as Akerlof framed it, is applied in our case as a function of the median voter belief "β", and the percentage "ρ" of voters that consider the representative agency implementing a reasonable effort. The better the agency follows the median voter the higher the reputation of the agency manager (8) and (9).

$$\Gamma = f(\beta, \rho) \tag{8}$$

and

$$\dot{\rho} = g(\rho, \beta) \tag{9}$$

So $\dot{\rho}$ drives the change in Γ at any given time. g maps voter belief and support to a change in support. It is explained by the current level of agreement that a policy be implemented, ρ and a metric, β that anchors their belief. It should be noted that β is driven by policy relevant observable variables. The relationship between Γ and

V is as follows: Γ^* can be seen as a steady state level of reputation at a manageable level of voice or conflict V^* at equilibrium (10). h is a function that maps V into the residents' utility function.

$$\Gamma^* \equiv h(V^*) \tag{10}$$

The change in reputation is negatively correlated with voice $\frac{\partial \Gamma}{\partial V}$. $\dot{\Gamma}$ changes as $\dot{\rho}$ changes . So the percentage of voters that support the agency policy is a function of voice at a given point in time (11).

$$\dot{\rho} = g(\rho, \beta) = h(V^*) \tag{11}$$

As voice changes, ρ decreases, The cost minimization problem then becomes (12) with an added constraint that reflects a reputation index.

$$\begin{aligned} &\underset{x}{\text{minimize}} \quad C = \sum_{i=1}^{k} r_i x_i \\ &\text{subject to} \quad y \leq f(X; s, N, \Gamma) \end{aligned} \tag{12}$$

We assume the relationship between Γ and V is $\Gamma(V, \beta) \geq \bar{\Gamma}$ where $\bar{\Gamma}$ indicates a minimum or baseline level of reputation for the public enterprise manager. Input demand (13) then incorporates not just the usual explanatory factors of input price

and output levels, but indices related to spatial and neighborhood characteristics, and indices that reflect reputation. Factor demand then is function of the usual the modified cost minimization model but then there is an added constraint and we assume reputation has an increasing effect on input levels but at a diminishing marginal rate.

$$\begin{aligned} &X = j(r, y; s, N, \Gamma), \\ &\text{where} \Gamma' > 0, \Gamma'' < 0 \end{aligned} \tag{13}$$

3 An Empirical Model of Policing Services

The modeling framework proposed in this paper incorporates the notion of a public enterprise that has to react to both markets and local politics, driven by cultural and social relationships. Spatial and neighborhood characteristics are included as explanatory factors that bring in unique local characteristics within a well-defined jurisdiction (as opposed to a private firm that can always consider market issues outside the jurisdiction where they reside). The framework also brings in the concept of reputation discussed above that links the managers decisions to the local or community body politic. The framework also has to link decisions on both the input markets which can be national or regional as well as the service provision levels based on social/cultural characteristics of a community and the associated urban form that exists in the locality.

The role and goal of the manager is to provide public services to residents in

as efficient manner as possible given spatial and neighborhood characteristics. To maintain a positive relationship the manager develops the agency program to her constituents perceived needs. An agency program that meets constituents needs results in a positive reputation. The relationship between reputation and voice is likely very complicated but we propose a simple relationship between reputation and level of service: residents compare their level of observed inputs with other jurisdictions.

Consider the case of public safety provision and the requisite inputs. The assumption is that residents can more readily monitor patrolling than objective measures of area crime rates. Hence their voice is registered not about service levels (crime prevention) but on the service input (desired policing). The proxy for reputation Γ is based upon what residents can readily see in their area: officers on patrol. We construct a simplified reputation function where "x" is the level of inputs (or as in our case the number of police officers), and xe is the difference between staffing locally and the average level of staffing in comparable jurisdictions $xe = x_i - \bar{x}$. If "x" diverges too much from xe then residents respond with "voice" and attempt to convince the manager to reconsider staffing levels. Average staffing across jurisdictions "xe" positively effects the level of inputs provided to produce the public service. If $\frac{\partial x}{\partial T} > 0$ then inputs increase as the reputation of service providers rises. If $\frac{\partial x}{\partial xe} > 0$ then the change in inputs also increase as the level of inputs in other jurisdictions increase.

Given these simple relations citizens are thought to obtain utility from public services: public service levels matter. As their utility declines due to less than

desirable levels of public services, citizens respond. Citizens that do not move in response to perceived suboptimal public services complain. The complaints are a means of signaling about such services to public service providers. The reputation of the agency and/or governing body is impacted by the complaints. Service providers then raise their reputation by increasing essential policing amounts that determine the level of public safety. These amounts are modified not only by complaints but by the levels of neighboring jurisdictions, an external candidate for the reputation modification and consequently for affecting policing levels.

This introduces a minimum political threshold to the agency objective function. It is important to note that our function is a simple relationship that acts as a proxy for what is more likely a complicated reciprocity relationship that is occurring. Exploring that reciprocity relationship in detail is outside the scope of this paper. The indicator is about setting service levels as per cost, output and expectations.

We solve the modified cost minimization model described in (14) by using the difference between current staffing and average staffing across county jurisdictions as a metric that the resident uses to assess reputation of the sheriffs office.

$$minC = \sum_{i=1}^{k} r_i x_i + \lambda_1[y - f(X, s, n, xe)] + \lambda_2[x - xe] \tag{14}$$

λ_1 and λ_1 are the relevant shadow prices. Calculating first order conditions and solving for factor demand yields (15). Reputation then becomes an argument in input demand. Inputs levels are explained by expected output levels and input prices, local spatial and neighborhood characteristics, as well as reputation attributes perceived

by managers and driven by political and social signals. Combining input demand into the primal cost function yields a dual cost function where spatial attributes, neighborhood characteristics, and reputation attributes are explanatory variables (15).

$$C = c(r, y; s, N, xe) \tag{15}$$

where
C = cost
r = input prices
y = public service level, defined as the inverse of the crime rate
s = spatial distribution of the built environment
N = neighborhood characteristics
xe = the reputation metric as the difference between predicted staffing minus average staffing across jurisdictions

The empirical model then is based upon (15) where xe reflects a community's preferences of agency performance relative to other jurisdictions in the state and s and n reflect spatial and neighborhood characteristics .The inclusion of "s" serves to evaluate the premise that low-density developments distant from centers of service provision are more expensive to serve than more proximate and high-density developments, n represents local characteristics, xe is an indicator of reputation. The inclusion of s and n in (15) reflect both urban form and the totality of neighborhood characteristicds the influence cost. With these conceptual pieces we estimate a spatially explicit, reputation-adjusted public service cost function.

The empirical work presented here addresses policing services in Laramie County, Wyoming USA. A cost function for policing services in Laramie County is presented below. The econometric model of the cost function specified (16) is based on (15). It explains law enforcement expenditures as a function of prices, outputs, neighborhood characteristics, urban form, the reputation metric, and unobserved factors.

$$C_t = a_0 + a_1 w_t + a_2 o_t + a_3 m_t + a_4 xe_t + a_5 Nx_t + \mu_t \tag{16}$$

where
C represents total estimated annual local government policing costs,
w represents wages
o is a measure of output, the county crime rate
m represents the spatial index that captures urban form by land use
xe is the reputation variable
Nx represent vector of service conditions, in this case extra-municipal population
u are residuals.

4 Study Area, Data and Methods

The research question is addressed using a case study analysis of the provision of policing services in Laramie County, Wyoming. Laramie County is an example of a fast-growing community with considerable development occurring beyond the urban fringe. The county seat, Cheyenne, is the state capital of Wyoming and primary node and source of service provision in the county. Growth in Cheyenne and Laramie County has been spurred by the northern expansion of the front range of Colorado.

Table 1: Description of Variables

Variables	Definition	Units
C	Annual Costs of providing policing services for the Laramie County Sheriff's Dept	Millions of $USD 2010
W	Wages	$USD 2010
CPSI	County public safety index (service output)	(Index Crimes / Pop)*10K
Res	Spatial index representing residential urban form	Spatial Index
es	Actual minus predicted officers	Individuals
es2	Actual officers squared minus predicted officers squared	Individuals
EMPop	Extra-municipal population	Individuals
t	Time	Years

The proximity of Cheyenne to the junction of two major interstate highways, I-25 and I-80, led to the opening of two major chain retail distribution centers in the past ten years. Oil and gas development is also contributing to population growth, employment and income in the county.

Explanatory variables in this analysis are summarized in Table 1. Variables used in the regression analysis include a public safety index, local government inputs, neighborhood characteristics and the spatial index. These are time series data covering 21 years from 1990 through 2010. In all cases data represent 21 observations.

Law Enforcement Expenditures- The annual costs of policing services provided by the Laramie County Sheriffs department are published by the Wyoming Department of Audit (2011). A gap in the data required law enforcement expenditures for 1990 to be modeled based on annual percent changes occurring over the remainder of the time period of the analysis (1991-2010). These and all other fiscal data are inflation adjusted to 2010.

Extra-municipal population- Population in both incorporated and non-incorporated areas may have an effect on county government service costs as welll as on local government costs in incorporated areas themselves. Hawley (1951) and Brazer (1959) note expenditures of municipal government are more closely related to the population size of the surrounding area than to the population of the cities themselves. There are four municipalities in Laramie County: Albin, Burns, Cheyenne and Pine Bluffs. Cheyenne has a municipal police department. Pine Bluffs had a police department for at least part of the time period of the study. For the purposes of this work extra municipal population is defined as the total population of the county less Cheyenne and Pine Bluffs. Population data for the unincorporated areas of Laramie County are from the Wyoming Division of Economic Analysis (WDEA 2011a, b, 2010). Over the time period of this study, 1990 - 2010, Laramie County increased in population by 25.4 pct.,from 73,142 in the 1990 census (WDEA 2011a) to 91,738 in the 2010 census (WDEA 2011b).

Wages- Wage data were obtained from the United States Department of Labor Bureau of Labor Statistics (2012) Quarterly Census of Employment and Wages program. Data used here are local government annual average pay data from Laramie County, Wyoming from 1990 through 2010. These data do not capture salaries of the Laramie County Sheriffs department exactly. Lacking specific salary data for the Laramie County, Sheriff's department, these data serve as an index that captures inter-temporal spending on salaries by local governments in the county. Data were inflation adjusted to 2010.

Service Output- Level of service is indicative of the output and/or effects produced through local government expenditures. A county public safety index (CPSI) is used to quantify the output of the policing services based on Heikkila (2000) who argues the appropriate measure of policing outputs is the absence of crime as indicated by a measure of public safety and security. The CPSI is measured as the inverse of the crime rate for the area served by the Laramie County Sheriff's department, the entirety of Laramie County including all municipal and extra-municipal areas. Data used to construct the CPSI were calculated based upon index crimes from the Wyoming Department of Criminal Investigation (1990-2011). Wyoming Department of Criminal Investigation methods were followed for calculation of crime rates, but population data from the Wyoming Division of Economic Analysis was incorporated in the calculations rather than Wyoming Department of Criminal Investigation population estimates.

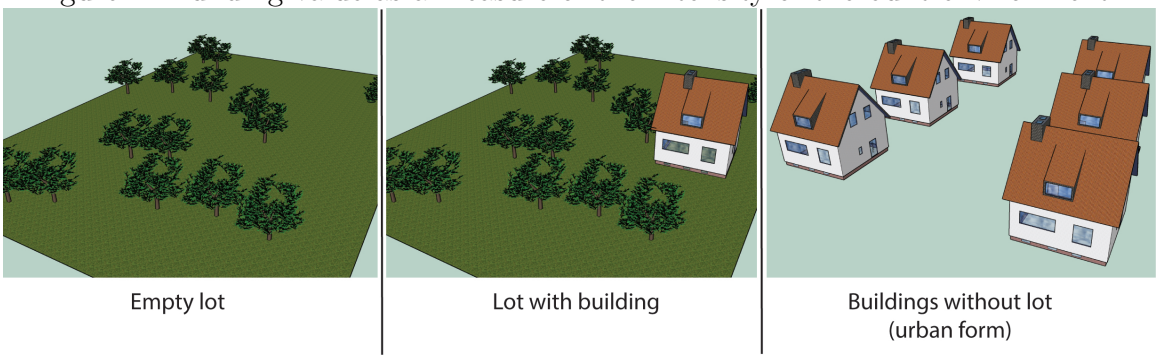
Urban Form- Following Lieske et al. (2012) urban form is measured with a spatial index that captures both local values of clustering and dispersion for individual areal units as well as an overall value for clustering and dispersion for a study area. The index is a spatial statistical measure of the intensity of residential land use based on building values (measured in dollars) aggregated within an analysis grid consisting of cells one square mile in size. Building value is based on county assessor's data and is therefore assessed and not market value. A lengthy body of literature suggests property assessment is indicative of demand for services (Brazer 1959, Schmandt and Stephens 1960, Hirsch 1961, Sacks and Hellmuth 1961) as property valuation reflects fiscal capacity (Scott and Feder

1957). Sacks and Hellmuth (1961) and Hirsch's (1961) empirical results show increases in assessed valuation to be associated with increases in local government expenditures in general and police expenditures in particular. Musgrave (1959) presents the idea taxation is a price for services rendered. Hirsch (1970, 1968) argues that for police and fire services property value is related to cost of service, ability to pay for service and ability to demand service.

The relationship between building value and urban form is represented graphically in Figure 2. The first panel shows an empty lot with no building value and no urban form. Figure 2 panel 2 shows a lot with building, both of which have an associated assessed value.The intensity of the built environment (urban form) in Figure 2 panel 2 may be quantified based upon the assessed value of the building shown. Figure 2 panel 3 shows buildings, all of which have an assessed value, without lots, arranged in space. With multiple buildings, urban form may be measured with the Moran's I statistic. Moran's I enables quantifying urban form based on the assessed value of buildings in such a way that incorporates spatial effects (spatial heterogeneity and spatial autocorrelation). Moran's I also allows quantifying urban form both locally, using cells in an analysis grid, as well as with a summary value that quantifies urban form for an entire study area. Figure 2 panel 3 represents the spatial configuration of the fixed elements of the built environment, the basis of our quantitative assessment of urban form.

Figure 3 illustrates the time trends of the spatial indices for residential and combined commercial and industrial development in Laramie County. Residential urban

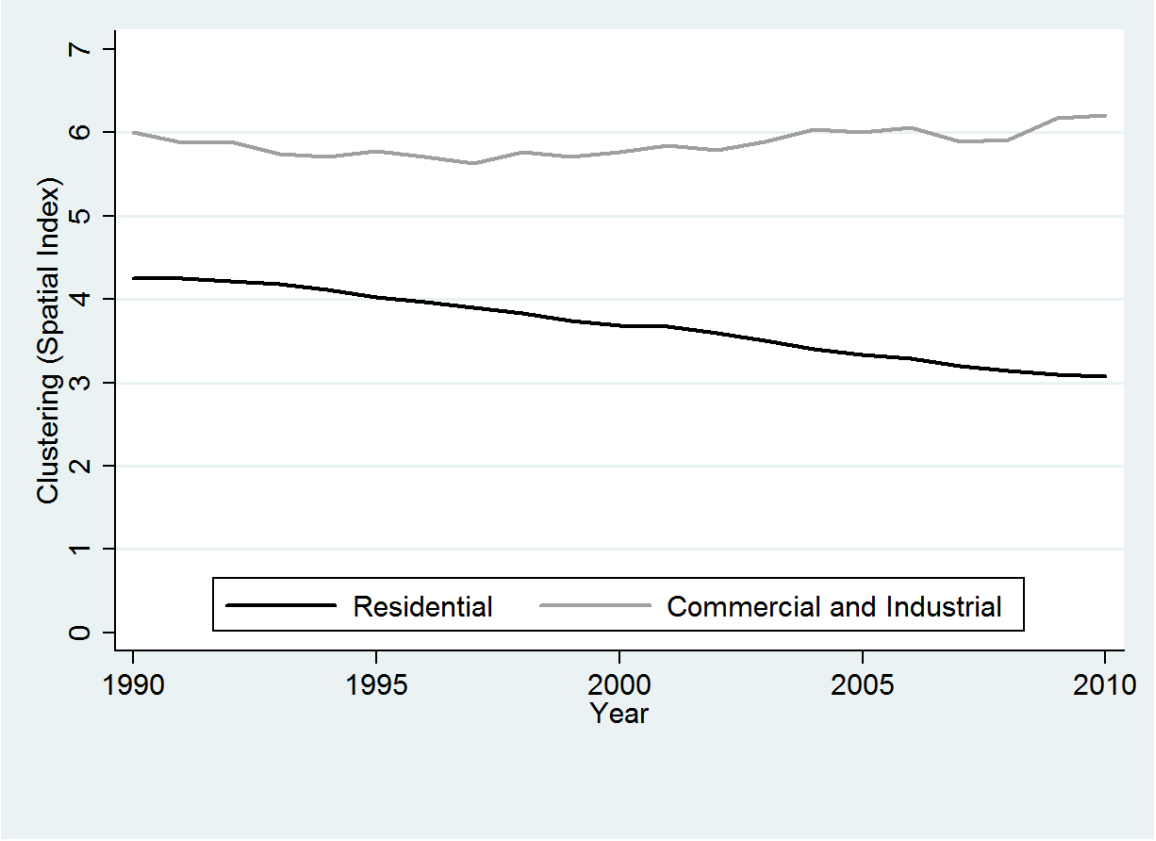
Figure 2: Building value as a measure of the intensity of the built environment.



form decreases in clustering over the time period of the study. Commercial and industrial clustering increases slightly over the time period of the study.

Actual minus predicted officers- Following the argument presented in section 3, we use the actual minus predicted officers variable to establish reputation costs to the Sheriff's department. The variable represents an adjustment to input quantities based on the afore-mentioned political calculus. This difference between actual and predicted is a proxy for the reputation level. Sheriffs use the market for hiring but have to use a political calculus for evaluating output where a market is distorted, incomplete or does not exist. The Sheriff then compares herself to the staffing in other counties. If the staffing is below average then it can potentially damage her reputation and ultimately her ability to get re-appointed or re-elected. Predicted officers are an index of a reputation function. By contrasting data on the actual number of officers with the predicted value for number of officers we can quantify how the manager aligns her reputation with community expectations. It is also noted that labor is a significant portion of the cost of public services in general and policing services in particular. Hirsch

Figure 3: Time trends of the spatial indices for residential (black) combined commercial and industrial (grey) and land uses on a 1 square mile grid.



notes public services tend to be labor intensive and wages tend to overshadow other factor prices (Hirsch 1968, 1970). Furthermore, the idea that operation costs are proportional to employment is a simplifying assumption that has been used effectively (Fortune 1983).

Data on the number of county law enforcement officers are published by the Wyoming Department of Criminal Investigation (2011) and the Federal Uniform Crime Reports (DOJ 1990-2008). Predicted officers is based on a time-series - cross sectional estimation used to come up with a weighted average of number of officers across the state. The reputation function is established based on the population in a jurisdiction and size of service area and the relative size of the actual Laramie County law enforcement staffing relative to the predicted law enforcement staffing.

5 Econometric Results of the Cost Model

The construction of the reputation instrument is an intermediate step towards the estimated model. The outcome of the reputation index is reported in Table 2 and the full cost model in Table 3. The variable represents an adjustment to input quantities based on the afore-mentioned political calculus. This difference between actual and predicted is a proxy for the reputation level.

Results for the modified cost function are presented in Table 3. We used ordinary least squares (OLS) results from the empirical estimation of the cost function. Results indicate wages, urban form, actual minus predicted officers and rural population to

Table 2: Regression results for the reputation Index.

Variable	**Estimate and t statistic**
Intercept	5.3366893
	-1.39
Pop	-0.806816
	(-14.99)
Area	-0.128056
	(-3.88)
Predicted Ave Officers per Co.	2.2243353
	-26.57
year	0.0006488
	-0.34
R2	0.8608
R Adj2	0.859675
Root Mean Square Error	0.269235
Mean of Response	3.170074

be statistically significant determinants of cost.

The independent variables in the cost function all show the expected signs based on their presumed influence on costs of policing services provision. The positive coefficients on annual wages (AnnualWages), extra-municipal population and crime rate (CSI) indicate that as those determinants increase costs also increase. The inverse formulation of the spatial index indicates that as the built environment becomes more dispersed, costs increase. As the spatial index decreases, indicating a decrease in clustering or increase in sprawl, there is a corresponding increase in cost. The positive sign on actual minus predicted officers and negative sign on actual officers squared minus predicted officers squared means that as managers increase staffing, costs increasd at a decreasing rate. Post-estimation tests show no evidence of heteroskedasticity or serial correlation. There is also no evidence of endogeneity (tested

for in a two staged least squares framework).

Table 3: Regression Results for the Policing Services Cost Model

variable	**estimate and t statistic**
AnnualWages (adj)	0.00004**
	3.03
Rural Pop	0.0011***
	4.77
1/res	70.219**
	3.29
CSI	-0.0761
	-2.16
Actual-Predicted Officers	0.0776**
	3.12
Actual2-Predicted Officers2	-0.00064**
	-3.24
Year	-0.755***
	-4.95
constant	-37.878***
	-4.90
R-sqr	0.921
dfres	13

* $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$

6 Spatially Explicit Cost and Jurisdictional Fiscal Efficiency

Inclusion of the spatial index in the cost function allows the opportunity to map the influence of urban form on both the cost and fiscally efficient provision of policing services. As with the calculation of the spatial index, the areal units in play are those cells with a residential building value greater than zero. The first step in spatially

explicit cost modelling is to quantify the influence of each cell (the local Moran's I values) on the overall spatial index with a set of similarly signed values. The set of local Moran's I values that contribute to calculation of the spatial index are both positively and negatively signed. In order to generate similarly signed values, equation (17) calculates the perturbation around the mean $\mathrm{P}lM_i$ for each cell where local building value is greater than zero, $c^{>0}$.

$$PlM_i = \frac{(\sum_{i=1}^{k} m_i^{>0}) - m_i^{>0}}{nc - 1} \tag{17}$$

where for k parcels
PlM_i represents the influence of each cell on the global spatial index M where residential building value is greater than zero,
$m_i^{>0}$ is the local Moran's I value of cell i from the set of cells where building value is greater than zero, and
nc is the number of cells where building value is greater than zero.

In the second step we evaluate the ceteris paribus change in total cost of policing services for the county due to differing urban form within each areal unit in play. Equation (18) models total cost based upon each grid cell in play using a modified spatial index from (17) as one of the explanatory variables. We use 2010 cost and clustering data, the latest year in the database, to estimate (18):

$$\hat{c_i}^{2010} = a_0 + a_1 r_i^{2010} + a_2 cpsi_i^{2010} + a_3 PlM_i + a_4 es_i^{2010} + a_5 N_i^{2010} \tag{18}$$

where

$\hat{c}_i^{2010}$ represents the relative influence of cell i on total estimated annual local government expenditures on policing services in year 2010,

i represents each cell where building value is greater than zero,

r^{2010} represents the average salary in 2010,

$cpsi^{2010}$ represents level of service outputs,

$lPIM_i$ is the global spatial index described in (17),

es^{2010} represents the 2010 values of the reputation indicator,

N^{2010} represents the 2010 values of neighborhood characteristics relevant to the cost function, and

a_k denotes estimated parameters including the constant from (16)

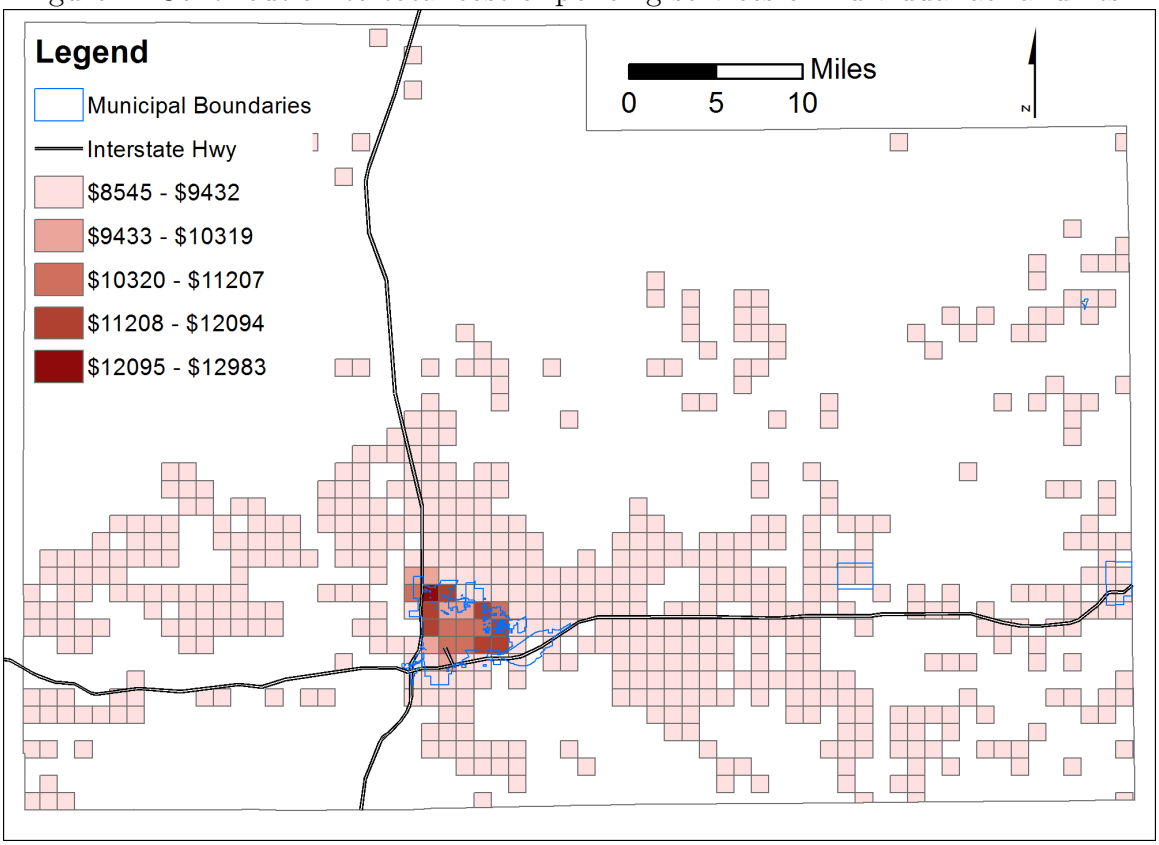
Equation (18) models cost using a modified spatial index based upon (17) as one of the explanatory variables in the estimated cost function. Equations (17) and (18) are calculated on a per cell basis for those cells where summed building value is greater than zero. The magnitude of the difference between c values (from equation 16) and predicted $\hat{c_i}^{>0}$ (from equation 18) indicates the degree to which that cell influences costs. Step 3, the contribution of each cell to the total cost of policing services is calculated by dividing $\hat{c_i}$ by the number of cells where residential building value is greater than zero (19).

$$\hat{c_i} = \frac{\hat{C_i}^{>0}}{\text{nc}} \tag{19}$$

where,

c_i is the contribution of an individual areal unit (cell) to the total cost of policing services for each cell i and

Figure 4: Contribution to total cost of policing services of individual aerial units.



$\hat{C}_i^{>0}$, represents the relative influence of cell i on total estimated annual local policing services costs,

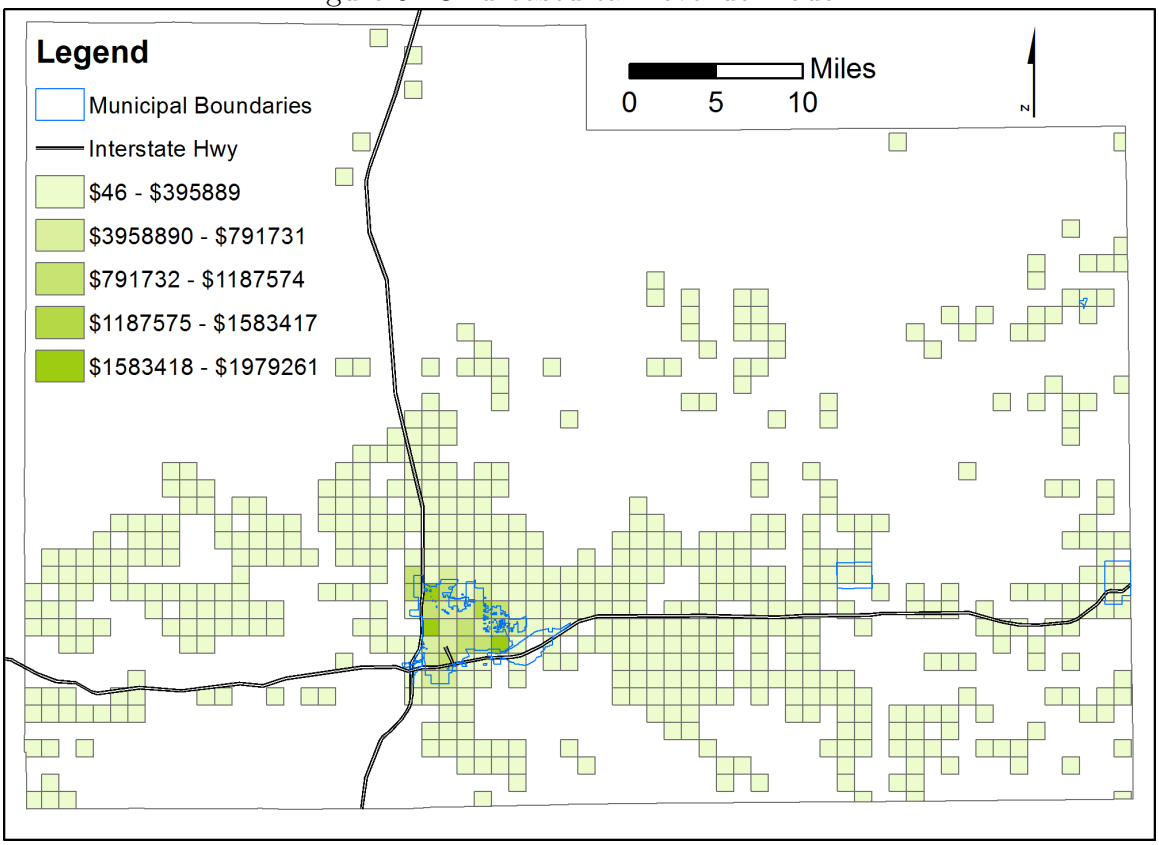
nc is the number of cells where residential building value > 0.

Mapped outputs of $\hat{c}_i$, the contribution of an individual areal units (cells) to the total cost of policing services for the 1 square mile are presented in Figure 4. The pattern presented in Figure 4 demonstrates that more highly clustered cells result in greater per cell costs and more dispersed cells result in lower per cell costs. More highly clustered cells will incur greater costs than more dispersed cells.

The next step is the development of the revenue model. Property tax is the primary input to county revenues paid by a landowner and is therefore the emphasis of the investigation here. Property taxes may be estimated with a simple three step model that is identical to the calculation used by the county tax assessor. The first step in developing the revenue model is assigning the correct mill levy (a specified tax rate) to each parcel based upon tax district. The second step is to calculate the assessed valuation. The final step consists of multiplying the assessed valuation by the mill levy which results in an estimate of actual property tax for each parcel. In order to make the parcel-based revenue model compatible with the grid-based expenditure model values are extracted from the parcel-based revenue model and attributed to cells in the planning analysis grid. The parcel-based tax revenue model is shown in Figure 5. Comparing Figure 4 with Figure 5 indicates both costs and revenues are highest in the central city areas of Cheyenne, indicated in the figures by the municipal boundary located at the intersection of the two interstate highways.

The contribution of individual aerial units to the total cost of policing services may be contrasted with the grid-based revenue model to estimate fiscal efficiency in a spatially explicit fashion. Combining the cost grid output with the revenue grid output as a difference between revenues and costs generates the spatial data for an estimate of fiscal efficiency. Based on an the average annual contribution of property taxes needed to cover the expenditures of the Laramie County Sheriff's Department over the time period of the study, eight percent of all county revenue goes to pay for policing services. In order to capture the distribution of revenues and expenditures in the county we evaluate fiscal efficiency for policing services based on whether

Figure 5: Grid-based tax revenue model.

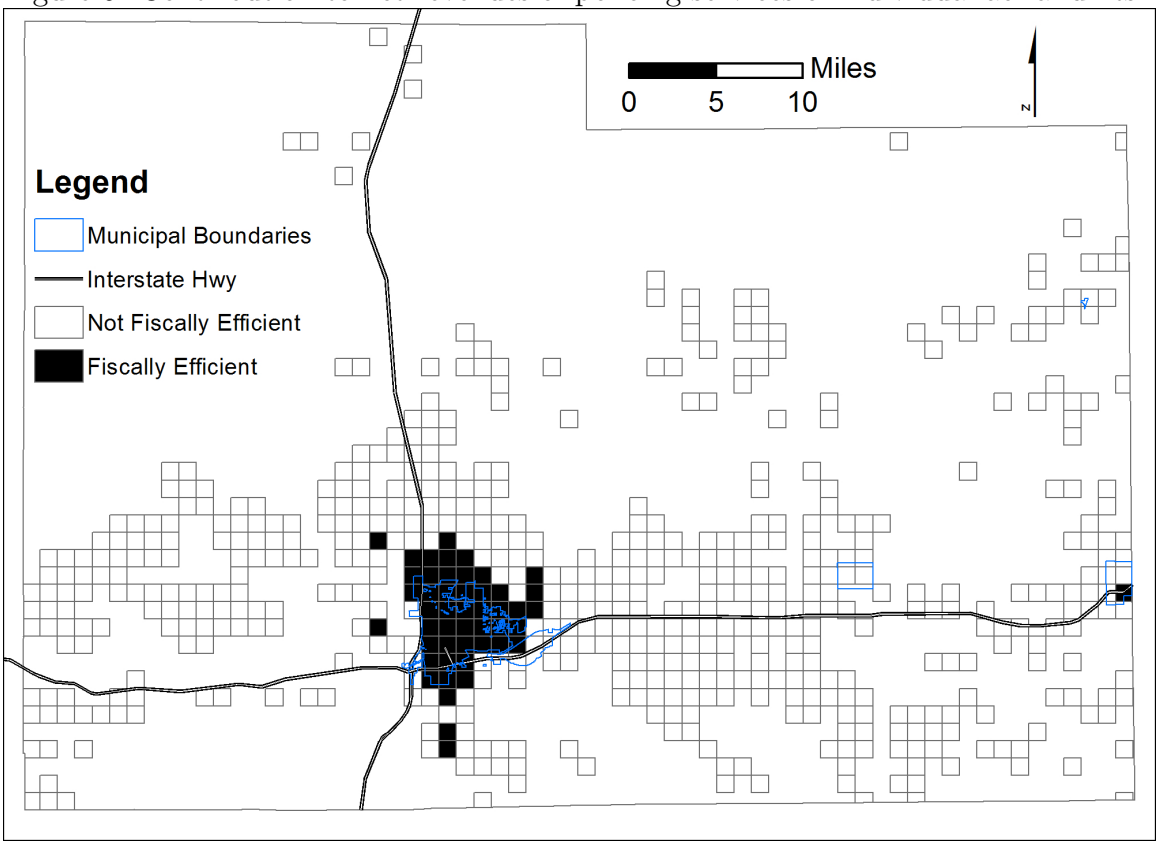


eight percent of property taxes cover expenditures. Evaluation of fiscal efficiency is accomplished with a simple 'if / then' formula comparing the contribution of individual aerial units to the total cost of policing services with property tax revenues. The output is a Boolean value indicating whether or not a grid cell contributes more in revenue than it costs to provide service to the cell, or vice versa. Figure 6, indicates the areas of Laramie County that are fiscally efficient for the provision of services. Results of the model indicate the core urban area in Laramie County, areas in and around the city of Cheyenne, are fiscally efficient for the provision of policing services. There are also non-contiguous residential developments south and west of Cheyenne that are indicated as fiscally efficient for policing services provision. The polycentric nature of fiscal efficiency model outputs is also demonstrated by determination of fiscal efficiency for policing services within the municipality at the extreme eastern edge of the county, Pine Bluffs.

7 Discussion and Conclusions

This modeling framework extends both Borcherding and Deacon (1972) and Tiebout (1956) to account for the spatial and political realities of providing local government services. We use Heikkila and Craig (1990) and Heikkila (2000) as a basis for building a spatial econometric structure and use Hirschman (1970) and Akerlofs (1980) work to inform a modified version of optimal public service provision configurations. The modeling framework directly builds urban form, demographic and social attributes that can affect resource use, and reputation effects that can drive agency objectives,

Figure 6: Contribution to net revenues of policing services of individual aerial units.



into an agency's resource optimization framework. The modeling framework links citizen preferences on levels of service with public officials response (the indicator used to establish reputation costs), input constraints and ultimately public service costs. The result is a robust cost function that incorporates spatial effects within a political jurisdiction where reputation explains part of the quantity or quality that is managed for.

Statistically significant dependent variables in the estimation of the cost function are wages, extra-municipal population, urban form, and the reputation variable. The conceptualization of extra market or political constraints in the reputation variable supersedes purely market forces allocating inputs. The reputation index used in this framework was a simple metric that linked what is observable, officers patrolling, to citizen support or lack there of. The role of political debate in informing the quantity and quality of service levels is in reality considerably more complex than we modeled. Our intention was to explore how a dual cost function for a public agency might be constructed that relies on markets for inputs and factors of production for service levels on one side while depending upon a local political processes and professional recommendations on the other.

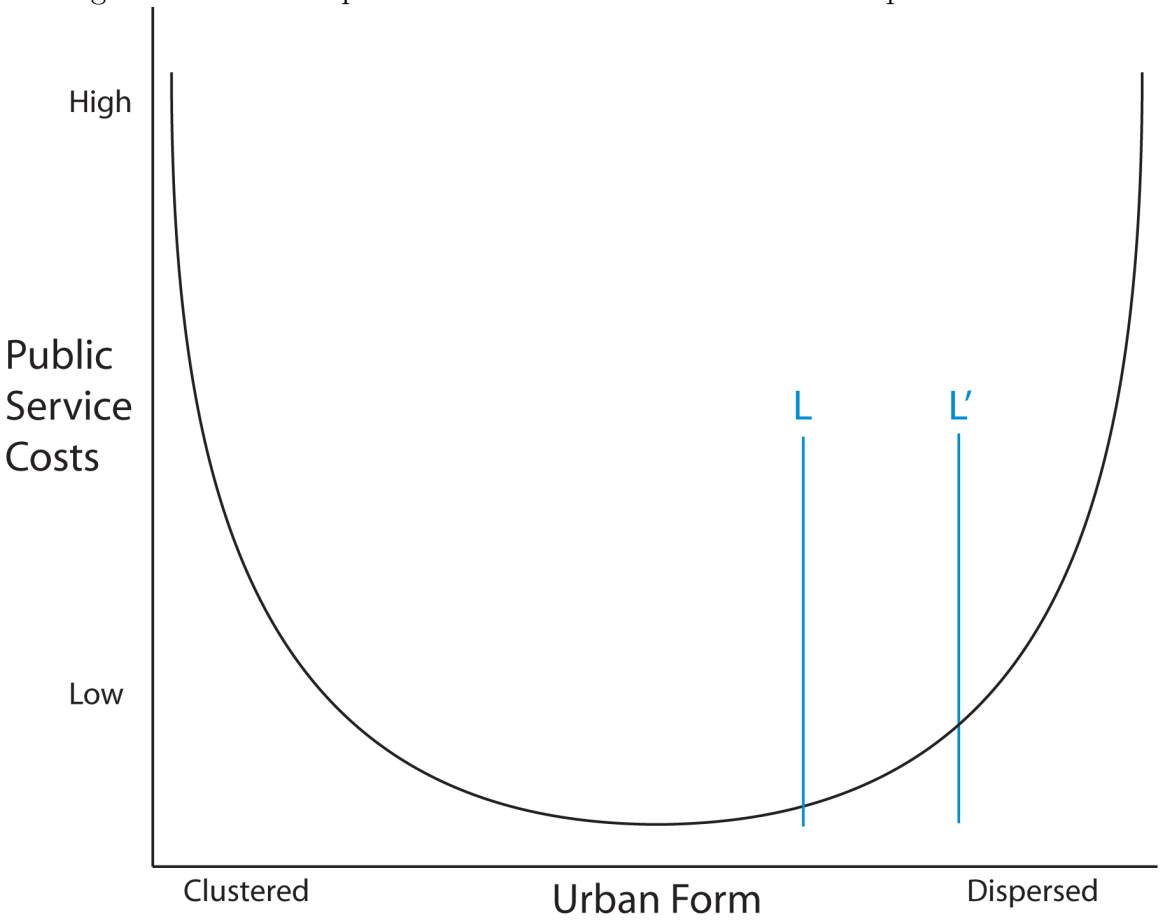
Empirical results indicate a statistically significant relationship between urban form and the cost of policing services provided by the Laramie County Sheriff's Department. As the built environment becomes more dispersed (increasing dispersion of residential land use over time in Laramie County is shown in Figure 3) there is a corresponding increase in the costs of policing services. Results of the econometric model are then used to model and map the contribution of individual aerial units to

the total cost of policing services. The contributions of individual aerial units to the total cost of policing service are juxtaposed with a spatially explicit revenue model to indicate areas that are fiscally efficient for the provision of policing services. Next, a simple spatially explicit property tax model is used to determine revenues for areal units.

Spatial model outputs are based on the idea of fiscal efficiency. For each fiscally efficient areal unit, user charges (in this case property taxes) entirely cover the cost of providing service to that area. By contrasting revenues and expenditures for each spatial unit we are able to determine and map areas of Laramie County that are fiscally efficient for the provision of policing services. Maps of areas that are efficient for the provision of services may be used to guide future development in the hopes of using growth to bring about greater fiscal efficiency in local government operations. Mapped results can provide planners a better understanding of the effects of exurban development and be used to inform state and local government policies on regulations and incentives that address where to accommodate and where to limit growth.

These results are congruent with work that associates increasing costs with increasing congestion with a U-shaped relationship between urban form and public service costs as shown in Figure 7.This relationship between public service costs and urban form was hypothesized by Studenski (1930) and Colm (1936) and noted more recently by Ladd (1992) and Warner and Pratt (2005) where low density developments incur higher costs but decline as density increases. At some higher density level costs begin to rise. Results here indicate only a portion of the cost curve in Figure 7 as indicated by the lines L and L'. Every land-use decision in every community

Figure 7: The U-shaped influence of urban form on costs of public services.



is a choice between moving left and right on the cost curve in Figure 7.

Further research can include several lines inquiry. We focus policing services because it is a service "delivered" to residents across the county and not a service that county residents travel in to use (e.g. County Clerk's office). Such a service then is particularly vulnerable to dispersed patterns of the built environment. Other delivery-based services in local government are potential areas of research, including emergency services, fire suppression, road maintenance, and more. Furthermore the

U-shaped pattern of expenditures as it relates to density suggests the minimum cost point can be different for different services and certainly reputation influences will be different, respectively. Further research is required in order to more broadly demonstrate the veracity of this relationship as well as to indicate, for specific communities and for specific development decisions, where they fall on this curve.

Continued refinement of both the spatial and non-spatial parameters that inform the pattern of growth in the exurban built environment are needed. This analysis' use of Moran's I is innovative because it combines nearness to the county centroid as well as near-ness to neighbors. However, other models may be appropriate. Notions of patch development and patch relationships are also possible alternative models. Finally the role of reputation and political sensitivity is an important extension for future research. Managers respond to both markets and politics and the employment and allocation of resources are governed by both institutions. Our use of reputation is a simple interpretation to what is likely a complex set of rules and relationships governed by notions of reciprocity and mutualism. Future research into what is considered quality and how those understandings of quality a affect resource employment and service provision would be important.

Acknowledgement

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References

[1] Anderson, W., P. S. Kanaroglou and Eric J. Miller. "Urban Form, Energy and the Environment: A review of Issues, Evidence and Policy". *Urban Studies*, 33 (1996), 7-35.

[2] Akerlof, G. "A Theory of Social Custom: of Which Unemployment May be One Consequence". *Quarterly Journal of Economics* 94, (1980) 749-75.

[3] Bartholomew, Harland. (1940). *The Present and Ultimate Effect of Decentralization upon American Cities* (Chicago: Urban Land Institute)

[4] Behrman, Jere R., and Steven G. Craig. *"The Distribution of Public services: An Exploration of Local Government Preferences".* American Economic Review, 77(1987): 37-49.

[5] Bergstrom, T, and R. Goodman (1973). Private Demands for Public Goods. Department of Economics, UCSB. UC Santa Barbara: Department of Economics, UCSB.

[6] Bewley, T. F. "A Critique of Tiebouts Theory of Local Public Expenditures". *Econometrica* 49(1981), 713-740.

[7] Borcherding, T., and R. Deacon. "The demand for services of non-federal governments", *American Economic Review*, 62 (1972), 891-901.

[8] Branch, Melville C. "Physical Aspects of City Planning." *Annals of the Association of American Geographers* 41 (1951), 269284.

[9] Brazer, Harvey Elliot. "City Expenditures in the United States". NBER Occasional Paper 66, 1959.

[10] Colm, G. "Theory of public expenditures". *The ANNALS of the American Academy of Political and Social Science*, 183(1936), 1-11.

[11] Davenport, D. (1926) An analysis of the cost of municipal and state government and the relation of population to the cost of government, net taxable income and full value of real property in New York State, J.B. Lyon Company, Albany, New York.

[12] Deacon, Robert T. "A Demand Model for the Local Public Sector". *Review of Economics and Statistics*, Vol. 60 (1978), 184-192.

[13] Downing, P. (1977). Local service pricing policies and their effect on urban spatial structure. Vancouver: University of British Columbia Press.

[14] Fortune, P. "A test of the Cobb-Douglas assumption for local governments." *National Tax Journal*, 36(1983), 233-236.

[15] Gaffney, M. Mason.(1964). "Containment Policies for Urban Sprawl", In *Approaches to the Study of Urbanization*, Richard L. Stauber, ed. 115133. Governmental Research Series no. 27. Governmental Research Center, University of Kansas.

[16] Gudeman, S. (2008). Economy's Tension: The Dialectic of Community and Market, New York: Berghahn Books.

[17] Hawley, Amos H."Metropolitan Population and Municipal Government Expenditures in Central Cities". *Journal of Social Issues*, 7(1951), 100-108.

[18] Heikkila Eric. (2000). The Economics of Planning. Center for Urban Policy Research, New Brunswick, NJ.

[19] Heikkila, E. and S. Craig. "Nested Fiscal Impact Measures Using the New Theory of Local Public Goods", *Journal of Regional Science*, 31(1991), 65-81.

[20] Hirsch, Werner Z. (1961). Measuring Local Services, In *Exploring the Metropolitan Community*, John C. Bollens (ed.) Berkeley: University of California 353 - 368.

[21] Hirsch. W. Z. (1968). "The supply of urban public services", in Harvey S. Perloff and Lowdon Wingo, Jr. eds., Issues in urban economics (Johns Hopkins University Press. Baltimore). 477 525.

[22] Hirsch W. Z., 1970 The Economics of State and Local Government (McGraw-Hill, New York).

[23] Hirshman, A.,(1970) Exit, Voice, and Loyalty: Responses to Decline in Firms, Organizations, and State. Cambridge: Harvard University Press.

[24] Hortas-Rico, M. and Solé-Ollé, A. (2010). Does Urban Sprawl Increase the Costs of Providing Local Public Services? Evidence from Spanish Municipalities. Urban Studies, 47(2010) 1513-1540.

[25] Isard, W.. "Distance Inputs and the Space-Economy 1 Part I: The Conceptual Framework." The Quarterly Journal of Economics 65(1951)181-198

[26] Kollman, John H. Miller and Scott E. "Political Institutions and Sorting in a Tiebout Model". American Economic Review, 87(1997), pp. 977-992.

[27] Ladd, Helen F. "Population growth, density, and the costs of providing public services" Urban Studies, 29(1992): 273-295.

[28] Lieske S. N., D. M. McLeod, R. H. Coupal R. and S. Srivastava, "Determining the relationship between urban form and the costs of public services" Environment and Planning B, 39(2012): 155-173.

[29] Lyon, L. S. Economic Problems of American Cities, American Economic Review 32 (1) Part 2, Supplement, Papers and Proceedings of the Fifty-fourth Annual Meeting of the American Economic Association(Mar., 1942), pp. 307-322

[30] Musgrave, R. A. 1959. The Theory of Public Finance: A study in public economy. New York: McGraw-Hill.

[31] Perkins, G. M. 1977. The demand for local public goods: elasticities of demand for own price, cross prices, and income. National Tax Journal 30(4): 411-422

[32] Romer, T. and H. Rosenthal. 1979. "Bureaucrats versus Voters: On the Political Economy of Resource Allocation by Direct Democracy". Quarterly Journal of Economics 93(4):563-87.

[33] Sacks, S. and W. Hellmuth Jr. 1961. Financing Government in a Metropolitan Area: The Cleveland Experience. Free Press of Glencoe. New York.

[34] Schmandt, H. J., and G. R. Stephens. 1960. Measuring Municipal Output. National Tax Journal, 13(4): 369-375.

[35] Scott, S. and E. L.Feder.1957. Factors associated with variations in municipal expenditure levels : a statistical study of California cities. Bureau of Public Administration, University of California. Berkeley.

[36] Studenski, P. (1930). The government of metropolitan areas in the United States. National Municipal League. New York.

[37] Tiebout, Charles M. 1956. A Pure Theory of Local Expenditures. The Journal of Political Economy 64 (5): 416424.

[38] United States Department of Labor, Bureau of Labor Statistics. 2012. Quarterly Census of Employment and Wages program . Accessed May 30, 2012. ES202 Data downloaded from http://www.bls.gov/cew/

[39] U.S. Department of Justice, Federal Bureau of Investigation. (1990-2010) "Crime in the United States, Uniform Crime Reports. Washington, D.C.

[40] Warner, M. E., and Pratt, J. E. (2005). Spatial diversity in local government revenue effort under decentralization: a neural-network approach. Environment and Planning C: Government and Policy, 23(5), 657-677.

[41] Wood, R. C. and V. V. Almendinger 1961. Fourteen Hundred Governments: The Political Economy of the New York Metropolitan Region. Harvard University Press. Cambridge, MA.

[42] Wyoming Department of Audit. 2011 Cost of Maintaining County Government http://audit.state.wy.us/PFUNDS/reports_to_legislature.asp

[43] Wyoming Department of Criminal Investigation. 2011. Wyoming Department of Criminal Investigation Annual Crime Reports 1999-2010 http://attorneygeneral.state.wy.us/dci/CrimeInWyomingReports.html

[44] Wyoming Division of Economic Analysis. 2011a. Annual Population for Wyoming, Counties, and Municipalities: 1990 - 2000. http://eadiv.state.wy.us/pop/c&sc90_00.htm

[45] Wyoming Division of Economic Analysis. 2011b. Intercensal Estimates of the Resident Population for Counties of Wyoming: April 1, 2000 to July 1, 2010 http://eadiv.state.wy.us/pop/ctyest01-09.htm

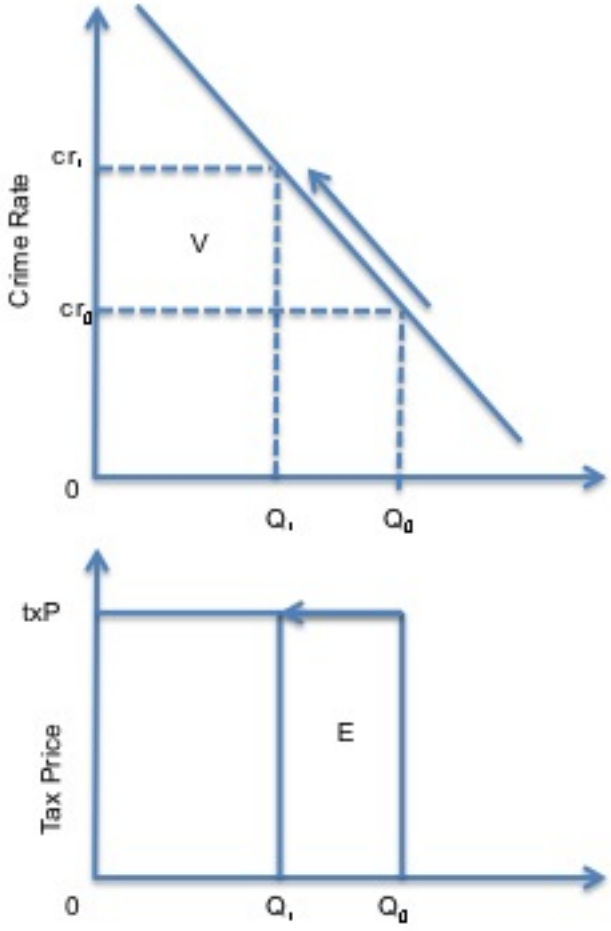
[46] Wyoming Division of Economic Analysis. 2010. Wyoming Incorporated Place Population Estimates: April 1, 2000 to July 1, 2009. http://eadiv.state.wy.us/pop/SUB-09EST.htmAccessedOctober21,2010.

A Applying Hirschman's Exit, Voice, and Loyalty to pubic finance.

Applying Hirshman's approach (outlined in his appendix a) to this analysis provides results similar to Hirshmans general results. Figure 2 summarizes Hirshmans approach applying it to the issue of policing services. The top panel represents a demand relationship for the quantity Q of policing services. Instead of a usual price variable on the vertical axis we use the crime rate as a representation of decreasing quality. The bottom panel represents revenues to the agency as the number of officers is reduced and crime rates increase. The vertical axis is the tax price txP. The area circumscribed in the lower panel (txP, 0, Q1) represents the revenue after residents exit the jurisdiction for another one. E represents the number of people leaving the area. V represents the voice of residents that remain that curb the drop in funding of policing services. The box E in the lower panel is the change in revenues as the number of officers is reduced. The more successful V is the less E causes a drop in revenues and thus the levels of policing services. This voice would represent the managers responding to local residents in the political process. The particular relationship between E and V is complicated and mutually complimentary.

We modify Akerlof's reasoning as follows: Public service managers (or the elected representatives that hire the managers) assess their constituents perspectives on the effectiveness of a local public service. Here voice readily serves as the signal public service providers monitor and gauge. This political calculus is a consideration that may influence input levels as an extension of the Borcherding and Deacon (1972)

Figure A1: Exit and Voice approach to a jurisdiction with rising crime rates.



public service demand. Private goods are provided in accordance with market price signals for outputs and inputs. Public goods are delivered as per capacity or volume consideration, with signaling coming from citizen pressures. Each approach is assumed to seek least cost inputs with the private firm moving freely in and out of markets according to the effect of prices on net revenues.

The likening of a public agency to a firm permits some decision insights but can only be applied in part due to the nature of factor supplies to the public sector and the responsibility to provide public services. Within the public goods decision framework resource allocation is solved through cost minimization, the use of the minimum quantity of factors in order to produce a given level of service (efficiency assumption). Resource allocation requires deciding what and how much will be produced. Whatever heuristic managers use to drive levels of service are specific to the local communities and can vary from community to community.