Alternative Service Delivery Strategies for Local Governments

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Abstract: A model for observing public service delivery choice in the presence of economic expansion is presented. Regression techniques were used to estimate the share of county population served by volunteer fire protection from variables measuring community demands for and relative costs of fire protection services.

Keywords: firefighters, volunteer organizations, taxes, municipal service demands, local spending, population growth, median voter

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Introduction

The face of Rural America is changing. Typically characterized by a dispersed population and low population density, low-money income, and population shifts that have major effects on small communities, rural areas are experiencing changes in economic structure, aging, and population density which affect the level of and mix of local services demanded. A critical issue is the provision of services that maintain efficiency while adapting to a changing structure of demand.

Volunteer fire protection exemplifies this phenomenon. While fiscal pressures have led governments to turn to alternative delivery mechanisms for many public services (Demone, 1983; Ferris, 1986; Hirsch, 1995) -- education, sewer, transport, water, etc.-- the majority of U.S. fire departments continue to be staffed by volunteers (FEMA, 1999). However, the institution of volunteer fire protection is being threatened by changes in employment structure that diminish the availability of volunteer firefighters, surges in development that increase fire calls, and government regulation of fire protection services. Concerns for cost and efficiency are driving local governments to re-evaluate their fire protection options.

This paper reports on analyses of alternatives faced by rural communities in their assessment of public service delivery, with direct reference to fire protection. A literature review is followed by a presentation of conceptual model of fire protection, the empirical model, data, and estimation results with a final discussion of conclusions.

Literature Review

Rural area response to economic expansion relies upon economies of scale, increased quality or quantity of service, public finance, and changes in production techniques. Rural areas lack economies of scale limiting their ability to bargain effectively for lower priced inputs, or to take advantage of quantity discounts and overall above-average costs of providing services (Stinson, 1981;Ladd and Yinger, 1994; Deller and Nelson, 1991; Warner, 1999). This applies to fire protection. Economies of scale result from specialization of labor and management, or from lower-cost methods of production. If economies of scale were to exist, an increase in population requiring more direct outputs could reduce average production costs. In the presence of scale inefficiency, average costs rise with population. Lack of managerial expertise contributes to local government scale inefficiency (Deller and Nelson, 1991).

Service quality and cost are paramount concerns to expanding communities. Congestion and the 'publicness' of the local service are of interest. A pure Samuelsonian public good is insensitive to the size of the consuming group, and a private good is highly sensitive to population size. In a study of fire departments in cities with populations higher than 30,000, Brueckner (1981) found fire protection exhibits substantial publicness, resulting in a weaker congestion effect than that of a private good. The level of fire protection increases with the size of the community, holding per capita fire expenditures fixed and considering only communities with relatively good fire insurance ratings. Implicitly, a given level of fire protection may be provided at a lower per capita cost in a larger community. This confirms the finding that savings result from high-density planned development (Downing, 1977). Brueckner did not test his hypothesis on rural communities, however, omitting volunteer and combination fire departments because in these departments, expenditures are not as closely tied to spending capacity and fire insurance ratings are typically low (Brueckner, 1981; Coe, 1983). Additionally, Brueckner's findings on quality (assuming fire protection level and quality are equal) omit the impact of timing on local government financing.

There is evidence that local governments are challenged by public finance issues --delayed finance flows, short-run inefficiencies, shrinking levels of redistributive aid, and pressures associated with devolution (Deller, 1998). The timing of finance flows relates to the speed at which a community can finance economic expansion with tax revenues. The degree to which current taxpayers subsidize new development depends on timing, whether or not changes were anticipated and accounted for in planning horizons. In the presence of unanticipated change, the tax burden will rise when short-run inefficiencies (front-end financing problems) are present (Coelen, 1981). These inefficiencies occur when property tax revenue receipts are collected after public services have been expanded and investments in infrastructure have been made using via bond issues (Coelen, 1981). If the financing could be spread out over time fully in line with receipt of services from the capital, high capital outlays in response to growth would not burden current residents (Ladd, 1992). The problem resides in that bond maturities are typically restricted by law to periods shorter than the useful life of capital investments. In sum, only when excess service capacity is present can local governments postpone expenditures and circumvent lags in financing; otherwise, and this is normally the case, current residents subsidize future residents by paying more taxes than they use in capital services (Stinson, 1981; Ladd, 1992; Fodor, 1997).

The tax burden may rise disproportionately if local governments are unable to respond quickly to changes in service delivery costs. Duncombe (1992) shows that local governments have low elasticities of substitution and demand indicating that local governments are vulnerable, in the area of fire protection, to significant cost increases due to union pressure, increases in building costs or equipment prices, and state and federal mandates on equipment usage or firefighting training

Inefficiencies in timing may have an adverse effect on the service quality. For counties that are moderately populated, fiscal burdens from population growth result in higher costs and reduced service levels—referred as “population density” and “surge” effects (Ladd, 1991). County boundaries are fixed so population growth will inevitably increase density. Higher density leads to the creation of a harsher environment translated into higher marginal costs for providing public services, as inferred by cost inefficiencies. A surge in population creates a need for capital outlays. If communities are slow to respond to these needs, and this is suggested by timing inefficiencies, per capita spending on current operations may not increase leading to a decline in current service levels (Ladd, 1991). In sparsely populated counties the results are ambiguous. In these areas, increased density reduces per capita cost thereby producing fiscal benefit (lower tax rate); however, slow government adjustment can lead to a deterioration of service levels.

Expansion places pressure on the already-limited financing alternatives of local governments. Revenue originates from both economic and political sources. Rural areas are constrained in economic capacity due to low per capita income resulting from labor markets dominated by routine manufacturing, services, or extractive industries (McGranahan and Ghelfi, 1994; Warner, 1999). They can influence political capacity however, with local effort as well as State and Federal redistributive aid (Warner, 1999). Evidence has shown that redistributive aid can equalize fiscal disparities among cities, thereby providing more assistance to cities with lower tax bases (Yinger, 1986); however, recent studies show that rural non-adjacent areas (population 20,000) receive less redistributive aid than metro core areas (population one million) (Warner, 1999), and that local governments are receive less support from the federal government (Duncombe, 1992). This is in part attributable to devolution.

Local governments have grappled with challenges inherent in devolution—pressures on local authorities to increase autonomy and efficiency—as well as the emergence of state mandates and tax/expenditure limits since the 1970's (Deller, 1991; Bice 2000). State mandates require counties to provide new services or programs, many of which involve public safety. Increasing federal training requirements for volunteer firefighters is one example (Thompson, 1992). By restricting the production process of local public services or compensation of local government employees, state mandates have increased the cost of providing public services (Bice, 2000). Mandates, in addition to fiscal limits--tax ceilings on property tax rates and rate increases --intensify the use of volunteer firefighters (Bice, 2000).

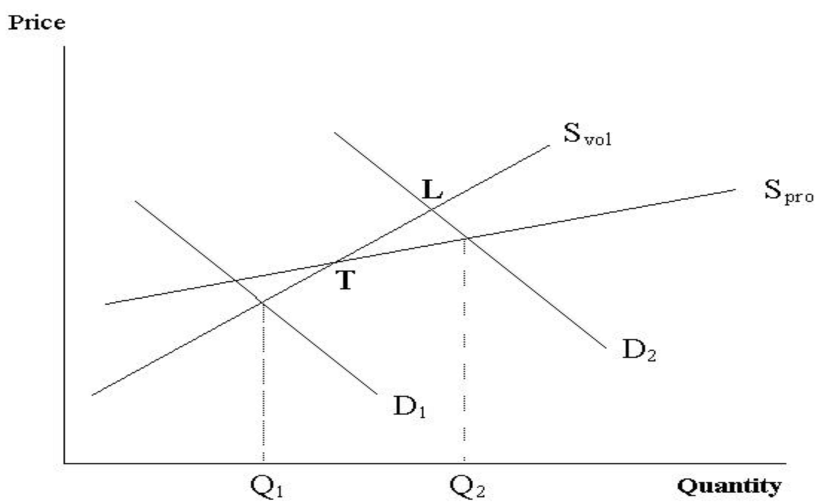
In sum, local governments are fiscally-constrained. These pressures surface in an environment of increasing concern for firefighter safety, increasing demand for emergency medical service, and a growing array of other services required to be provided by fire departments (such as advanced life support) (FEMA, 2000). To shift the reliance on property taxes, fire departments are being encouraged to seek alternative financing in three areas (1) other local financing--borrowing, leasing, benefit assessment charges, fees, strategic alliances, cost sharing and consolidation, fines and citations, sales of assets and services, subscriptions, and impact development fees, (2) state and federal financing-- fire insurance surcharges, vehicle related fees, special state grant programs, general state revenues, state provided services and federal grant programs--, and (3) private sector resources--private foundations, corporate donations, public/private partnerships, direct solicitation, fundraising, sales of products and services (FEMA, 2000). Only one study cites that private fire protection services face less difficulty securing financing versus volunteer fire protection (Guardino et al, 1993).

Lastly, changes in production technology influence service cost and quality. Expansion provides an impetus for an evaluation of production alternatives (service delivery options) (Deller,1992; Savas, 1988). Generally, fire protection services are provided by local governments and funded by tax receipts (Ahlbrandt, 1973). Provision, however, refers to the activities of financing, management, delivery or a combination of all of the above. Eight models have been suggested for providing public services: government service, intergovernmental agreement, contract or purchase of service, franchise, grant, voucher, free-market, voluntary service, and self-service (Savas, 1988; Stein, 1990). Deller (1998) notes that privatization is not always viable for smaller rural governments while cooperative arrangements present a worthwhile opportunity. While fire protection services can be provided by a private corporation, by a local government or by volunteer squad, they are generally grouped by staff type-- professional (all-paid), combination paid and volunteer, or all-volunteer firefighters. This is due to the amount of labor utilized in fire protection and cost differences among staffing requirements.

A Model of Fire Protection Choice

The median voter model has been used extensively for analysis of government spending and service provision. Figure 1 presents two median voter demand curves. The horizontal axis measures quantity of fire protection demanded by the median voter. The price of fire protection measured (P) is the median voter tax burden, or tax price (Mueller, 1989). Borcherding and Deacon (1973), Hayes (1986) and Duncombe (1991) use the median voter model to analyze the demand for fire protection.

Figure 1. A Model of Fire Protection Choice



The median voter model identifies several variables as determinants of the level of demand for public services: income, prices and tastes or preferences. Higher levels of income are associated with greater demand for public services (Duncombe,1991). Duncombe found that a one-percent increase in median income increased fire protection demand by 1.3 percent. Higher "tax prices" are associated with lower levels of fire protection demand. Therefore, it is expected that counties with higher median incomes will have a fewer residents served by volunteer departments because higher income earners demand more fire protection, and professional departments were hypothesized to be the least cost alternative for provision. Tastes and preferences are inherently not observable and therefore have been less consistently modeled. Proxies for tastes have included education levels, age, the presence of children in households, and political party.

An increase in median voter income triggers an outward shift in demand at any tax price represented in the figure by a shift from D_1 to D_2. Higher income reflects greater ability to pay for fire protection, implying that the median voter has more valuable property to protect. This increase prompts a switch to professional fire protection. As more fire protection is demanded, the relative cost of volunteer protection rises relative to professional protection. Before the income expansion, the downward-slope of the demand curve D_2 implies that communities with higher incomes are more likely to use professional fire protection.

The cost difference between volunteer and professional fire protection is the key that allows this model of the level of fire protection to serve as a model of the volunteer/professional choice. Cost differences between volunteer and professional fire services are represented in Figure 1 by the different positions of the volunteer and professional supply relationships, S_{vol} and S_{pro}. The contrasting slopes of these curves illustrate differences in marginal costs between volunteer and professional fire services relating to overall budget costs, fire fighting environment costs, and recruitment costs. There is evidence of cost differences between volunteer and professional fire departments (Ahlbrandt, 1973; Hilke, 1986; Perkins, 1987; Simpson, 1996). With respect to quality, volunteer fire departments have the highest losses per fire among combination and professional departments and in terms of response time, volunteer fire departments average 1.1 minutes longer than those for professional departments (McDavid, 1986).

The vertical axis measures tax price. At low levels of protection, the tax price for volunteer services is lower relative to professional services. The opposite is true at higher levels of service. At the transition point, T, professional fire services cost less than volunteer services. Changes in the relative costs of volunteer and professional fire protection will change the location of point T.

The conceptual model provides evidence that volunteer and professional costs differ primarily in the pay, recruitment, training and administration costs of firefighters. An increase in the level of fire protection must be matched by an increase in the number of paid firefighters. Professional firefighters can be induced to move to the community through a job offer, yet the pool of potential volunteers is fixed by the boundaries of the community. As the required number of volunteers increases, the volunteer department must recruit less committed firefighters who are typically willing to work fewer hours, are more costly to train, and are more likely to quit leading to increases in turnover. The costs of training and managing this greater number of less committed volunteers increases more than proportionally, confirming Brudney and Duncombe's (1992) conclusion that as administrative costs rise to specified levels, mixed and professional departments face lower costs than volunteer departments.

The predictions of our model also depend on the relative costs of delivering fire protection in more difficult fire fighting environments. Brueckner (1981), Southwick and Butler (1985), Brudney and Duncombe (1992) and Duncombe (1991, 1992) each tested a number of environmental variables—tall buildings, urban sprawl, and presence of industrial property-- showing that some environments are more difficult than others. Ladd (1994) finds that environmental costs will increase as density increases. Other environmental variables that increased costs in at least one study were higher poverty rates, more old buildings, and crowded buildings. Comparisons of the effect of environment on volunteer versus professional costs are scarce. Brudney and Duncombe (1992) show that professional departments are more prevalent in communities with more industrial property, more poverty and taller and older buildings. Hilke (1986) found volunteer departments to be less costly in his sample of relatively small communities, which probably have less challenging environments. If these measures correlate with difficult environments, this is evidence for our hypothesis.

Volunteer recruitment can also influence service delivery choice. Simpson (1996) asserts that suburban communities have more difficulty recruiting volunteers than do rural and working class communities. Perkins (1987) notes that the declining number of people working in agriculture and increases in mobility and urban employment threaten volunteer firefighter recruitment. Daytime volunteers become increasingly scarce when the number of commuters increases. Suburban, professional, commuter communities have higher volunteer costs relative to professional costs, making them more likely to choose professional departments (Perkins, 1987).

Finally, it may be that there are some levels of fire protection that simply cannot be attained by volunteer departments. Mandated training requirements and part-time volunteer management could mean that volunteers would have to devote themselves to their departments nearly full time. At some high level of Q the volunteer supply line S_{vol}

may become vertical (figure 1), and higher levels of fire protection may be unavailable by volunteers at any price (McDavid, 1990).

Local governments generate revenue primarily using property tax instruments (Warner, 1999). While tax price determines the demand for fire protection, it works through its effect on fire protection supply. To arrive at the median voter's share the following must be derived. If the price of a level of fire protection to the community's government is defined by C(Q), as the level of protection Q rises, its cost C rises. This cost is financed by taxes, property taxes in most jurisdictions in the United States. The property tax rate is set by dividing the cost of providing protection by the tax base, V, a measure of the taxable property of the community. The tax rate is

(1) $T = C(Q) / V.$

The tax price paid by the median voter is this tax rate times the median voter's taxable property, H. In most jurisdictions, the median voter is a homeowner who owns little or no other taxable property. The median voter's tax price is

(2) $P = T \times H$

Substituting (1) into (2) and rearranging the terms yields

(3) $P = (H/V) \times C(Q)$

implying that the median voter's tax price depends on the community's overall cost of protection C (Q), and on the voter's share of taxable property, H/V. Changes in the tax price will affect the volunteer/professional supply choice. The larger is the median voter's share of taxable property, the higher will be the median voter's tax price for any level of protection, and the lower will be the level of protection the voter will demand. In other words, given a downward sloping demand, the higher is the median voter's share of the tax base, the more likely will the community choose a staffing combination that gravitates towards more volunteer protection. It is important to note that the decision on volunteer versus professional fire departments is more continuous than discrete. In this context, Figure 1 then should not be interpreted as a discrete choice, but rather a continuous choice among fire protection staffing choices. A higher tax price causes the median voter to choose a lower level of fire protection. At a lower level of fire protection, fire departments that staff predominantly volunteers are likely to have the lowest costs.

The tax price variable is implied by the median voter model. Duncombe (1991) provides a review of the literature, finding tax price elasticities in past studies of between -0.2 and -0.8. However, his results indicate no tax price response--fire protection was perfectly inelastic. Represented in our figure by a vertical demand function, this implies that quantity demanded, and therefore the choice between volunteer and professional fire protection, is invariant to tax price.

The median voter model assumes that government institutions are perfectly responsive to voter demands, that candidates and the voters are aware of the costs for both volunteer and professional departments, and that the volunteer/professional choice is made solely on the basis of lowest cost. A contrasting view proposes that government institutions influence the level of service delivery at least as much as voters. Institutions may cause the level of services to diverge from the demands of the median voter. Romer and Rosenthal (1979) and Mueller (1989) provide reviews. The median voter may think his or her tax price is lower than it really is (Pommerehne and Schneider, 1978). Turnbull and Djoundourian (1994) find that the median voter model explains the overall level of spending, but not spending on individual services. However, several studies that have compared the median voter and institutional models find that the median voter model better explains spending levels (Reid, 1991; Sass, 1991; Congleton and Bennett, 1995)

The median voter model of fire protection choice may diverge from the real choice if the community values other elements of volunteer protection, making it willing to pay a premium above minimum cost. Situations may exist where volunteers withhold information from elected officials in an attempt to resist change, thereby perpetuating their current situation. Finally, based on the literature provided, timing of finance flows may not allow local governments to change their current provision arrangement. In Figure 1, all these possibilities may be represented by point L (for "lag"). At that point, volunteer protection costs exceed those of professional protection. If demand and costs were all that mattered, the community would choose professional protection at Q_2.

Data and Empirical Model

A model of community choice between volunteer and professional fire protection was tested using data for Indiana counties. The measure of community fire protection choice was the share of county population protected by volunteer departments in 1991, a measure which can be viewed as a proxy for the percent of volunteers. The data were provided by the Indiana State Office of Public Safety, Public Safety Training Institute 1996 publication entitled, “Number of Residents Served by Volunteer Fire Departments Indiana.” This report was compiled utilizing information from the 1991 Census, a 1991 listing of all Indiana fire departments, a 1995 Indiana Emergency Services Registry (SEMA, 1995), a 1991 listing of all paid and combination fire departments, and personal accounts recorded by the Fire Chiefs of fire stations across Indiana (Nevill, 1999).

Data were used for 91 of 92 Indiana counties. Marion County (Indianapolis) was excluded because it is has a quasi-consolidated form of government unique among Indiana counties. Table 1shows the definitions, means and standard deviations of the data. The median market value of homes and the assessed value of the county were included. Indiana's assessment practices were not designed so that the assessed values of homes fully reflect the market values of homes. Indiana is the only state that declares that its assessed values are not market values (Indiana Code (6-1.1-31-6c). In 1998 the Indiana Supreme Court found Indiana assessment practices to be unconstitutional, but no changes have yet been made.

Home values and total assessed value were used separately, rather than as a ratio. The proxy for the numerator of the tax price, median home value, was expected to have a positive sign, holding total assessed value constant. The denominator of the tax price, assessed value, was expected to have a negative sign, holding median home value constant. Higher home values and lower assessed value imply a higher tax price, which leads to a lower demand for protection. Volunteer departments have a cost advantage at lower protection levels.

The average years of education for adults in a county was used as a proxy for tastes. It is suggested that individuals with higher education support greater levels of public services Meanwhile, evidence shows that at certain levels of fire protection, volunteer departments simply do not exist. The coefficient of this variable was hypothesized as negative.

Seven costs measures were used included in the model-- rental percentage, manufacturing employment percent, farm receipts per capita, old house percent, poverty rate, fire brigade and emergency medical service (EMS) responses. Another variable, the percentage of rental housing, may indicate the presence of multistory buildings and denser development, both of which increase firefighting costs and the use of professionals. In comparison to homeowners, renters may have less interest in fire protection leading to a stronger reliance on volunteer fire protection. Older houses are often greater fire hazards, therefore, the percentage of houses built pre-1939 in the county is an indicator of a costly environment. The percentage of county residents with incomes below the poverty level is expected to have a negative sign due to poor quality structures (increased fire hazards). Finally, the presence of farms, measured by per capita farm crop and livestock receipts, represents a reduced fire risk making the coefficient positive.

Multistory buildings and the presence of hazardous materials are typical to industrial facilities and may present special fire fighting risks, thereby increasing the cost of fire protection. However, the presence of large number of manufacturing employees may provide a pool of potential volunteers, particularly third shift workers available in the daytime. The share of manufacturing employment in total county employment measures the presence of industrial facilities and manufacturing employees. The sign of this coefficient is ambiguous.

The presence of industrial fire brigades is treated as another cost variable. Some industrial businesses create their own professional fire brigades, thereby internalizing fire protection services. Since these professionals do not serve the population at large, they are not included in the volunteer percentage calculation. The presence of industry tends to increase fire protection costs; its influence should be captured in the density variable. Ordinarily, these higher costs should promote professional departments; however, if the industry adopts mechanisms for self-protection, the remainder of the community may continue to rely on volunteers. The sign of this coefficient should be positive.

A variable measuring the level of EMS demanded by a county was included in the model. The EMS variable records the number of EMS responses-- trauma emergencies, medical emergencies, emergency responses, and convalescent transports-- normalized by population for each Indiana County. The reasons for including this variable are threefold: one, fire departments are responsible for 56 % of EMS providers in Indiana, two, EMS runs constitute a large portion (50-70%) of fire service calls, and three, volunteer and professional fire departments provide different levels of EMS services --paid departments achieve higher levels of training (Indiana State Fire Marshall, 1999). The hypothesis was that an increase in the number of EMS calls would increase the cost of producing fire services, thereby reducing the use of volunteers. Based on Figure 1, an increase in cost (quality) of service would provide more rationale for the utilization of a professional department. This would support studies showing that the provision of EMS services has been proven to increase fire department costs (Brudney and Duncombe 1992;Thompson and Bono, 1993), and all-paid departments have a higher percentage of EMS calls relative to volunteer fire departments (Brudney and Duncombe, 1992).

Three proxies represent recruitment costs--commuter percent, manufacturing wage, and percent age 18-34. Commuters are typically unavailable during the day to answer fire calls. Counties with large numbers of out-commuters are likely to find the recruitment of volunteers more costly, therefore the sign of this coefficient is likely to be negative. The higher these opportunity costs for firefighters to volunteer, the less likely they are willing to devote their time. Manufacturing wage was used to represent the economic gain forfeited by a volunteer firefighter. The sign of this coefficient is expected to be negative. However, this variable may serve as a proxy for paid firefighter salary. Increases in a paid firefighter's salary are met by increases in fire protection and the tax price, making it more likely that the median voter demands a lower level of service. Finally, since volunteers are usually drawn from younger age groups, the percentage of residents in the 18 to 34 year old age group is a measure of the potential pool of volunteers and is predicted to have a positive coefficient.

Two variables were introduced to measure a delayed transition—number of governments and intergovernmental aid. Constraints on information may forestall change. Since communities often learn about the costs of fire protection alternatives by examining departments in nearby communities, communities in counties with a larger number of local government units may have a greater opportunity to learn from each other. The greater the number of townships, cities and towns in a county, the more likely is the volunteer percentage to be smaller. Lastly, as mentioned earlier, local revenues come from property taxes as well as intergovernmental (state and federal) aid. Communities that receive more aid (taken in the 1986-1997 time period) will have more public services. In Indiana, where 51% of fire departments are fully volunteer, an increase in aid will lead departments to uphold the volunteer tradition. The sign of this variable will be positive. While intergovernmental aid can offset the disadvantages that communities face with respect to the financing of expansion, it may also contribute to and provide evidence for a lag in service delivery.

Two variables are introduced to capture dynamic effects--the percent change in median income and the percent change in population density. Counties that are growing rapidly do not have the time to collect data or to address opposition to professional departments. The percentage change in median income and population density between 1980 and 1990 are chosen to measure these changes. Income is often the most important demand side variable in public service regressions, while density is the broadest of the measures of costs. Counties where income and density are increasing more rapidly may not have completed the transition to professional departments, so higher percent increases were expected to be associated with higher volunteer percentages.

County-level data were used in this analysis due to data availability. Fire protection is not provided at the county level in Indiana, yet all the available data are county data. There is a potential aggregation problem; in particular, it is possible for changes in the urban-rural distribution of population to influence the results. Urban departments are more likely to be professional; rural departments volunteer. If a county experiences more urban population growth than rural growth, the percentage of the population served by volunteers will decline, even if no individual department switched from volunteer to professional. The dependent variable may be more a measure of county population distribution, not fire department choice. To test for this possibility, the percentage changes in population in incorporated (within cities and towns) and unincorporated areas in each county are included. If aggregation is a problem, there should be a higher volunteer percentage in places where rural population is growing rapidly. Likewise there should be a lower volunteer percentage in counties with more rapid urban growth.

The aggregation problem can be rationalized by considering that the national average of square miles per county is close to three times that of Indiana. The national average of square miles per county is 1138 (except Alaska); the average for Indiana is 390. While the shortcomings of county-level data are noted, the large number of counties in proportion to the area covered supports the use of this data for hypothesis testing.

Estimation Results

The dependent variable used in this study was the percentage of county residents served by volunteer fire departments. We performed White's test for heteroskedasticity of error terms. The result of the White test was an F-statistic of 0.77 with a probability of 0.801, meaning that the test was insignificant and that a linear specification of the model is the correct approach. Two OLS regression models were specified. While we tested a logistic form of the regression models using the dependent variable specified in logistic form, the results closely resembled those of the linear models. The results of the logistic form of the model therefore lead us to believe that the original linear specification is appropriate.

Table 2 reports the results of three OLS regression estimates. Regression 1 shows the results including all the explanatory variables described above. To avoid of multicollinearity, an additional regression with a more parsimonious use of explanatory variables is reported. Using R-square statistics, the explanatory variables explained 73%, and 72% of the variation in the volunteer percentage in models one and two respectively. Using adjusted R-square statistics, the explanatory variables account for 65% and 66% of the variation in the volunteer percentage in each model. Adjusted R-square modifies adjusts the R-square for the number of explanatory variables in the model.

Each of the four variables utilized to represent demand characteristics were significant, thereby providing support for the conceptual model. The coefficient on median income was negative and significant at the ten percent level in both regressions, as expected. If increases in income increase demand for fire protection, as many previous authors have found, the likelihood that protection will be provided by professional departments increases--if professional fire departments are less costly at higher levels of protection. The negative sign on the median income variable favors designing a model with different cost structures for volunteer and professional service provision.

Similar evidence is provided by the positive sign on the coefficient of median house value that proved significant at the five-percent level in both regressions. Holding assessed value constant, the higher the median house value, the more people receive fire protection from volunteer departments. The variable is our proxy for the numerator of the tax price ratio in equation (3). In our model, the higher the house value, the greater the tax bill for local government services paid by the median voter, and the lower the level of fire protection demanded. Volunteer departments will be more likely to provide fire protection in counties with higher median home values, if volunteer departments are less costly at lower levels of protection. The positive coefficient on the median house value confirms that volunteer departments face lower costs at lower levels of protection, and professional departments face lower costs at higher levels of protection.

Assessed value has a positive sign, as expected. As the denominator of the tax price ratio, it was expected to have a negative sign, holding median house value constant. With more taxable property owned by others, the median voter was expected to demand more fire protection, likely provided by professionals. It is interesting to note that the simple correlation between assessed value and the volunteer percentage is -0.51 implying that bigger, wealthier counties are less likely to use volunteers.

The coefficient on the final demand variable--number of years of education--was negative and significant at the five percent level in both regressions, implying that counties with people who have more schooling are less likely to receive fire protection from volunteers. This is consistent with evidence that individuals with more education demand more fire services.

Of the ten variables selected to test the significance of environmental and recruitment costs on the choice of fire protection, only two were significant at the five percent level in both regressions. The coefficient for the percentage of a population living in rental housing was negative, showing that a rise in the rental percentage will be followed by a fall in volunteer use. It is likely that the rental percentage variable may be capturing a density effect. Greater density is likely to increase the costs of the firefighting environment due to more congestion, traffic, structures closer together, and taller buildings. Farm receipts per capita is positive and significant at the five percent level in both regressions. This shows evidence that agriculture presents fewer fire fighting challenges and in counties where farming is pervasive, jurisdictions are more likely to use volunteer departments. Volunteers have cost advantages in less difficult fire fighting environments. The negative sign on this variable, and the positive sign on the farm receipts variable provide evidence for the hypothesis that professional departments have cost advantages in more difficult fire fighting environments. None of the variables included to measure recruitment costs were significant. The measurement of recruitment costs necessitates further consideration.

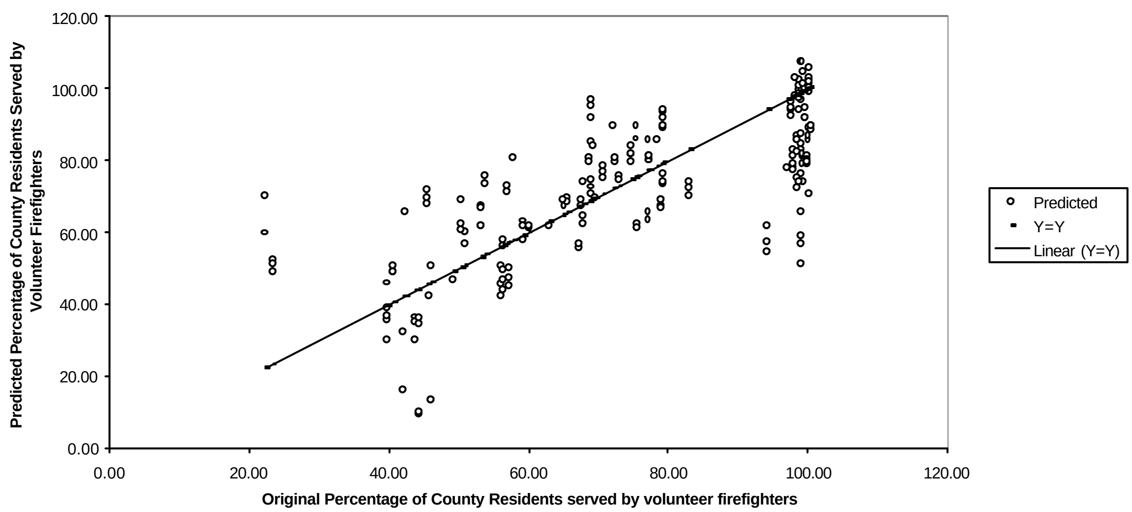
Two variables attempted to test whether communities delay their transitions from volunteer to professional departments. The intergovernmental aid variable is positive and significant at the five percent level in two regressions indicating that, as Warner (1999) and Yinger (1986) suggest, the amount of aid affects the level of provision of public services. Holding total county government revenues constant, an increase in intergovernmental aid will result in a rise in the number of residents served by volunteer fire departments. As a community expands, volunteer fire departments will become more prevalent, providing evidence for short-run inefficiencies and a lag.

Two variables were included to test for complications with the use of aggregated data. The percent change in urban population was significant at the five percent level in both models, providing evidence that some variation in the volunteer percentage is due not to choices by jurisdictions but to changes in the populations of jurisdictions. Meanwhile the coefficient on urban population change is negative, implying that increases in city and town populations where professional fire departments are prominent tends to decrease the percent of the population service by volunteers.

Validation

Validation of the model results was attempted to gauge the predictive capability of the specification. From the 91 observations in the data set, 81 observations were used to generate variable coefficients from which ten simulations of twenty variables were predicted. Confidence intervals were formulated following the procedure suggested by Neter et al, (1996). The mean square error from the 81 variables was then used to calculate a vector of explanatory variables for each predicted value to get the predicted variance. The predicted variance was used to construct two confidence intervals at the five and ten percent levels. Figure 2 illustrates a comparison of the predicted value with the original data.

Figure 2: Original Fire data versus Predicted Fire data with Confidence Interval



The model formulation predicts with a reasonable degree of accuracy for fire departments that staff between 40-80 percent volunteers (Figure 2). Due to the fact that the dependent variable in this model is the percentage of residents served by volunteer firefighters, it is expected that model predictions will not be as accurate on the upper and lower tails of the zero to one distribution.

Conclusions

Empirical evidence from a sample of fire departments in the state of Indiana suggests that volunteer fire departments are a lower cost alternative to professional departments where less fire protection is demanded and where the firefighting environment is less difficult. These results can aid policymakers planning for and adjusting to changes such as increases in suburban and business developments, newly introduced to rural areas in this time of long economic expansion.

In sum, as incomes rise residents demand quicker response times and more emergency services, which may be beyond the capacity of volunteer departments to provide at reasonable cost. Growth in population density new industries increases the task of fighting fires, perhaps beyond the abilities of part-time volunteers. These trends may cause communities to switch from volunteer to professional departments, yet rising home values may create pressure to maintain volunteer departments. Owners of high valued homes may accept lower levels of fire protection provided by volunteer departments for lower property taxes. The arrival of high valued ex-urban housing development in a rural area is not necessarily the beginning of the end of volunteer fire protection.

There is a need to verify the conclusions of this piece in other geographic locations and other time periods, and to validate the hypotheses presented in this model with individual fire department data and/or case studies of departments. Such extensions would allow for a better opportunity for testing the tax price-- ie, where assessment practices are more consistent. Future studies may include more extensive testing of the lag concept and a more rigorous treatment of the model, including both the demand and supply side of the market, with derivations of reduced form equations. Further treatments of public finance issues in rural areas should consider alternative financing methods that shift reliance away from intergovernmental aid. Another option is for rural communities to separate provision from production of public services and consider different service delivery options, from cooperative arrangements to privatization (Deller, 1992). We have provided evidence that, with respect to fire protection, rural communities need to consider staffing options, from utilizing all-volunteer to all-paid (professional) firefighters. There are examples where communities have selected each.

Table 1. Definitions, Means and Standard Deviations (units in parentheses)

Variables	Definition	Mean	St. Dev.
Volunteer Percentage	Percentage of county population served by volunteer departments, 1991 (%)	73.0	21.5
Median Income	Median household income, 1989 (000)	27.5	4.30
Median House Value	Median estimated house selling price, 1990 (000)	48.4	12.0
Assessed Value	Assessed value of taxable property, post exemptions & deductions, 1991 (billions.)	0.40	0.50
Yrs. of Education	Average yrs of education, county residents over age 25, 1990 (#)	12.4	0.40
Rental Percentage	Percentage of hhlds living in rent housing, 1990 (%)	21.8	5.30
Farm Receipts per capita	Value of livestock and grain sales per person (millions)	1.70	1.40
Old House Percent	Percentage of single-family housing built pre-1939, as of 1990 (%)	28.8	9.20
Poverty Rate	Percentage of households earning incomes below the poverty level (%)	11.2	2.80
Fire Brigade	Dummy =1county has an industrial fire brigade, =0 otherwise, 1991	0.20	0.43
EMS Responses Percent of Population	Total EMS responses by county normalized by county population, 1995	9.60	4.40
Manager/Professional Employment	Percentage of employees working as managers or professionals, 1990 (%)	18.4	4.40
Commuter Percent	Percentage of working people who live but do not work in a county (%)	35.9	16.7
Manufacturing Wage	Avg. annual wage paid to manufacturing employees, 1990 (000)	32.7	4.50
Percent Age 18-34	Percent of county population aged 18-34, 1990 (000)	25.4	3.40
Intergovernmental Aid	County Intergovernmental aid 1986-7 / General Revenue, 1986-7 (%)	43.6	9.40
Number of Governments	Number of township, town or city governments in county, 1991(#)	17.3	5.60
Percent Change Median Income	Percent change in median household income, 1980-90 (%)	65.7	10.0
Percent Change Population Density	Percent change in population per square mile, 1980-91 (%)	1.60	8.40
Percent Change Urban Population	Percent change in population living in incorporated city/town, 1980-90 (%)	0.50	6.10
Percent Change Rural Population	Percent change in population living outside incorporated city/town, 1980-90 (%)	1.20	9.10

Table 2. Regression Results

Variables	**Regression 1** Coefficient	(t-statistic)	**Regression 2** Coefficient	(t-statistic)
Median Income	-2.72*	(1.77)	-2.69*	(1.92)
Median House Value	1.32**	(2.46)	1.16**	(2.52)
Assessed Value	-8.16*	(1.73)	-5.33	(1.29)
Years of Education	-26.9**	(3.58)	-26.5**	(3.60)
Rental Percentage	-1.08**	(2.29)	-1.03**	(2.33)
Farm Receipts per capita	4.05**	(2.78)	4.03**	(2.92)
Old House Percent	0.09	(0.37)	0.02	(0.11)
Poverty Rate	-1.45	(1.15)	-1.85	(1.61)
Fire Brigade	5.20	(1.37)		
EMS Responses Percent of Population	-0.39	(1.06)		
Manager/Professional Employment	-0.23	(1.04)	-0.23	(1.11)
Commuter Percent	-0.14	(0.83)	-0.15	(0.97)
Manufacturing Wage	0.15	(0.31)	0.17	(0.42)
Percent Age 18-34	0.706	(0.91)	0.72	(0.96)
Intergovernmental Aid	33.5**	(2.00)	36.05**	(2.29)
Number of Gov'ts	0.133	(0.45)		
Percent Change Median Income	-0.022	(0.11)		
Percent Change Population Density	0.043	(0.10)		
Percent Change Urban Population	-0.54**	(2.07)	-0.53**	(2.16)
Percent Change Rural Population	-0.11	(0.44)	-0.04	(0.25)
Constant	430.5 **	(4.77)	434.0**	(4.99)
R-squared	0.73		0.72	
Adjusted R-squared	0.65		0.66	
F-statistic	9.40**		7.62 **	

** Significant at 5% level * Significant at 10% level

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