DETERMINANTS OF MUNICIPAL GOVERNMENT EXPENDITURES IN ALBERTA USING MULTIPLE REGRESSION ANALYSIS

by

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ABSTRACT

This thesis analyzes the influence of selected expenditure determinants on the supply and demand for police, fire, and recreational services provided by Alberta municipalities. In addition, aggregate expenditures which are the sum of police, fire, and recreational services are analyzed.

The model tested is fitted in semi-log form, where the dependent variable is in logarithmic form and the independent variables are linear, using the method of ordinary least squares regression (OLS). The results are first analyzed using pooled urban and rural data, and secondly separating urban and rural data.

The pooled urban and rural results show that police expenditure tends to be influenced by population characteristics, while fire expenditure tends to be influenced by geographical characteristics. Recreational and aggregate expenditure do not show any specific tendencies. The most important finding in this exercise is the significance of the urban dummy variable in police, fire, recreational and aggregate regressions. This finding shows that urban and rural municipalities differ and should be analyzed separately.

The urban results show distinct differences between cities on the one hand and towns and villages on the other. However, there is very little distinction between towns and villages. This may be due to the population size of cities when compared to towns and villages. The rural results also show a distinction between counties and municipal districts.

Other than certain dummy variables, the rural results have only two significant independent variables TG (total grants) and ILI (incidence of low income) in two of the four regressions. The limited number of observations available in the rural analysis may explain the fewer significant independent variables.

Commonalities of the pooled urban and rural results and separate urban and rural results include: a preference for the log-linear functional form and OLS estimation; the unsatisfactory results of the aggregate regression; the insignificance of equalized assessment (defined as the value of property) as an independent variable; and the significance of grants from the province to municipalities.

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CHAPTER 1

INTRODUCTION

There has been a long-standing interest in the relationship between social and economic characteristics, and government expenditures. From the earliest studies, by Colm (1936) and Fabricant (1942), expenditure determinant analysis has been conducted to determine the relative importance of factors affecting government expenditures. Studies have analyzed state, provincial, and municipal expenditures. Some studies focused on aggregate expenditure; others on expenditures on specific services, and others on both.[1]

Determinant studies add to our knowledge of government expenditure patterns, and suggest the effects of various social or economic characteristics on expenditures. Although determinant studies do not derive a service cost function, they do help in explaining why expenditure levels differ among services and governments. The results can assist the process of planning for public services when used for forecasting government expenditures and assessing the impact of certain forces.

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A literature review is provided in Chapter 2.

Despite their relevance for public policy makers, only a few expenditure determinant studies have been conducted using Canadian data. Michas (1969) studied provincial-municipal expenditures across Canada, and Bodkin and Conklin (1971) studied the determinants of municipal government expenditures in the Province of Ontario.

A literature search did not provide any expenditure determinant studies conducted in Alberta. With reasonable confidence, it can be stated that the variation between the level of expenditures of municipal governments in Alberta has not been studied to date.

Like other Canadian provinces, the Province of Alberta covers a large, somewhat diverse region. Alberta municipalities differ in terms of services provided and ability to generate revenue, and it is useful to analyze these differences in terms of social, economic, and demographic characteristics. As Alberta municipalities, along with provincial and federal governments, face financial dilemmas, it is becoming more important to understand the causes of differing public service needs at the municipal level.

This thesis analyzes the influence of selected expenditure determinants on the supply and demand for police, fire, and recreational services provided by Alberta municipalities. In addition, aggregate expenditures which is the sum of police, fire, and recreational services will be analyzed. The following chapter reviews numerous expenditure determinant studies, which were conducted primarily in the United States. Chapter 3 consists of an overview of Alberta municipalities and the services they provide. Chapter 4 explains the model, data used, functional form, and diagnostic testing conducted in formulating and estimating the model. In chapter 5, the selected municipal services are analyzed using all Alberta municipalities. In chapter 6, the selected municipal services are analyzed in terms of urban and rural municipalities. Chapter 7 provides a summary and conclusions of the results of the study.

CHAPTER 2

REVIEW OF EXPENDITURE DETERMINANT STUDIES

There have been a substantial number of studies directed at examining expenditure determinants of governments at all levels. The earliest studies used scatter diagrams to illustrate the relationship between expenditures and various socio-economic, geographic and political variables, while more recent studies have used multiple regression analysis and cross-sectional data to explain the relative importance of different variables in determining expenditures. As previously mentioned in chapter one, few expenditure determinant studies have been conducted in Canada. The following expenditure determinant studies have been conducted in the United States unless otherwise stated.

In 1936, Colm used scatter diagrams to find the impact on different categories of state-municipal spending of income, urbanization, industrialization, and population density. Shortly after, in 1942, Fabricant used multiple regression analysis to study the relationship between operating expenditures of state and local governments, and the variables population density, urbanization, and income. Fabricant (1942) found a significant correlation between population density, urbanization, income and government aggregate operating expenditure, as well as individual services such as schools, highways, public welfare, health and hospital, police, and fire protection.

Fabricant's study stimulated numerous studies with variations in methodology. Fisher (1961) replicated Fabricant's study using 1957 data. Fisher's study concluded that while population density, urbanization, and income explain a significant proportion of the total variation in expenditures, the amount explained varied considerably by function. In addition, the unexplained proportion of variation required further study.

Kurnow (1963) tested Fabricant's and Fisher's studies using a multiplicative regression model rather than an additive model. A multiplicative regression model takes into account the fact that a change in expenditures resulting from a unit change of one of the independent variables is also dependent on the value of the other independent variables. Using the same data as in the previous studies, Kurnow's joint regression model proved to be more appropriate, accounting for more of the variability than the previous studies.

Shortly after, Sacks and Harris (1964) compared

Fabricant's and Fisher's results with a similar analysis using 1960 data, and then went on to add state and federal aid as additional variables. The study found that income, state aid and federal aid were significantly correlated with expenditures. Other variables such as, population density and urbanization, were insignificant except in the case of highway expenditures.

In 1964, Fisher grouped expenditure determinants into three categories. The independent variables were designated as economic, demographic and socio-political. Out of the original fourteen independent variables tested, seven were found to be statistically significant. These were:

Economic
- percentage of families with an aggregate income less than $2,000
- yield of representative tax system as per cent of U.S.average

Demographic
- population per square mile
- percent of population in urban places
- percentage increase in population

Socio-political Variables
- index of two-party competition
- percent of population over 25 with less than 5 years schooling.

The above seven independent variables were tested against the total aggregate expenditure for each municipality as well as other individual municipal service expenditures. All regressions were significant at the .001 level except in the case of public welfare service expenditure.

Sharkansky (1967) analyzed per capita state government expenditures in 1963 in terms of aggregate as well as individual expenditures and compared it to the aggregate of state and local expenditures in the United States. In addition to the independent variables used in previous studies, Sharkansky incorporated two new variables: state role and previous expenditures.[2] Though the analysis showed that the two new variables had the expected positive relationship to each measure of per capita expenditures, the state role variable was statistically insignificant, where as, the previous expenditures variable showed significant positive relationships with each measure of service expenditure tested.

Osman (1968) examined intergovernmental aid or municipal grants as an independent variable in municipal expenditure studies. The study concluded that federal aid is a statistically significant determinant of state and municipal expenditures.

Pidot (1969) examined determinant studies to gain insight into the municipal government decision-making process and to assess the impact of certain forces. Expenditure and revenue

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State role was defined as the percentage of state and local expenditures spent by state agencies. Previous expenditures were defined as expenditures per capita in 1961.

data from eighty-one U.S. cities were regressed individually against demographic and economic characteristics. The results of the study showed variables measuring urbanization, wealth, size, population age or poverty, commercial-residential, and stagnation to be significant in determining the level of the majority of service expenditures. These variables were found to explain differences in local government expenditures as well as revenue.

Weicher (1970) used 1960 per capita police, fire, sewer and sanitation, and highway expenditure data from two hundred and six central U.S. cities. That study concentrated on incorporating demographic factors, socio-economic factors, and service conditions.[3] The results showed that, in addition to commonly used measures of fiscal capacity, the ethnic composition of the city tends to have a significant effect on most of the services studied. The age distribution and education level of the population were found to be significant in the cases of police and fire protection.

Other studies have focused on certain expenditures or on a specific category of municipality. Schofield (1978) studied fire and social service expenditures of non-London boroughs in

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These are defined as the variety of physical human, financial, legal and political factors that can make it easier, or more difficult, for governments to provide services of a specified quantity and/or quality.

England and Wales for the financial year 1971-72. The study found evidence of scale effects in fire services but no scale effects in social services. Statistically significant explanatory variables for expenditure on fire services included population change, class composition of population, employment conditions, and housing conditions. The results for social services found statistically significant variables to include fiscal capacity, population density or population (whichever was used), proportion of the population permanently ill, age composition of the population, and percentage of immigrants.

Gabler (1969, 1971) studied the influence of population on city per capita expenditures. In 1969, Gabler attempted to assess the effects of three population factors: population size, population density, and the rate of population change on certain urban public services. The study selected data from U.S. cities ranging in population size from 25,000 to 250,000 within the states of Ohio, Texas, and New Jersey. The results of the study showed no statistically significant relationship between population size and per capita expenditures. Population density showed a significant inverse relationship with per capita expenditure. Population change was found to be the most significant variable and had an inverse relationship with per capita expenditure.

In 1971, Gabler repeated his 1969 study to include more cities in additional states, and to utilize more recent data. The study reinforced his previous study's findings with the exception of population change. Among the statistically significant results, population change indicated both a positive and negative relationship with expenditure per capita.

In 1975, Hufbauer and Severn tested the theory that municipal expenditures tend to increase with urban "sprawl". Several municipal services were analyzed by regressing service expenditure on independent variables such as area, income, population and fiscal capacity. This study provided scant support for the hypothesis that urban sprawl significantly increases the cost of municipal services.

Applying concepts and techniques used in other studies, Michas's pioneering Canadian work (Michas,1969) analyzed provincial-municipal expenditures combining time series and cross sectional data from 1951, 1956, and 1961. The results of the study identified the most significant expenditure determinant variable as per capita income, followed by urbanization.

Bodkin and Conklin (1971) studied the determinants of municipal government expenditures in the province of Ontario, focusing on possible economies or diseconomies of scale in the provision of general municipal services. The results of the study showed very little evidence of economies of scale in the provision of municipal services, and the significance of each variable varied for each municipal service. No general observations could be concluded.

Weicher and Emerine (1973) conducted a study which compared the results of six individual service expenditure regressions to an aggregate regression which was a summation of all six services for central cities of U.S. Standard Metropolitan Areas in 1960. The study used identical independent variables for each individual service regression and the aggregate regression. The authors concluded that the aggregate regression serves no useful purpose; it provides no information that is not already available in the individual regressions, and it frequently misrepresents and distorts the results of the individual regressions.

Inman (1979) compared the determinant study of Brazer (1959), for central cities; of Henderson (1968), for counties; and that of Sharkansky (1967), for state governments. Inman concluded that in order to avoid biased results, determinant studies should try limiting the data to municipalities which are politically and geographically similar. He argued that aggregated data would yield accurate results only if all the units which comprise the aggregate react in the same way to changes in the independent variables.

In the last fifteen years, municipal determinant studies seem to have dissipated. An extensive search for relevant studies has been conducted. The studies that were published and available to the public have been reviewed.

The studies reviewed in this chapter may not constitute all of the determinant studies undertaken. The review provides a fundamental understanding and a framework for developing additional determinant studies. Previous studies have found that the most common influences on municipal government spending patterns tend to be demographic, social, geographic, and economic characteristics such as fiscal capacity, urbanization, population size, population density, income, grants, and area. The model tested in the subsequent chapters in this thesis draw on the findings of previous studies in terms of their structure.

CHAPTER 3

ALBERTA MUNICIPALITIES

This chapter describes the taxonomy of Alberta municipalities, municipal legislation in the Province of Alberta as it applies to municipalities services and policy makers, and the kind of municipal services provided by municipalities in Alberta.

3.1 Taxonomy of Municipalities

In Alberta, as well as the rest of Canada, the lowest level of government is the municipal or local government. Local governments within Alberta differ so widely in terms of demographics, expenditures, and fiscal capacity that generalizations about Alberta municipalities cannot be made. This causes the implementation of province-wide policies and redistribution of wealth by the Provincial Government of Alberta to be a very difficult task. A brief history of Alberta municipalities and the services they provide is needed in order to understand the theoretical model used in the following chapters.

This study used data relating to the year 1988. Research for this study began in 1991; at that time data for the year

1988 were the most recent financial data available for Alberta municipalities. As of that date, Alberta municipalities were classified into eight categories, the majority of which were incorporated. Legislation passed by the Provincial Government regulates and defines each municipal category. Incorporated municipalities vote for their legislative representatives with the exception of Improvement Districts and Special Areas (5 million acres in southeast Alberta), which are provincially and federally administered. Rural municipalities, as opposed to urban municipalities, are less densely populated but contain populous hamlets[4]. Therefore, the designation "rural" should not be interpreted to include farm or resource base only.

Alberta municipalities are categorized as follows:

URBAN

City - population of over 10,000.

Town - population of 1,000 to 10,000.

Villages - a minimum of 75 occupied dwellings.

Summer Villages - a minimum of 50 dwellings which are occupied anytime in the previous six months.

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4 The County of Strathcona contains the hamlet of Sherwood Park which has a population of over 10,000.

RURAL

Counties - includes farmlands and unincorporated communities plus an education board.

Municipal Districts - includes farmlands and unincorporated communities.

Improvement Districts - unincorporated areas which are federally and provincially administered.

Special Areas - five million acres in southeast Alberta.

The population distribution of Alberta is illustrated in Table 1.

Table 1.--Population Distribution of Municipalities in Alberta as of 1988

URBAN MUNICIPALITIES	Total	Total Population	Percentage of Alberta's Population
Cities	16	1,608,944	65.89%
Towns	108	314,280	12.87%
Villages	122	45,384	1.86%
Summer Villages	50	3,700	0.15%
Total Urban	296	1,972,308	80.77%
RURAL MUNICIPALITIES			
Counties	30	251,580	10.30%
Municipal Districts	22	118,602	4.86%
RURAL MUNICIPALITIES	Total	Total Population	Percentage of Alberta's Population
Improvement Districts	19	81,301	3.33%
Special Areas	3	18,030	0.74%
Total Rural	74	469,513	19.23%
GRAND TOTAL	370	2,441,821	100.00%

In 1988, approximately 66% of Alberta's population resided in cities, with the two largest cities Calgary (population 657,118) and Edmonton (population 576,249) contributing 51% of Alberta's total population. Rural municipalities constituted only approximately 19% of Alberta's population.

3.2 Municipal Legislation

Municipalities are governed by elected municipal councils which have the authority to undertake a variety of activities and actions within provincial statutes and regulations. A council's responsibilities include:

- passing bylaws, policies and regulations for: the peace, order and good government of the municipality, promoting health, safety, morality and welfare of it, and governing the proceedings of the council, the conduct of members and the calling of meetings;
- establishing an administration to carry out the responsibilities of the municipality;
- entering into agreements including those with other municipalities or school districts;
- raising funds through property and business taxes, borrowing, fines and fees for services provided;
- adopting plans and regulations for the use and development of land and;
- providing a variety of services to its residents.

Any changes in municipal authority or legislation must be approved by the government of the Province of Alberta.

The functions and services carried out by a municipal council are regulated by statutes administered by the Department of Municipal Affairs and other provincial departments. Some of the more important statutes include:

- the Municipal Act which provides for the incorporation of different classes of municipalities in accordance with pre-determined criteria. Establishes the guidelines and provides the authority under which the council may legislate for the administration of the municipality;

- the County Act which provides for the establishment of a local government unit, which incorporates the whole or any part of an existing municipality or school division that is within its boundaries to be known as a county;

- the Local Authorities Board Act which provides for the composition, responsibilities and authority of the Board;

- the Municipal Taxation Act which controls and regulated level of assessments for real property throughout the Province of Alberta. An Act which defines the property subject to assessment and taxation and sets forth the procedures to be followed in assessing and levy a tax for the purpose of municipal property tax, a municipal business tax, and a municipal special local improvement tax or a special local benefit tax and;

- the Planning Act which provides a comprehensive mechanism whereby plans, bylaws and related measures may be prepared to benefit the municipality.

In addition to municipal councils, local boards and committees are also involved in governing municipalities. The most significant local governing board outside the municipal council is the local school authority. Basic powers of the school board include the provision of educational services and facilities, the borrowing of funds for operating and capital purposes, the ability to enter into contracts, and the requisitioning of municipalities for funds to be collected through a school tax levy. Other important boards include hospital boards, regional planning commissions, regional library boards, and police commissions.

Again, any changes to municipal acts and statutes which would change the authority of the municipality must be approved by the provincial legislature. Therefore, a municipality's ability to change municipal policy is restricted to the legal authority granted to it by the provincial government.

Municipal councils can lobby the provincial government for policy changes as they see fit. It is important to note that municipal government decisions are highly influenced by municipal administrators. Municipal administrators are civil servants hired by the municipality to carry out duties and perform tasks under the guidance of municipal councils. Since most administrators are career civil servants, municipal councils rely on administrators for their advice and expertise.

3.3 Municipal Services

Since Alberta became a province in 1905, Alberta municipalities have evolved from providing basic services such as fire and road construction to include services such as police protection, social services, and recreational and cultural facilities. Services provided by Alberta municipalities can be classified on a more personal and direct level than provincial and federal government services, and changes to municipal services tend to affect residents immediately.

In Alberta, the majority of municipalities provide the following services:

Police
Fire
Disaster Services
Ambulances
Bylaw Enforcement
Common Services and Pool Equipment
Roads, Streets, Sidewalks
Airports Services
Public Transit
Storm, Sewers/Drainage
Water Supply/Distribution
Sanitary Sewage/Treatment
Garbage Collection/Disposal
Family and Community Support Services
Daycare
Other Public Health
Cemeteries/Crematoriums
Planning, Zoning, Development
Community/Agriculture Services
Subdivision Land/Development
Public Housing
Land/Housing/Building Rental
Recreation Board and Others
Parks/Recreation Facilities
Cultural Facilities
Convention Centre
Gas Production/Distribution
Electrical Production/Distribution
Telephone System.

The percentage of total municipal expenditures by each service for each municipal category in 1988 is displayed in Table 2. Smaller municipalities may provide some services through contracts with other municipalities.

Table 2.--Municipal Service by Percentage of Total Expenditure for each Municipal Category for 1988

MUNICIPAL SERVICE	CITIES	TOWNS	VILLAGES	SUMMER VILLAGES	COUNITIES	MUNICIPAL DISTRICTS	IMPROVEMENT DISTRICTS
Council & Other Legis.	0%	1%	2%	3%	1%	2%	2%
General Admin. & Other	8%	13%	19%	29%	13%	12%	13%
Police	6%	6%	0%	5%	2%	0%	0%
Fire	5%	3%	3%	4%	3%	2%	2%
Disaster Serv. & Emerg.	0%	0%	0%	0%	0%	0%	0%
Ambulance & First Aid	1%	1%	0%	0%	1%	0%	1%
By-Law Enforce.	0%	1%	0%	1%	0%	1%	1%
Common Serv. & Equip. Pool	4%	4%	2%	2%	5%	3%	1%
Road/Streets/Walks/Lights	9%	18%	23%	25%	56%	66%	49%
Airport Services	0%	0%	0%	0%	0%	0%	0%
Public Transit	8%	0%	0%	0%	1%	0%	0%
Storm Sewers & Drainage	1%	1%	0%	0%	0%	0%	4%
Water Supply & Distribution	6%	13%	17%	0%	2%	1%	7%
Sanitary Sewage & Treatment	4%	6%	8%	9%	2%	1%	2%
Garbage Coll. & Disposal	1%	3%	4%	7%	1%	1%	2%
Family/Community Supp. Serv.	1%	2%	1%	0%	1%	1%	1%
Day Care	0%	0%	0%	0%	0%	0%	0%
Other Public Health	0%	0%	0%	0%	0%	0%	0%
Cemeteries & Crematoriums	0%	0%	0%	0%	0%	0%	0%
Planning Zoning & Develp.	1%	1%	0%	0%	0%	1%	1%
Community/Agri. Services	0%	1%	1%	0%	4%	5%	6%
Subdivision Land & Develop.	2%	4%	2%	0%	0%	0%	0%
Public Housing	1%	0%	0%	0%	0%	0%	0%
Rentals & Other	1%	0%	0%	0%	0%	0%	0%
Recreation Brd & Other	0%	1%	2%	1%	1%	1%	6%
Parks & Rec. Facilities	7%	13%	10%	11%	4%	2%	3%
Culture	2%	2%	2%	1%	1%	0%	1%
Convention Centre	0%	0%	0%	0%	0%	0%	0%
Gas Production & Dist.	1%	3%	2%	0%	2%	0%	0%
Electrical Product. & Dist.	24%	2%	0%	0%	0%	0%	0%
Telephone System	6%	0%	0%	0%	0%	0%	0%
Total Expenditure	100%	100%	100%	100%	100%	100%	100%

Table 2 shows that the services demanded by residents vary from rural to urban municipalities or from cities to summer villages. Therefore, not all services are provided by all municipalities. The predominant expenditures consist of general administration, roads/streets/walks/lights, water supply and distribution, parks and recreational facilities, and electrical production for cities only. According to the studies renewed in Chapter 2, differences in demographic, economic and geographic conditions, as well as public preferences, can explain why a municipal service involves a minor or a major expenditure for a municipality.

CHAPTER 4
MODEL AND DATA

This chapter describes the model, the variables, the data, the functional form, and the diagnostic testing used to estimate the regressions. The theory is based largely on the literature review in chapter two. All of the variables defined in this chapter may not be used in every one of the regressions.

4.1 Model

The financial, social and economic conditions of a municipality affect the ability of that government to collect revenue and in turn provide services to the residents. Financial conditions are concerned with the corporate aspect of a municipality and can be represented by such variables as tax base or fiscal capacity and debt. Social and economic conditions can be represented by variables such as population, poverty, and income. Variables may fall under more than one condition. For example, wealth is a social condition but it is also an economic condition of the residents in the municipality.

The following expenditure model incorporates variables to uncover the financial differences in Alberta municipalities. The dependent variables in the analysis are per capita police, fire, recreation, and aggregate (as defined below) operating expenditures.[5] Operating expenditures exclude any capital expenditures, depreciation and interest which occurs periodically and may distort the data. Once infrastructure is built it may last for years without requiring replacements or additions.

The dependent variables are defined as follows:

Police Operating Expenditure (POLICE) - defined as activities involving police protection for public safety and law enforcement (including police commissions, police force and various police departments), divided by the municipality's population size[6].

Fire Operating Expenditure (FIRE) - defined as activities required to provide fire protection services for the municipality, either through its own fire fighting force or through contracted arrangements with other

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Exploratory work was also conducted on Total Operating Expenditures, which is defined as the sum of all of the services provided by municipalities listed in Table 2. The model was not effective and additional extensive analysis would have been required to explain these expenditures.

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Population size is defined as the number of residents in a municipality.

jurisdictions, divided by the municipality's population size.

Recreation Expenditure (REC) - defined as services of a social and cultural nature divided by the municipality's population size. This variable includes expenditures on recreational boards, park facilities and programs, community halls, libraries, museums, and convention centres.

Aggregate Operating Expenditure (AGG) - defined as the summation of police, fire, and recreation expenditures as stated above.

The independent variables postulated to influence these dependent variables are as follows:

Equalized Assessment (EA) - equalized assessment divided by population size. Equalized assessment is defined as the value of residential and commercial property. A municipality's equalized assessment is an aggregate of each municipal resident's assessment, which is then equalized by a complex formula developed by the Alberta Assessment Equalization Board. The assessments of all municipalities are brought to an equal level and are used by requisitioning authorities.

Grants (TG) - total grants divided by population size. Total grants is defined as all provincial and federal money given to municipalities over the 1988 calendar year, including conditional and, unconditional transfers, and grants in lieu of municipal property tax.

Household Median Income (HMI) - the median income of persons 15 years and over.

Incidence of Low Income (ILI) - percentage of family units with low incomes as established by Statistics Canada. Low income bench-marks are determined separately for families of different sizes and living areas of different degrees of urbanization.

Equalized Assessment Mix (EAM) - the percentage of the total equalized assessment of properties in the municipality represented by commercial assessment.

Age Composition of Population (AGEa) - percentage of population between the ages of 0-4, and 65 years or more.

Age Composition of Population (AGEb) - percentage of population between the ages of 0-14, and 65 years or more.

Population Density (DEN) - the total area of the municipality in square kilometres, divided by population size.

Area (AREA) - the square kilometres of the municipality.

Dummy Urban (U) - additive dummy variable for urban municipalities.

Dummy Rural (R) - additive dummy variable for rural municipalities.

Dummy Cities (C) - additive dummy variable for cities.

Dummy Towns (T) - additive dummy variable for towns.

Dummy Villages (V) - additive dummy variable for villages.

Dummy Counties (CO) - additive dummy variable for counties.

Dummy Municipal Districts (MD) - additive dummy variables for municipalities districts.

Multiplicative Dummy Variables - can be identified as the product of the additive dummy variable and the appropriate independent variable. The significant variables are defined as:

Urban x Total Grants (UTG)

Rural x Total Grants (RTG)

Urban x Household Median Income (UMHI)

Urban x Population Density (UDEN)

Urban x Area (UAREA)

Rural x Area (RAREA)

Cities x Equalized Assessment (CEA)

Cities x Total Grant (CTG)

Cities x Household Median Income (CHMI)

Cities x Incidence of Low Income (CILI)

Cities x Equalized Assessment Mix (CEAM)

Cities x Age Composition of Population b (CAGEb)

Towns x Equalized Assessment (TEA)

Villages x Equalized Assessment Mix (VEAM)

Villages x Age Composition of Population b (VAGEb)

Counties x Equalized Assessment (COEA)

Counties x Total Grants (COTG)

Counties x Incidence of Low Income (COILI)

Counties x Area (COAREA)

Municipal Districts x Equalized Assessment (MEA)

Municipal Districts x Total Grants (MTG)

Municipal Districts x Household Median

Income(MHMI)

Municipal Districts x Incidence of Low Income(MILI)

Municipal Districts x Equalized Assessment Mix(MEAM)

Municipal Districts x Age Composition of Populationb (MAGEb)

Municipal Districts x Density (MDEN)

Municipal Districts x Area (MAREA)

Dependent and independent variables such as equalized assessment, grants, and population density are divided by population size. A municipality's population is likely to be the most important determinant of municipal expenditure and revenue, judging by the results of previous studies cited in chapter 2. Consequently, it is logical to analyze the model using per capita data.

The regression equations to be tested are therefore as follows:

$Exp_{pi} = f_p(EA, TG, HMI, ILI, EAM, AGE, DEN, AREA, DUMMIES)_i + \varepsilon_{pi}$

$Exp_{fi} = f_f(EA, TG, HMI, ILI, EAM, AGE, DEN, AREA, DUMMIES)_i + \varepsilon_{fi}$

$Exp_{ri} = f_r(EA, TG, HMI, ILI, EAM, AGE, DEN, AREA, DUMMIES)_i + \varepsilon_{ri}$

$$Exp_{ai} = f_a(EA, TG, HMI, ILI, EAM, AGE, DEN, AREA, DUMMIES)_i + \varepsilon_{ai}$$

where the subscript "p" refers to police expenditure, the subscript "f" refers to fire expenditure, the subscript "r" refers to recreation expenditure, the subscript "a" refers to aggregate operating expenditure in municipality "i", and epsilon is the random error term. Ultimately, not all independent variables are included in each of these models.

In reality, each dependent variable may also be influenced by variables other than the variables defined in the expenditure model. For example, the historical tradition of a municipality, the priorities of the elected representatives and municipal administration, and local public issues may influence expenditures, but they are not easily measured. Such variables cannot, therefore, be included explicitly in our analysis, and so care must be taken to appraise the quality of our estimated regression models by means of diagnostic testing.

Other variables which are associated with time-series analysis such as inflation or stagnation are not included, as this study deals with cross-section data. In addition, time-series variables such as percentage increase in population and expenditures are not included because of the difficulty in obtaining the data. The provincial government's strategy to incorporate Improvement Districts, and the disincorporation of some municipalities has changed the boundaries of municipalities in Alberta. In addition, municipal financial data are not publicly available, and therefore, are difficult to obtain. The results from estimating the expenditure model are to be viewed in light of the fact that not all conceivably influential variables are included. However, as long as these omissions do not affect the statistical results in any systematic way (which can be verified by means of various mis-specification tests), the estimated models can still be used as the basis for the inferences in which we are interested.

4.2 Hypothesis Testing

This section will discuss the anticipated influence of each of the independent variables. Each independent variable in the model may not significantly influence POLICE, FIRE, REC or AGG. The analysis will reveal which variables are the most prominent in explaining expenditure differences, and in turn financial differences, among municipalities.

The model is fitted in semi-log form using the method of ordinary least squares (OLS) regression. See Section 4.4 for an explanation of the diagnostic tests which resulted in adopting a semi-log form and OLS regression.

4.2.1 Supply-side Variables

Population density (DEN) and area (AREA) are variables used to allow for possible economies of scale. The variable population is not included as a scale variable as expenditures are defined in per capita terms and this causes statistical difficulty in estimating the regression. The coefficient signs on population density and area cannot be predicted *a priori*.

The independent variable household "median income" (HMI) is both a supply-side and demand-side variable and the sign of its coefficient cannot be predicted *a priori*. As a supply-side variable, the influence of household median income on expenditures is expected to be positive. That is, the higher the household median income of a municipality, the higher the expected expenditure for service. As a demand-side variable, the influence of household median income on fire, police, and recreation expenditures cannot be predicted.

Equalized assessment (EA) represents the fiscal capacity and wealth of municipalities. A municipality's assessment is equalized so it can be made comparable to all other Alberta municipalities. Municipal property tax revenue is collected by applying the mill rate, which is a tax rate set by municipal administrators yearly, to a resident's property assessment. As a supply-side variable, the greater a municipality's equalized assessment the greater the capacity for collecting property tax revenue. Therefore, equalized assessment is expected to have a positive influence on the dependent variables.

Total Grants per 1000 population (TG) is expected to have a positive influence on expenditure. Municipal grants from provincial and federal governments will increase a municipality's fiscal capacity without increasing property taxes.

Equalized assessment mix (EAM), which represents the percentage of commercialized assessment in a municipality's total equalized assessment, is expected to have a positive sign. In general, commercial property provides a wealthier tax base than residential property for municipalities, and hence, would provide municipalities with a larger fiscal capacity to supply services.

4.2.2 Demand-side Variables

Incidence of low income (ILI) represents the percentage of poor in a population. This population characteristic may have a positive influence on the selected expenditures; the greater the incidence of low income the higher the expected expenditure on police, fire, and recreation. Poor households rely more on municipal governments for services such as recreational activities, family and community support, day care, and public housing. In addition, increased police and fire services are required for low income areas.

The influence of the age composition (AGE) of a municipality on the dependent variables is expected to be negative for police, and unknown for fire and recreation expenditure. The greater the population proportion of very young and very old, the smaller the demand for police services. A municipality with a large percentage of young and old tends to have a lower crime rate. The more significant age composition variable was used in each regression.

Dummy variables are included to allow for the influence of unmeasured variables and between different types of municipalities.

4.3 Data

Data for the study relate to all Alberta municipalities with the exception of Summer Villages and Improvement Districts. Summer Villages and Improvement Districts are not comparable municipalities because of their unique accounting procedures. Therefore they are excluded from this study. In addition, numerous critical statistics, for example incidence of low income and household median income, are not available for Summer Villages and Improvement Districts.

All municipal service expenditure data (see Table 2 for a list of municipal services), and municipal age composition data are for 1988. The Municipal Services Branch, Alberta Municipal Affairs is the source of all municipal service and age composition data.

Census Canada 1986 published by Statistic Canada is the source of data for municipal population, incidence of low income, and household median income. Data for these variables could not be provided for all municipalities. A municipality lacking data for a specific variable is excluded from the analysis. See Appendix A for a list of excluded municipalities.

4.4 Diagnostic Testing

The following is a summary of the econometric analysis that was used in developing the model's log-linear form and OLS estimation. The econometric computer program SHAZAM (White 1993) was used to undertake all of the estimation and testing.

4.4.1 Functional Form

Preliminary estimates were obtained by using pooled urban and rural data. Based on the previous expenditure studies discussed in chapter 2, all dependent variables (police, fire, recreation, and aggregate per capita expenditures) were "explained" individually using linear models and OLS estimation. Though all independent variables defined in chapter 4 were originally included, the obviously insignificant regressors were dropped. To test the null hypothesis that a coefficient was significant the usual t-ratio was employed.

Diagnostic testing showed that the linear model did not satisfy Ramsey's (Ramsey 1969) RESET tests which test for misspecified functional form as well as whether unknown variables have been omitted from a regression specification.[7]

Using the same procedure, the model was subsequently tested in log-log and semi-log form. The semi-log form, where the dependent variable is in logarithmic form and the independent variables are linear, was found to be the most suitable model for all four equations. Indeed, the semi-log form was the only form to satisfy Ramsey's RESET test. The coefficients produced by the model can be interpreted as follows:

$$\text{coefficient} = \frac{\text{percentage change in the dependent variable}}{\text{unit change in the independent variable}}.$$

This implies that a unit change in an independent variable will be measured as a percentage change in the dependent

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See Appendix B for the construction of the statistic for the RESET test.

variable.

4.4.2 System Estimation

The four equations were also estimated as a seemingly unrelated regression (SUR) model. The SUR model is a system of equations in which the independent variables are non-stochastic and the error terms across equations are correlated. As the error terms of the equations are correlated, the method of joint maximum likelihood (ML) estimation is asymptotically more efficient than OLS estimation.

In two instances OLS estimation will be equivalent to SUR estimation. First, if there is indeed no relationship between the equations, and the error terms of the equations are uncorrelated, the error covariance matrix will be diagonal and OLS estimation will be numerically equivalent to ML estimation. Second, if the equations have identical explanatory variables then OLS and ML are identical numerically.[8]

To test whether the error terms of the equations are correlated, the Likelihood Ratio Test (LRT) (Harvey 1990) and

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See Appendix B for the construction of the statistics for testing if the error covariance matrix is diagonal in a SUR model.

the Breusch-Pagan Lagrange Multiplier (LM) Test (Breusch and Pagan 1980) were used. Both tests found that the covariance matrix was non-diagonal, implying that the error terms are correlated and full maximum likelihood estimation of the SUR model is asymptotically more efficient than OLS. However, when examining the RESET tests of the SUR model, it was found that the model was misspecified and single-estimation OLS estimation was used.

4.4.3 Other Tests

In addition to testing for omitted variables and mis-specification, the final model has been tested for heteroscedasticity, the significance of the regression, and the independence of the regressors and errors.

The Breusch-Pagan-Godfrey (Breusch and Pagan 1979) Test and Glejser (Glejser 1969) Test were used to test for unknown forms of heteroscedasticity. Heteroscedasticity was found to be present in all of the POLICE regressions, the FIRE and AGG pooled data, and the AGG urban data[9].

The adverse implications of inconsistent standard errors caused by heteroscedasticity was rectified by using White's (White 1980) heteroscedastic-consistent covariance matrix

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See Appendix B for the results and construction of the statistics for the diagnostic test.

estimator. This robust estimated covariance matrix allows appropriate asymptotic inferences to be made, based on the results of OLS estimation, without specifying the type of heteroscedasticity.

The *F* statistic is used to test for the significance of the regression as a whole. At the 5 percent level of significance, all regressions were found to be significant. See tables 4, 5, and 6 for the results.

The Hausman (Hausman 1978) specification test is used to test for the independence of the regressors and errors. If the regressor and error terms are not independent then OLS estimation is inconsistent. In all cases, the regressors are independent of the errors and OLS estimation is consistent[10].

The symptoms of multicollinearity have been examined and the results show no severe signs. When multicollinearity is present the problems that can be observed are: coefficients may have high standard errors and low significance levels in spite of the fact that they are jointly highly significant and the R^2 in the regression is quite high; and coefficients will have the wrong sign or an unlikely magnitude.

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See Appendix B for the results and constructions of the statistics for the diagnostic test.

CHAPTER 5

POOLED URBAN AND RURAL DATA

This chapter presents and analyzes the results for pooled urban and rural data. The independent variables which are defined in chapter four are used to explain the dependent variables per capita municipal police (POLICE), fire (FIRE), recreation (REC), and aggregate operating expenditures (AGG).

As mentioned in chapter four, the expected signs for the coefficients, where + represents a positive relationship, - represents a negative relationship, and ? represents a positive or negative relationship, are as follows:

Table 3.--Hypothesis Testing Summary

	POLICE	FIRE	REC	AGG
EA	+	+	+	+
TG	+	+	+	+
HMI	?	?	?	?
ILI	+	+	+	+
EAM	+	+	+	+
AGE	-	?	?	?
DEN	?	?	?	?
AREA	?	?	?	?
DUMMY	?	?	?	?

5.1 Results

The results for pooled urban and rural data are presented in Table 4. The first row reports the coefficient of the independent variable which is multiplied by 1000 and the figure below in parentheses are the t-ratios. Note that not all independent variables are included in all of the regressions. In addition, the table reports the coefficient of determination (adjusted for degrees of freedom), F-test, diagnostic tests, and the degrees of freedom associated with the diagnostic tests.

Table 4.--Pooled Urban and Rural Results

	Dependent Variables			
	POLICE	FIRE	REC	AGG
TG			3.42 (2.75)	3.65 (3.25)
HMI	0.09 (4.41)			
ILI	52.83 (2.52)			
EAM	2210.20 (2.22)		1006.50 (2.62)	635.10 (1.73)
AGEb	-57.69 (-2.38)			
DEN		8.59 (1.94)		3.82 (1.33)
AREA		-0.001 (-1.21)	0.005 (2.60)	
U	1195.2 (3.38)	799.86 (3.19)	833.36 (2.44)	721.96 (2.36)

Table 4.--Pooled Urban and Rural Results

	Dependent Variables			
	POLICE	FIRE	REC	AGG
UTG	11.73 (3.61)			
RTG	-4.89 (-2.30)			
UHMI			0.03 (3.36)	0.03 (4.96)
UDEN		-471.20 (-3.56)		
UAREA		0.03 (5.37)		0.02 (4.23)
RAREA			-0.007 (-2.31)	
CONSTANT	- 2173.40 (-1.50)	2417.2 (9.97)	2494.70 (8.23)	3107.20 (11.07)
$\bar{R}^2$	.2846	.1285	.3349	.3587
F-test (df)	23.4 (7,238)	8.9 (5,240)	17.2 (7,238)	22.2 (7,249)
Breusch-Pagan-Godfrey Test (df)	25.1 (7)	23.2 (5)	10.2 (7)	15.4 (6)
Glejser Test (df)	40.0 (7)	27.3 (5)	19.6 (7)	25.2 (6)
RESET Test 2 (df) 3 (df) 4 (df)	0.5 (1,237) 4.6 (2,236) 3.1 (3,235)	1.1 (1,239) 4.2 (2,238) 3.5 (3,237)	0.0 (1,237) 4.4 (1,236) 3.00 (1,235)	0.8 (1,238) 3.1 (2,237) 2.4 (3,236)
Hausman Test (df)	2.7 (7)	0.0 (5)	3.3 (7)	4.9 (6)
LRT Test (df)	806.88 (6)			

Table 4.--Pooled Urban and Rural Results

	Dependent Variables			
	POLICE	FIRE	REC	AGG
LM Test (df)	338.22 (6)			

The LRT and LM Tests were used to test whether the SUR model's error covariance matrix is diagonal. These results support the use of SUR but for the reasons explained in Appendix B the method of OLS is used.

The overall power of the model to explain variations in dependent variables appears to be satisfactory and is in line with other studies of municipal expenditures that used cross-section data (e.g., Weicher 1970, 1972; Schofield 1978). The power of the model appears to be rather greater in respect of recreation, police, and aggregate than fire expenditures.

The F-test which tests for the significance of the regression as a whole was found to be significant at the 5 percent level of significance for all the regressions. The results of the remaining diagnostic tests, Breusch-Pagan-Godfrey, Glejser, RESET, and Hausman are described in detail in Appendix B. The Breusch-Pagan-Godfrey Test and Glejser Test found unknown forms of heteroscedasticity the effects of which were rectified by using White's heteroscedastic-consistent covariance matrix estimator. The RESET, Hausman, and SUR tests when considered jointly support the single equation OLS estimation.

TG (total grants per capita) has a highly positive significant influence on recreational and aggregate expenditure. The evidence indicates that the reduction or elimination of municipal grants will have a significant impact on recreational services provided by municipalities, and this will also influence the overall aggregate expenditure of police, fire, and recreation.

The independent variables HMIs (household median income) and ILI (incidence of low income) are significant only when explaining police expenditures. The positive relationship between HMI and police expenditures indicates that the supply-side of HMI is offsetting the opposite demand-side effect; that is, the higher the income of a municipality the higher the expected police expenditure.

As expected, ILI is a demand-side variable which has a positive influence on police expenditure. This indicates that increased police services are required for municipalities with low income areas.

The variable EAM (equalized assessment mix) is positively significant or near-significant in all of the regressions, with the exception of fire expenditures. This shows that an increase in commercial buildings does not necessarily warrant an increase in fire services. A larger commercial assessment base provides a municipality with more fiscal capacity to provide police and recreational services.

The variable AGEb, which represents the percent of the population between the age of 0-14 and 65 plus, is only significant in the police regression. AGEa, which represents the percentage of population between the age 0-4 and 65 plus is not as significant as AGEb. As expected, the negative relationship between AGEb and police expenditures implies that the greater the population proportion of very young and very old the smaller the demand for police services.

The scale variable DEN (density), though not statistically significant, is identified by the RESET test as an important variable in the recreation and aggregate regressions. This indicates that the greater the degree of density, the higher the level of expenditure for fire and aggregate services.

The scale variable AREA is significant only in the recreation regression. The positive relationship between area and recreational expenditure demonstrates that an increase in area would require an increase in recreational expenditure to accommodate a larger region or domain. Area is not statistically significant in the fire regression. However, the negative relationship indicates that the greater the area the fewer fire services required. This may result from the fact that fire services are mobile and can accommodate an increase of area to a certain degree without increasing expenditures.

The intercept dummy variable U (urban) is highly significant in all the regressions. This implies that urban and rural municipalities differ according to the expenditures analyzed, and it is appropriate to separate the municipalities in terms of being urban or rural. Chapter 6 analyzes urban and rural municipalities separately.

Significant slope dummy variables are shown in Table 4. The police expenditure slope dummy UTG (urban multiplied by total grants) and RTG (rural multiplied by total grants) indicates opposite differential slope coefficients for urban and rural municipalities. This implies that an increase in grants would result in an increase in police expenditures for urban municipalities, whereas an increase in grants for rural municipalities would result in a decrease in police expenditures. Slope dummy variables UDEN and UAREA are significant in the FIRE regression, and UHMI and RAREA are significant in the REC regression. The AGG regression includes the dummy variables UHMI and UAREA.

5.2 Summary

All independent variables have the predicted sign and influence. Police expenditure tends to be influenced by population characteristics, while fire expenditure tends to be influenced by geographical characteristics. Recreational and aggregate expenditure do not show any specific tendencies.

The aggregate expenditure regression did not have the same significant independent variables as the POLICE, FIRE, or REC regressions. It can be concluded that expenditures must be analyzed individually and not in aggregate in order to arrive at valuable results.

It is important to note that EA (equalized assessment) was not significant in any of the regressions. This may be due to the fact that tax revenue is dependent on the mill rate rather than equalized assessment.

An important result of this exercise is the significance of the urban dummy variable (U) in police, fire, recreational and aggregate regressions. This finding shows that urban and rural municipalities differ and should be analyzed separately. Chapter 6 analyses urban and rural municipalities separately.

CHAPTER 6

URBAN AND RURAL DATA

This chapter presents and analyzes the results obtained by separating the urban and rural data. The independent variables which are defined in chapter four are used to explain the dependent variables per capita municipal police (POLICE), fire (FIRE), recreational (REC), and aggregate operating expenditures (AGG).[11]

6.1 Urban Results

The results for urban municipalities include cities (C), towns (T) and villages (V), and are presented in Table 5. The first row reports the coefficient of the independent variable which is multiplied by 1000 and the figure below in brackets reports the t-ratio. Note that not all independent variables are included in all of the regressions. In addition, the table reports the coefficient of determination (adjusted for degrees of freedom), F-test, diagnostic tests, and the degrees of freedom associated with the diagnostic tests.

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See Table 3 for the Hypothesis Testing Summary.

Table 5.--Urban Results				
	Dependent Variables			
	POLICE	FIRE	REC	AGG
TG	5.03 (2.26)		3.17 (2.64)	2.47 (2.41)
EAM				992.23 (3.20)
AGEb	-111.74 (-3.88)			-16.66 (-2.44)
T	-1633.00 (-1.59)	174.74 (2.02)	697.22 (6.98)	884.72 (7.66)
V	-2606.60 (-2.66)	90.22 (0.82)	-501.32 (-1.77)	347.09 (2.67)
CEA		0.38 (5.18)		
CTG		14.54 (4.42)	-455.21 (-2.00)	
CHMI				0.01 (3.51)
CILI		153.22 (9.67)		70.35 (6.49)
CEAM		-7317.10 (-5.02)	1068.00 (3.01)	
CAGEb	150.59 (12.77)	-45.18 (-5.82)	27.76 (5.57)	
TEA	0.65 (3.94)			
VEAM			1853.30 (2.97)	
VAGEb	89.53 (2.59)			
CONSTANT	3195.50 (4.48)	2927.30 (41.96)	3863.90 (47.77)	4312.4 (15.86)

Table 5.--Urban Results				
	Dependent Variables			
	POLICE	FIRE	REC	AGG
$\bar{R}^2$	.4982	.1472	.1642	.3315
F-test (df)	255.4 (7.198)	37.4 (7,188)	37.7 (7,188)	35.9 (7,188)
Breusch-Pagan-Godfrey Test (df)	40.9 (7)	13.8 (7)	13.4 (7)	22.5 (7)
Glejser Test (df)	130.7 (7)	20.0 (7)	39.4 (7)	33.9 (7)
RESET Test 2 (df) 3 (df) 4 (df)	 0.3 (1,187) 4.0 (2,186) 2.8 (3,185)	 0.3 (1,187) 0.4 (2,186) 0.3 (3,185)	 0.7 (1,187) 1.2 (2,186) 0.8 (3,185)	 2.3 (1,187) 1.7 (2,186) 1.1 (3,185)
Hausman Test (df)	0.9 (7)	*	0.0 (7)	0.1 (7)

* Test is not applicable. IV is equal to OLS.

Again, the overall power of the model to explain the variations in the dependent variables represented by the adjusted R squared figure appears to be satisfactory when compared with previous studies which use cross-section data. The adjusted R squared for fire and recreational expenditures is somewhat lower. This indicates the explanatory power of the model appears to be higher for police and aggregate expenditures than for fire and recreational expenditures.

The F-statistic was found to be significant at a 5 percent level of significance for all the regressions. The results of the remaining diagnostic tests, Breusch-Pagan-Godfrey, Glejser, RESET, and Hausman are described in detail in Appendix B. Again the Breusch-Pagan-Godfrey Test and Glejser Test uncovered unknown forms of heteroscedasticity which were again allowed for by using White's heteroscedastic-consistent covariance matrix estimator. The RESET and Hausman tests support the single equation OLS estimation. Since the results of the pooled data SUR model estimation was grossly misspecified, SUR model estimation for the urban data was not conducted, and the LRT and LM tests which test for the diagonal covariance matrix were not required.

The results for urban municipalities show that TG (total grants per capita) is a highly positive significant influence on all of the expenditures, with the exception of fire services. The evidence indicates that the reduction or elimination of municipal grants will have a significant impact on all the services with the exception of fire. This suggests that the least discretion attaches to the provision of fire services. Of the services analyzed, in other words, fire is apparently the most essential.

The variable EA (equalized assessment) is positively significant only for aggregate expenditures. This implies that commercial assessment does not affect the fiscal capacity to provide individual services such as police, fire, and recreation. However, it does affect the fiscal capacity to provide the aggregate of the expenditures mentioned. This would imply that EAM does not affect the individual services in this study but does affect the total delivery of all services.

The variable AGEb, which represents the percentage of the population between the age of 0-14 and 65 plus, is significant in the police and aggregate regressions. AGEa, which represents the percentage of population between the age 0-4 and 65 plus was not as significant as AGEb. As expected, the negative relationship between AGEb and police expenditures implies that the greater the population proportion of very young and very old the smaller the demand for police services. This implies a municipality with a large percentage of young and old will tend to have a lower crime rate and will require fewer police services.

The constant or intercept term is an estimate of the dummy variable C (city) which is significant in all the regressions. It can be concluded that the level of police, fire, and recreation expenditures provided by cities differs from that provided by towns and by villages.

The dummy variable T (town) is significant in all the regressions with the exception of police services, and V (village) is only significant in police and aggregate regressions. The results of the intercept dummies T and V show that towns spend more on all the services, especially recreational services, than do villages.

Significant slope dummy variables are shown in Table 5. The city slope dummy variables identified as CEA, CTG, CHMI, CILI, CEAM, and CAGEb are very significant. This, along with the significance of the constant term which estimates the dummy variable C (city), indicates that the characteristics of cities are more significant than other urban municipalities such as towns and villages.

The independent variables EAM (equalized assessment mix), HMI (household median income), ILI (incidence of low income), DEN (density) and AREA (area of a municipality) are not significant in any of the regressions. The influence of these variables appears to be accounted for simply by splitting the data, presumably because values for these variables reflect their unrban or rural context.

6.2 Rural Results

The results for rural municipalities include counties and municipal districts, and are presented in Table 6. Again, the first row reports the coefficient of the independent variable which is multiplied by 1000 and the figure below in parentheses reports the t-ratio. Note that not all independent variables are included in all the regressions. In addition, the table reports the coefficient of determination (adjusted for degrees of freedom), F-test, diagnostic tests, and the degrees of freedom associated with the diagnostic tests.

Rural results included data from counties (CO) and municipal districts (MD). The number of observations is equal to 50.

Table 6.--Rural Results

	Dependent Variables			
	POLICE	FIRE	REC	AGG
TG			4.30 (1.60)	5.60 (2.94)
ILI				-29.31 (-1.52)
MD	-5.56 (-3.03	2.71 (4.76)	-3.73 (-12.13)	-411.15 (-2.14)
COEA		0.09 (3.02)		
COTG	12.65 (3.06)			
COILI	131.62 (4.21)			27.85 (3.24)
COAREA	0.02 (7.31)			0.001 (2.85)
MEA	1.51 (23.86)	0.87 (7.16)	-0.73 (-12.48)	

Table 6.--Rural Results

	Dependent Variables			
	POLICE	FIRE	REC	AGG
MTG	30.34 (35.36)	-4.28 (-2.61)	7.51 (2.70)	
MHMI	-0.07 (-29.01)	-0.13 (-28.75)	0.11 (50.54)	
MILI	293.15 (32.03)	55.30 (3.16)	-23.16 (-2.75)	
MEAM	-18.90 (-32.78)	-10551.00 (-9.58)	5730.00 (10.78)	
MAGEb	-129.02 (-31.81)	-28.98 (-3.74)	1.92 (20.40)	
MDEN	4067.30 (20.98)	2569.90 (6.94)	-2.09 (-11.67)	
MAREA	1.10 (10.24)	-1.67 (-8.55)	1.92 (20.40)	
CONSTANT	1904.40 (4.13)	3234.90 (27.89)	4650.40 (31.05)	5302.60 (26.41)
$\bar{R}^2$	.2612	.1543	.1594	.3395
F-test (df)	114.5 (12,37)	240.4 (10,39)	904.1 (10,39)	10.79 (6,43)
Breusch-Pagan-Godfrey Test (df)	21.8 (12)	4.6 (10)	7.0 (10)	9.1 (6)
Glejser Test (df)	49.8 (12)	18.3 (10)	17.0 (10)	7.4 (6)
RESET Test 2 (df) 3 (df) 4 (df)	 0.26 (1,36) 0.13 (2,35) 0.08 (3,34)	 1.33 (1,38) 1.54 (2,37) 1.96 (3,36)	 1.22 (1,38) 1.84 (2,37) 1.85 (3,36)	 3.56 (1,42) 2.47 (2,41) 2.10 (3,40)

Table 6.--Rural Results				
	Dependent Variables			
	POLICE	FIRE	REC	AGG
Hausman Test (df)	*	*	3.07 (10)	0.01 (6)

* Test is not applicable. IV is equal to OLS.

The coefficient of determination represented by the adjusted R squared figure appears to be satisfactory when compared to previous studies. As in the urban results, the adjusted R squared for fire and recreational expenditure indicates the variation of the dependent variable "explained" by the variation in the independent variables is lower than police and aggregate expenditure.

The F-test found all the regressions to be significant at the 5 percent level of significance. For detailed results of the remaining diagnostic tests, Breusch-Pagan-Godfrey, Glejser, RESET, and Hausman see Appendix B. Again, the problems caused by unknown forms of heteroscedasticity were identified by the Breusch-Pagan-Godfrey Test and Glejser Test and were rectified by using White's heteroscedastic-consistent covariance matrix estimator uncovered. The RESET and Hausman tests support the single equation OLS estimation model. Based on the misspecified results of the pooled data, SUR estimation was not conducted, and therefore the LRT and LM tests were not necessary.

As is the case with the pooled urban and rural analysis, TG (total grants per capita) has a highly positive significant influence on recreational and aggregate expenditure. The evidence suggests that the reduction or elimination of municipal grants will have a significant impact on recreational services provided by municipalities, and this will also influence the overall expenditure on police and fire.

The independent variable ILI (incidence of low income) is significant when explaining aggregate expenditures.

The dummy variable MD (municipal district) and counties (constant) are highly significant in all of the regressions. This implies that counties and municipal districts characteristics differ according to the expenditures analyzed.

The independent variables EA (equalized assessment), EAM (equalized assessment mix), HMI (household median income), DEN (density) and AREA (area of a municipality) are not significant in any of the regressions. Again, the influence of these variable may have been nullified and can be accounted for by splitting the urban and rural data.

The significant slope dummy variables are shown in Table 6 beginning with COEA (county multiplied by equalized assessment) and ending with MAREA (municipal district multiplied by area). All of the municipal district slope dummy variables are significant in all the regressions with the exception of aggregate expenditures. This would imply that Municipal District expenditures for services such as police, fire, and recreation differ from Counties.

6.3 Summary

The urban results show distinct differences between cities on the one hand and towns and villages on the other. However, there is very little distinction between towns and villages. This may be due to the population size of cities when compared to towns and villages. The rural results also show a distinction between counties and municipal districts.

Other than certain dummy variables, the rural results have only two significant independent variables TG (total grants) and ILI (incidence of low income) in two of the four regressions. The limited number of observations available in the rural analysis may explain the fewer significant independent variables.

The urban and rural results for aggregate expenditures did not produce any findings similar to the POLICE, FIRE, or

REC results. The aggregate expenditure results did not yield additional valid information when compared to the results produced by the individual services POLICE, FIRE, and REC.

CHAPTER 7

CONCLUSIONS

This chapter summarizes findings by comparing and contrasting the pooled urban and rural results with the separate urban and rural results; lists some applications of the results; and suggests further research that may be conducted.

7.1 Analysis of Results

Commonalities of the pooled urban and rural results and separate urban and rural results include: a preference for the log-linear functional form and OLS estimation; the quality of the aggregate regression results; insignificance of the independent variable EA (equalized assessment); and significance of total grants.

The pooled urban and rural results and the separate urban and rural results are in semi-log form and are estimated using OLS. All previous studies reviewed in chapter 2 did not state if diagnostic testing was performed to validate their linear models. If diagnostic testing was not performed studies reviewed in chapter 2 may have inaccurate results.

The comparison of the aggregate expenditure regressions results with the individual expenditure regressions results provides little information. An independent variable that is significant in an individual regression may or may not be significant in the aggregate regression. It can be deduced that an aggregate regression provides little information and to obtain meaningful results municipal services should be examined individually. This confirms the results of Weicher and Emerine's (1973) study which concluded that aggregate expenditure regressions are basically ineffective.

The independent variable EA (equalized assessment) is the only variable in the study that is insignificant in all of the estimated models. This may be due to the fact that municipal tax revenue is dependent on the mill rate rather than on equalized assessment and that the Provincial Government has attempted to equalize the assessment.

TG (total grants) is the only independent variable common to all three sets of results. It is significant or near-significant in the recreation and aggregate expenditures regression in all of the results. The evidence indicates that the reduction or elimination of municipal grants will have a significant impact on recreational services provided by municipalities, and this will also influence the overall aggregate expenditure on police, fire, and recreation.

The pooled urban and rural results and the separate urban and rural results differ in terms of the number of significant non-dummy variables, significance of municipal dummies, and significance of AREA (the size of the municipality).

The results based in the pooled urban and rural data reported in Table 4 show many more significant independent variables other than dummy variables compared to the results for urban and rural reported in Table 5 and 6. The separating of the urban and rural data may account for the insignificance of the independent variables. By separating the data the different municipal characteristics are accounted for.

The intercept and slope dummy variables show a distinct difference between urban and rural municipalities in the delivery of municipal services in the Province of Alberta. The urban dummy variable is significant in all the services implying that urban and rural municipalities should be analyzed separately. The economies of scale associated with a higher population density may explain this difference.

Further to that, the dummy variables also show a distinct difference in municipal services between cities and other urban municipalities, and between rural counties and municipal districts. Again, the higher population density in cities and municipal districts may explain this difference. Alberta municipalities differ in terms of demographic characteristics such as population and area which may explain the difference in the delivery of services.

The scale variable AREA is significant only in the recreation regression for pooled urban and rural data. The positive relationship between area and recreational expenditure demonstrates that an increase in area would require an increase in recreational expenditure. Once urban and rural municipalities are analyzed separately, scale variables are no longer significant.

7.2 Application

The results of this study can be used to determine expenditure patterns of Alberta Municipalities. This can assist municipal planners and government to determine future demands for services.

In addition, municipal planners and government can identify economies and diseconomies of scale of services. Scale effects may influence the structure of municipal governments. If an increase in the area of a municipality produces economies of scale for a service, municipalities may want to amalgamate the delivery of a service to reduce expenditures for that service.

Municipal governments can use the model to assess the impact of certain municipal characteristics allowing municipal governments the opportunity to plan the provision of public services more carefully. Information on the impact of service expenditure of variables which governments have control of should assist in the formulation of policies at the municipal level. For example, the variable TG (total grants) is significant for the provision of recreational services in all of the test results. If the amount of municipal grants were to decline then administrators could plan the level of recreational services accordingly.

It is also important to remember that municipal governments may no longer be monopoly providers of some public services. Private schools, sanitation companies and private swim clubs now offer significant competition to the public provision of local services. Municipal governments can use the results of this study to develop an appropriate model to estimate the demand for services and then determine the most cost efficient way to deliver services.

7.3 Further Research

This study is a first step in trying to determine the factors affecting municipal expenditures in the Province of Alberta. The next steps may involve incorporating more recent time-series data in a more elaborate model for forecasting purposes. In addition, other municipal services not included in this study could be analyzed. This could assist municipal planners and government to determine future demands for services, and to alter municipal grants to bring the needs and spending ability of different municipalities into balance.

The model might be extended by trying to incorporate the desirable level of public service as well as differences in quality and productivity of the services. This could be done by conducting local surveys. In addition, political factors affecting administration could also be included.

A study focusing on investigating scale effects and estimating cost curves in detail could be conducted. Scale effects influence the structure of municipal governments and may aid in determining how a service should be delivered. Estimating a U-shaped cost curve would help municipal governments and planners identify economies and diseconomies of scale of services. Scale effects may influence the structure of municipal governments and determine the optimal level of provision for a service. If an increase in the area of a municipality produces economies of scale for a service, municipalities may want to amalgamate the delivery of a service to reduce expenditures for that service.

BIBLIOGRAPHY

Bodkin, R.G., and D.W. Conklin (1971), "Scale and Other Determinants of Municipal Government Expenditures in Ontario: A Quantitative Analysis", International Economic Review, 12, 465-481.

Brazer, H. (1959), "City Expenditures in the United States." Reprinted in The Fiscal Performance of Local Government: An Interpretative Review, R.P.Inman, (ed). Baltimore and London, John Hopkins University Press, 1979.

Breusch, T. and A. R. Pagan (1979), "A Simple Test for Heteroscedasticity and Random Coefficient Variation", Econometrica, 47, 1287-1294.

Breusch, T. and A. R. Pagan (1980), "The LM Test and Its Applications to Model Specification in Econometrics", Review of Economic Studies, 47, 239-254.

Colm, G. (1936), "Public Expenditures and Economic Structure." Reprinted in The Economics of State and Local Government, W.Z. Hirsch, (ed). New York, McGraw Hill, 1970.

Fabricant, S. (1942), "The Trend of Government Activity in the United States since 1900." Reprinted in The Economics of State and Local Government, W.Z. Hirsch, (ed). New York, McGraw Hill, 1970.

Fisher, G.W. (1961), "Determinants of State and Local Government Expenditures: A Preliminary Analysis", National Tax Journal, 14, 349-355.

Fisher, G.W. (1964), "Interstate Variation in State and Local Government Expenditures", National Tax Journal, 17, 57-74.

Gabler, L.R. (1969), "Economies and Diseconomies of Scale in Urban Public Sectors", Land Economics, 45, 425-434.

Gabler, L.R. (1971), "Population Size as a Determinant of City Expenditures and Employment-Some Further Evidence", Land Economics, 47, 130-138.

Glejser, H. (1969), "A New Test for Heteroskedasticity", Journal of the American Statistical Association, 64, 316-323.

Government of Alberta, Alberta Municipal Affairs, Municipal Services Branch. (1988), Municipal Account Coding Structure Manual. Edmonton, Government of Alberta.

Greene, W.H. (1993), Econometric Analysis Second Edition. NewYork, Macmillan.

Harvey, A.C. (1990), The Econometric Analysis of Time Series, 2nd. ed. New York, Philip Alan.

Hausman, J.A. (1978), "Specification Tests in Econometrics", Econometrica, 46, 1251-1271.

Henderson, J. (1968), "Local Government Expenditures: A Social Welfare Analysis." Reprinted in The Fiscal Performance of Local Government: An Interpretative Review, R.P. Inman, (ed.). Baltimore and London, John Hopkins University Press, 1979.

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

Hufbauer, G.C., and B.W. Severn (1975-1976), "Municipal Costs and Urban Area", Journal of Urban Economics, 2-3, 199-211.

Inman, Robert P. (1979), The Fiscal Performance of Local Governments: An Interpretative Review. Baltimore and London, John Hopkins University Press.

Judge, G.G. (1980), The Theory and Practice of Econometrics. NewYork, Wiley.

Kurnow, E. (1963), "Determinants of State and Local Expenditures Reexamined", National Tax Journal, 16, 252-255.

Michas, N.A. (1969), "Variations in the Level of Provincial Municipal Expenditures in Canada: An Econometric Analysis", Public Finance, XXIV, 4, 597-617.

Midwinter, A., C. Mair, and C. Ford (1987), "Regression Analysis and the Assessment of Local Expenditure Need-A Reconsideration", Local Government Studies, 13, 35-51.

Osman, J. (1968), "On the use of Intergovernmental Aid as an Expenditure Determinant", National Tax Journal, 21, 437-447.

Pidot, G. Jr. (1969), "A Principal Component Analysis of the Determinants of Local Government Fiscal Patterns", Review of Economics and Statistics, 51, 176-188.

Ramsey, J.B. (1969), "Tests for Specification Errors in Classical Linear Squares Regression Analysis", Journal of the Royal Statistical Society, 31, 350-371.

Sacks, S., and R. Harris (1964), "Determinants of State Local Government Expenditures and Intergovernmental Flows of Funds", National Tax Journal, 17, 75-85.

Schofield, J.A. (1978), "Determinants of Urban Service Expenditures-Fire and Social Services", Local Government Studies, 4, 65-80.

Sharkansky, I. (1967), "Some More Thoughts About the Determinants of Government Expenditures", National Tax Journal, 20, 171-179.

Statistics Canada, (1986) Census Divisions and Subdivisions, Alberta: Part 2 (Catalogue 94-118). Ottawa, Government Printing Office.

Walchuk, W. (1987), Alberta's Local Governments-People in Community Seeking Goodness. Canada, Alberta Municipal Affairs.

Weicher, J.C. (1970), "Determinant of Central City Expenditure: Some Overlooked Factors and Problems", National Tax Journal, XXIII, 4, 379-396.

Weicher, J.C. and R.J. Emerine (1973), "Econometric Analysis of State and Local Aggregate Expenditure Functions", Journal of Public Finance, XXVIII, 69-83.

White, H. (1980), "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity", Econometrica, 48, 817-838.

White, K.J. (1993), SHAZAM User's Reference Manual Version 7.0. Canada, Ronald Printing.

APPENDIX A

Municipalities with a value of zero for the variable household median income (HMI) or incidence of low income (ILI)			
Observation	Municipality	Observation	Municipality
66	Irvine	177	Fort
126	Alliance	178	Gadsby
127	Amisk	179	Galahad
129	Arrowwood	183	Grassy Lake
136	Big Valley	184	Hairy Hill
137	Bittern Lake	185	Halkirk
138	Blackie	187	Heisler
139	Botha	192	Hussar
142	Burdette	194	Innisfree
144	Canmangay	199	Lavay
146	Caylay	202	Lomand
148	Champion	207	Milo
150	Chipman	208	Minburn
152	Cluny	211	Munson
156	Coutts	218	Paradise
159	Czar	220	Radway
161	Delia	222	Rosalind
162	Derwent	224	Rumsey
163	Dewberry	228	Standard
164	Donalda	230	Strome
167	Eaglesham	233	Tilley
168	Edberg	234	Torrington
171	Empress	238	Wanham
174	Ferintosh	241	Warspite
175	Foremost		

APPENDIX B

Appendix B is a summary of the following diagnostic testing:

1. Testing Seemingly Unrelated Regressions (SUR) vs Ordinary Least Squares (OLS)
2. Testing for Heteroscedasticity
3. Testing for Omitted Variables and Mis-specification
4. Testing for the Independence of the Regressor and Error

1. Testing Seemingly Unrelated Regressions (SUR) vs Ordinary Least Squares (OLS)

Both the Likelihood Ratio Test (LRT) (Harvey 1990) and the Breusch-Pagan Lagrange Multiplier (LM) Test (Breusch and Pagan 1980) were used to test whether the SUR model's error covariance matrix is diagonal.

Both of the associated test statistics are asymptotically chi-squared (with degrees of freedom equal to the number of distinct off-diagonal covariance matrix elements) under the null. If the null hypothesis of a diagonal covariance matrix is not rejected then there is no contemporaneous correlation between the errors of the different equations, and the single equation OLS estimator would be appropriate. If the null hypothesis is rejected then full maximum likelihood estimation of the SUR model is asymptotically more efficient.

H_0: Covariance matrix is diagonal

H_1: Covariance matrix is non-diagonal

Table 7.--Likelihood Ratio Test (LRT) and Breusch-Pagan Lagrange Multiplier (LM) Test Results

	Pooled Data
LRT (critical value)	806.88 (12.59)
LM (critical value)	338.22 (12.59)
degrees of freedom = 6 5% significance level	

Though the null hypothesis is clearly rejected at the 5 percent, or any other reasonable level of significance, suggesting that a joint SUR model should be estimated, in fact when this was done the SUR model was clearly badly misspecified, according to the results of the RESET tests and so single-estimation OLS estimation was used instead.

The mis-specification of the SUR model may be a result of the omission of other variables or of other functional forms, but the search for these is beyond the scope of this study. In light of the mis-specification of the SUR model, the validity of the results of LM and LRT tests could be challenged. Though there is some loss of asymptotic efficiency, OLS estimation was used because it satisfied Ramsey's (Ramsey 1969) RESET tests, and the Hausman (Hausman 1978) specification test.

2. Testing for Heteroscedasticity

The Breusch-Pagan-Godfrey Test (Breusch and Pagan 1979) and Glejser Test (Glejser 1969) were used to test for unknown forms of heteroscedasticity.

The Breusch-Pagan-Godfrey Test, which is ranked high in terms of power, models the variance of y_t, σ_t^2, as a function of a linear combination of a set of exogenous variables. That is,

$$\sigma_t^2 = \sigma^2 f(\alpha_0 + z_t\alpha)$$

where α is an (S x 1) vector of unknown parameters and $z_t = (z_{1t}, \ldots\ldots, z_{2St})'$ is an (S x 1) vector of nonstochastic variables that may be identical to, or functions of, the variable S in the vector x_t.

A Lagrange multiplier (LM) test is constructed to test the null hypothesis of homoscedasticity (if α is equal to zero) against the alternative hypothesis of heteroscedasticity (if α is not equal to zero). The LM statistic is asymptotically distributed as chi-squared with S degrees of freedom.

If the LM is greater than the critical chi-squared value at the chosen 5 percent level of significance, then the null hypothesis is rejected and the alternative hypothesis of heteroscedasticity is accepted.

Table 8.--Breusch-Pagan-Godfrey Test Results

	POOLED DATA	URBAN DATA	RURAL DATA
POLICE (critical value)	25.1 (14.1)	40.9 (14.1)	21.8 (12.6)
FIRE (critical value)	23.2 (11.1)	13.8* (14.1)	4.6* (12.6)
REC (critical value)	10.2* (14.1)	13.4* (14.1)	7.0* (18.3)
AGG (critical value)	15.4 (12.6)	22.5 (14.1)	9.1* (18.3)

* The null hypothesis is not rejected.

Heteroscedasticity was found to be present in all of the POLICE regressions, the FIRE and AGG pooled data, and the AGG urban data, at the 5% significance level.

The Glejser test (Glejser 1969) was also used to test for heteroscedasticity. This test regresses the absolute value of the residuals $|\hat{e}_t|$ on a number of alternative functions of the regressors.

The test statistic is asymptotically distributed as chi-squared with degrees of freedom equal to the number of independent variables.

Table 9.--Glejser Test Results

	POOLED DATA	URBAN DATA	RURAL DATA
POLICE (critical value)	40.0 (14.1)	130.7 (14.1)	49.8 (12.6)
FIRE (critical value)	27.3 (11.1)	20.0 (14.1)	18.3 (12.6)
REC (critical value)	19.6 (14.1)	39.4 (14.1)	17.0* (18.3)
AGG (critical value)	25.2 (12.6)	33.9 (14.1)	7.4* (18.3)

* The null hypothesis is not rejected.

Heteroscedasticity was found to be present in all of the regressions with the exception of REC and AGG in the rural data.

The adverse implications of inconsistent standard errors caused by heteroscedasticity were rectified by using White's heteroscedastic-consistent covariance matrix estimator. The "robust" estimated error covariance matrix allows appropriate asymptotic inferences to be made on the basis of OLS estimation, without specifying the type of heteroscedasticity.

3. Testing for Omitted Variables and Mis-specification

Ramsey's (Ramsey 1969) Regression Specification Error Test (RESET tests) were used to test for misspecified functional form and whether unknown variables have been omitted from a regression specification.

The RESET tests are calculated by regressing the dependent variable on the independent variables and on powers of the predicted dependent variable. R_0^2 is the coefficient of determination of the initial regression and R^2 is the coefficient of determination of the auxiliary regression.

Table 10.--RESET Test Statistics

	Regres s-and	Regressors	F-Test Statistic	Degrees of Freedom
RESET (2)	Y_t	X_t, $\hat{Y}_t^2$	$\frac{(R^2-R_0^2)}{(1-R^2)/(N-K-1)}$	(1,N-K-1)
RESET (3)	Y_t	X_t, $\hat{Y}_t^2$, $\hat{Y}_t^3$	$\frac{(R^2-R_0^2)/2}{(1-R^2)/(N-K-2)}$	(2,N-K-1)
RESET (4)	Y_t	X_t, $\hat{Y}_t^2$, $\hat{Y}_t^3$, $\hat{Y}_t^4$	$\frac{(R^2-R_0^2)/3}{(1-R^2)/(N-K-3)}$	(3,N-K-1)

Table 10 shows how the regressions and the F-test statistics are constructed. The test statistics are constructed from auxiliary regressions and test whether the coefficients on the extra regressors are zero.

If the calculated *F* statistic exceeds the tabulated critical value then the null hypothesis is rejected and the model is misspecified and/or unknown variables have been omitted. At a 1 percent level of significance, in all instances, the null hypothesis was not rejected, and so the model is correctly specified and unknown variables have not been omitted.

Table 11.--RESET Test Results

	POOLED DATA	URBAN DATA	RURAL DATA
POLICE			
RESET (2)	0.5	0.3	0.3
critical value	(6.6)	(6.6)	(6.6)
RESET (3)	4.6	4.0	0.1
critical value	(4.6)	(4.6)	(4.6)
RESET (4)	3.1	2.8	0.1
critical value	(3.8)	(3.8)	(3.8)
FIRE			
RESET (2)	1.1	0.3	1.3
critical value	(6.6)	(6.6)	(6.6)
RESET (3)	4.2	0.4	1.5
critical value	(4.6)	(4.6)	(4.6)
RESET (4)	3.5	0.3	2.0
critical value	(3.8)	(3.8)	(3.8)
REC			
RESET (2)	0.0	0.7	1.2
critical value	(6.6)	(6.6)	(6.6)
RESET (3)	4.4	1.2	1.8
critical value	(4.6)	(4.6)	(4.6)
RESET (4)	3.0	0.8	1.9
critical value	(3.8)	(3.8)	(3.8)

Table 11.--RESET Test Results			
	POOLED DATA	URBAN DATA	RURAL DATA
AGG			
RESET (2)	0.8	2.3	3.6
critical value	(6.6)	(6.6)	(6.6)
RESET (3)	3.1	1.7	2.5
critical value	(4.6)	(4.6)	(4.6)
RESET (4)	2.4	1.1	2.1
critical value	(3.8)	(3.8)	(3.8)

4. Testing for the Independence of the Regressor and Error

The Hausman (Hausman 1978) specification test was used to test for the independence of the regressors and errors. The test statistic is asymptotically chi-squared distributed with degrees of freedom equal to the number of coefficients (excluding the constant). The test statistic uses both OLS and instrumental variables (IV) estimators. In this case, the instruments used for the dependent variables (Y_i) are the predicted values in the regression of dependent variables on all of the independent variables (y_i).

The null hypothesis that the regressors and errors are not asymptotically correlated is tested against the alternative hypothesis that they are asymptotically correlated.

H_0: plim 1/n X' e = 0 (Not Asymptotically Correlated)

H_1: plim 1/n X' e =/ 0 (Asymptotically Correlated)

For OLS estimation or single equations if the Hausman test statistic is greater than the critical value then the null hypothesis is rejected and the alternative hypothesis is accepted that there is evidence of correlation between the regressor and error. No correlation implies OLS estimation is consistent and asymptotically efficient, whereas the evidence of correlation implies OLS estimation is inconsistent and asymptotically inefficient, and instrumental variable estimation is required.

Table 12.--Hausman Test Results

	POOLED DATA	URBAN DATA	RURAL DATA
POLICE (critical value)	2.7 (14.1)	1.0 (14.1)	*
FIRE (critical value)	0.0 (11.1)	*	*
REC (critical value)	3.3 (14.1)	0.0 (14.1)	3.1 (18.3)
AGG (critical value)	4.9 (12.6)	0.1 (14.1)	0.0 (12.6)

* Test is not applicable. GLS is equal to OLS.

In all single equation cases, the null hypothesis at a 5 percent significance level and appropriate degrees of freedom was not rejected. Therefore, it can be concluded that the regressors are independent of the errors and OLS estimation is consistent.

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