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Assessing The Impact Of Economies Of Scale And Uncontrollable Factors On The Performance Of U.S. Cities.

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ASSESSING THE IMPACT OF ECONOMIES OF SCALE AND UNCONTROLLABLE FACTORS ON THE PERFORMANCE OF U.S. CITIES

by

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ABSTRACT

Despite the increased interest among local governments in collecting data on performance measurement, empirical evidence is still limited regarding the extent to which these data are utilized to assess the impact on efficiency of economies of scale and uncontrollable factors. Data envelopment analysis (DEA) is a linear programming method designed to estimate the relative efficiency of decision-making units. In addition to assessing relative efficiency, DEA can estimate scale efficiency and incorporate the impact of uncontrollable factors. Using data from the International City/County Association (ICMA), this study utilized DEA to evaluate the impact of economies of scale and uncontrollable factors on the relative efficiency of municipal service delivery in the United States. The findings from this doctoral dissertation show that uncontrollable variables such as population density, unemployment, and household income suppress the relative efficiency of local governments. Moreover, the findings imply that the prevalence of economies of scale in city governments depends on the types of services these governments provide.

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CHAPTER ONE: INTRODUCTION

I. Overview

Performance measurement has been identified as “the ongoing monitoring and reporting of program accomplishments, particularly progress toward pre-established goals” (3) (GAO, 2005). Williams (2004) traced the evolution of performance measurement in the United States since its origin in 1912. According to Williams, early in its usage, performance measurement was used solely for budgeting. Later, through the efforts of New York Bureau of Municipal Research leaders, performance measurement became a tool that citizens could use to hold public leaders accountable. In the 1920s, it became an efficiency tool, assisting local governments in obtaining the desired results with limited resources (Holzer & Kloby, 2005). In the 1990s, interest in performance measurement increased as a result of administrative reform (specifically, the New Public Management movement) and the Reinventing Government movement led by Osborne and Gaebler (1992). Performance measurement has also captured the attention of governments at all levels: national, state, and local (Osborne & Plastrik, 2000). The Government Performance and Results Act of 1993 is an example of federal-level legislative interest in promoting the application of performance measurement. At the local and state government levels, benchmarking and reporting initiatives and efforts, supported by the Governmental Accounting Standards Board (GASB) and the Center for Performance Measurement at the International City/County Management Association (ICMA), are key forces behind promoting performance measurement (Nyhan & Martin, 1999a).

Ammons (1995) acknowledged the significance of performance measurement in assisting local governments to improve the quality and productivity of their services, and Poister and Streib (1999) explored and confirmed the extent to which it has been used and integrated in local governments' management. The increased demand for and involvement in performance measurement has made it crucial for officials in local governments to understand how to use the information that performance measures reveal. Ammons (2007) provided a list of uses for performance measures that emphasizes accountability and performance improvement. Benchmarking was one of the major uses included on the list. Benchmarking, or comparing the performance of local governments, is an important tool for utilizing performance-related data. By identifying best practices, benchmarking assists governments in improving their services' efficiency, quality, and effectiveness (Nyhan & Martin, 1999a). Many state and local governments have shown an interest in benchmarking best practices among jurisdictions (Ammons, 1996). Nyhan and Martin (1999b) identified some examples of government benchmarking efforts, such as Florida Benchmarks (FCGAP, 1996), Oregon Benchmarks (Oregon Progress Board, 1994), and Minnesota Milestones (Minnesota Planning, 1996).

II. Statement of the problem

As more local governments become involved in collecting data to measure their performance, it becomes crucial that they implement practical methods to utilize these data to support their decision making. Regardless of the noticeable increase in collecting data on performance measurement among local governments (Chan, 2004; Melkers & Willoughby, 2005; Ammons & Rivenbark, 2008), empirical evidence on the extent to which these data are utilized for benchmarking and efficiency determination and for understanding the impact of several uncontrollable factors on these local governments' performance is still limited. Worthington and Dollery (2002) suggested several reasons for this empirical limitation. Difficulty in establishing cause and effect between service activities and outcomes and in capturing negative or positive externalities in efficiency indicators are among these reasons. Lack of performance measurement tools that consider multiple indicators of efficiency and, at the same time, control for externalities or uncontrollable factors is a major reason for the empirical limitation. Commonly used tools for comparative performance measurement, such as simple ratio and regression analysis, are limited (Nyhan & Martin, 1999a) and lack the ability to incorporate uncontrollable variables. Uncontrollable variables, also referred to as *non-discretionary variables*, are factors that are beyond the control of the management of local governments. For example, if local governments seek to improve their efficiency by maintaining their outputs and reducing their inputs, they can only do that by reducing controllable inputs (such as expenditures and staff). Uncontrollable inputs (such as population size or density, geographical city size, poverty, and unemployment rates) are beyond managerial control. Uncontrollable variables could have a negative impact on the efficiency of local governments. Therefore, assessments of the efficiency of local government services may be incorrect if they do not take uncontrollable variables and other factors such as economies of scale into consideration. In order to connect performance measurement meaningfully to the decision-making process, more studies that utilize practical methods to investigate the impact of scale economies and uncontrollable factors on the efficiency of cities are needed. Providing local governments with new approaches by which to evaluate the impact of uncontrollable variables and economies of scale on their performance could encourage more local governments to collect performance measures and utilize them for the purposes of budgetary decision making; accountability to the media, citizens, and elected officials; benchmarking; and performance improvement.

III. Purpose of the study

The purpose of this study is to evaluate the impact of scale economies and uncontrollable factors on the relative efficiency of municipal service delivery (unit of analysis) in the United States using data envelopment analysis (DEA). Investigating the impact of uncontrollable factors on the performance of local governments has not been the focus of performance measurement research using either regression analysis or DEA. Traditional approaches lack the ability to consider scale economies and uncontrollable factors in their analysis. The outcomes of these analyses are therefore questionable. Uncontrollable factors could significantly influence local governments' performance; therefore, excluding these factors from efficiency determinations might lead to less meaningful decisions. Ammons and Rivenbark (2008) reported that factors such as population, economies of scale, and others that influence the outcomes of benchmarking are related to anxiety and reluctance to use performance measures for the purpose of benchmarking. This unwillingness to utilize performance measures for benchmarking is caused by a lack of confidence in controlling for such factors (Ammons & Rivenbark, 2008). Evaluating the impact of uncontrollable factors on performance measures could positively affect local governments by reducing fears or resistance on the parts of managers and staff resulting from their worry that such measures could hold them accountable for factors beyond their control (Bernstein, 2001). Utilizing the methods provided in this research to evaluate the impact of uncontrollable variables and economies of scale will encourage more local governments to use performance measures in benchmarking, performance improvement, budgetary decision making, and accountability to the media, citizens, and elected officials.

IV. Contribution to the body of knowledge

This study investigated the impacts of population density, mean household income, the unemployment rate, and economies of scale on performance (measured by efficiency) in selected cities in the United States. This study contributed to the body of knowledge with respect to performance measurements by local governments (cities) and data envelopment analysis applications by addressing major shortcomings in the literature: determining the influence of economies of scale and uncontrollable factors (population density, unemployment rates, and household income levels) on cities' performance as measured by efficiency.

V. Summary

Despite the noticeable increase in collecting data on performance measurement among local governments, empirical evidence is still limited regarding the extent to which governments have utilized these data to assess the impact of economies of scale and uncontrollable factors on efficiency. Evaluating the performance of local governments without taking uncontrollable variables and other factors such as economies of scale into consideration could lead to incorrect conclusions about efficiency and ultimately to inefficient decisions about resource allocation. Therefore, more studies are needed that investigate the impact of scale economies and uncontrollable factors on the efficiency of cities to determine these variables' relative influence. The purpose of this study was to evaluate the impact of population density, household income, unemployment, and economies of scale on the performance (measured by efficiency) of several cities in the United States.

CHAPTER TWO: LITERATURE REVIEW

I. Performance measurement in local governments

Local governments have shown renewed interest in benchmarking best practices in order to identify the most successful service-delivery strategies (Ammons, 2001). In addition to identifying best strategies, local governments have shown an increased interest in benchmarking as a way of managing and monitoring their performance (Ammons, 1995). Poister and Streib (1999) studied the extent to which local governments have incorporated performance measurement. They reviewed numerous studies that included surveys conducted by policy groups such as the Urban Institute (1971), the International City/County Management Association (ICMA, 1976), the Government Accounting Standards Board (GASB), and the National Academy of Public Administration (NAPA, 1997). In addition to these surveys, Poister and Streib (1999) examined budget documents to determine the degree of local governments' involvement in performance measurement. The outcome of this review indicated various degrees of local government involvement in performance measurements. For example, the 1971 Urban Institute survey showed that more than half of the responding cities and counties used performance measures in the budget process (Winnie, 1972); the 1976 ICMA survey, however, showed that only 30% of responding cities and counties did so (Fukuhara, 1977), while the 1996 GASB and NAPA survey showed that 37% of municipalities used performance measures in creating a budget (Poister & Streib, 1999). Researchers examining budget documents also found variations in performance-measurement use. For example, Hatry (1976) showed that 25% of local governments used effectiveness measures and 10% used efficiency measures. Usher and

Cornia (1981) showed that 59% of local governments used workload measures and 43% used effectiveness measures. Similarly to the GASB survey findings, Poister and Streib (1999) indicated that 38% of local governments used performance measures. Despite the variation in the level of performance-measurement use, these studies provide clear evidence of local governments' interest in and consideration of implementing performance measures in their systems. Chan (2004) conducted a survey that included 132 municipal governments in the United States. The purpose of the survey was to assess performance measurement's adoption and/or utilization among municipalities. The results of the survey showed that municipal governments developed measures in different performance areas. These municipal governments developed financial-performance measures (81.8%), operating-efficiency measures (76.6%), customer-satisfaction measures (71.9%), employee-performance measures (65.3%), and innovation or change measures (39.7%). When respondents to the survey (government administrators) were asked about the utilization of performance measures in their organizations, approximately half of them reported that measures related to customer satisfaction, operating efficiency, and employee performance were utilized in management activities. In general, Chan's (2004) study indicated a positive perspective on the value and quality of performance measurement among the selected governments. Melkers and Willoughby (2005) found a high level of performance-measurement utilization among local governments in the United States. The majority of their survey respondents (administrators and budgeters) expressed having had a positive experience with performance-measurement implementation and expected the continuous evolvement of its use in their departments (Melkers & Willoughby, 2005). A recent study by Ammons and Rivenbark

(2008) confirmed performance-measurement use among 15 local governments in North Carolina (participants in the North Carolina Benchmarking Project).

In addition to determining the level of performance measurement use in local governments, other studies examined the impact of its utilization. Bernstein (2001) confirmed the positive influence of performance measurement utilized for monitoring outputs and outcomes. This study suggested that performance-measurement use could have a positive impact on overcoming fears or resistance on the part of managers and staff resulting from their concern that such measures could hold them accountable for uncontrollable factors. Wang (2002) examined the impact of performance measurement and the influence of its implementation on city governments in the United States. His study indicated that performance-measurement utilization had a positive impact on local governments in regard to specifying their broad goals and objectives, identifying daily management problems and solutions, facilitating communication with stakeholders, and evaluating their strategies and implementation (Wang, 2002).

II. Performance-measurement approaches related to local government

Nyhan and Martin (1999a) provided a detailed explanation of using simple ratio and regression analysis to evaluate comparative efficiency among several services providers. Ratio analysis uses several measures or ratios (for example, the number of facilities per population, the number of training programs per FTE, the cost of programs per FTE, and so on) to estimate the level of performance for individual service providers. The problem with this approach is that using several ratios to determine the level of performance could lead to conflicting results and make the decision-making process even harder (Nyhan & Martin, 1999a). To compare the performance level of several service providers, these measures or ratios need to be weighted or prioritized based on their importance. Using weighted averages for each measure or ratio suggested by managerial or policy experts could solve this issue; however, it is very difficult to reach agreement on unbiased assigned weights. Regression analysis uses independent variables (inputs) to explain variations in dependent variables (output, quality, and outcome). The regression model predicts an average level of service providers' performance in a particular service; however, it lacks the ability to analyze the average level of performance in multiple services. The inability to identify the overall performance of best and worst practices to support the process of policymaking decisions is a major limitation of both regression and simple ratio analysis (Nyhan & Martin, 1999a).

In addition to the use of ratio and regression analysis, frontier analysis (explained in detail by Farrell, 1957) is another approach to utilizing performance-related data to estimate the overall efficiency among several service providers. Parametric (stochastic) and nonparametric analyses are two different approaches to frontier analysis. With parametric analysis, an aggregate production function is assumed to be either known or parametrically (statistically) estimated. The nonparametric approach requires no prior assumption about the form of the production function. Based on best practices (identified by the weighted inputs and outputs), a function frontier is estimated. Efficiency scores of inefficient providers are derived from their distance from the frontier. Data envelopment analysis applications are discussed further in this dissertation.

III. Economies of scale in local governments

To determine efficiency in local governments, several studies have tested for the existence of scale economies, defined as the reduction in long-run costs as a result of the increase in size of municipalities. Most of these studies found evidence of diseconomies of scale (an increase in long-term average cost or expenditures as a result of an increase in the size of municipalities) associated with larger cities. These studies include Balaguer-Coll et al. (2007) in Spain; Hughes and Edwards (2000) in Minnesota; Rouse and Putterill (2005) in New Zealand; Nyhan and Martin (1999b) in the United States; Moore et al. (2005) in the United States; and Geys and Moesen (2009) in Belgium. One study by Benitoa et al. (2007) found a generally positive correlation between efficiency and the scale of local governments; however, they found a negative correlation in providing police and refuse-collection services. Other (non-DEA) studies employed linear or quadratic functions to detect economies or diseconomies of scale (see Table 1). Byrnes and Dollery (2002) conducted a review of 21 worldwide and 9 Australian studies on scale economies in local governments. Most of the reviewed studies used population and per capita expenditures as measures of scale and costs, respectively. The authors indicated that 30% of the international studies found no relationship between expenditures and size, 8% found some evidence of economies of scale, and 24% found diseconomies of scale. Other studies investigated the impact of scale in providing services in particular areas such as police (Walzer, 1972; Finney, 1997; Gyimah-Brempong, 1987; McDavid, 2002; and Krimmel, 1997), fire (Duncombe & Yinger, 1992), and education (Bell, 1988). All police studies (except Krimmel, 1997) found negative relationships between scale and the cost of police provision. Using population as an indicator of scale, Duncombe and Yinger (1992) found no increased returns to scale in providing fire services.

Table 1. List of Empirical Studies Evaluating the Impact of the Scale of Local Governments on Efficiency and Costs

Author	Method	Findings
Geys & Moesen (2009)	DEA/Regression	Efficiency is negatively associated with scale.
Hughes & Edwards (2000)	DEA/Regression	Efficiency is negatively associated with scale.
Moore et al. (2005)	DEA/Regression	Efficiency is negatively associated with scale.
Rouse & Putterill (2005)	DEA/Regression	Efficiency is negatively associated with scale.
Nyhan & Martin (1999b)	DEA	Efficiency is negatively associated with scale (police service).
Balaguer-Coll et al. (2007)	DEA/Regression	Diseconomies are associated with large government.
Benitoa et al. (2007)	DEA/Regression	In general, scale is positively correlated with efficiency.
Byrnes & Dollery (2002)	Lit. review	30% of reviewed studies showed no relationship, 8% found evidence of economies of scale, and 24% found diseconomies of scale.
Walzer (1972)	Regression	Scale is negatively associated with average cost in police service.
Duncombe & Yinger (1992)	Regression	Increase returns to quality scale but not population scale in providing fire services.
Finney (1997)	Regression	Found decrease returns to scale in providing police services.
Gyimah (1987)	Regression	Diseconomies of scale as a result of large police department.
Krimmel (1997)	Regression	Negative relationship between scale and the cost of police provision.
McDavid (2002)	Simple comparison	Amalgamation is associated with higher costs (police).

Unlike business manufacturing, in which large distribution, large scale management, purchasing power (Bain, 1968), marketing, and research and development (Canback, 1997) drive economies of scale, governments are service industries in which labor-intensive services, bureaucracy, and costs (related to transition personnel and service) cause diseconomies of scale when they are consolidated (Pineda, 2005). Regardless of the common belief that larger local government units are more efficient at providing local services, no clear empirical evidence exists to support it. A main purpose of this study was to assess the performance of local governments while taking into consideration the following question: What is the influence of economies of scale on local governments' efficiency?

IV. The impact of uncontrollable factors on the efficiency of local governments

Several DEA studies have examined the impact of environmental/uncontrollable factors on local governments' performance. With few exceptions (e.g., More et al., 2005; Nyhan & Martin, 1999b), most of the studies that implemented DEA and explained the impact of uncontrollable variables on efficiency were conducted in countries other than the United States. The outcomes of these studies indicated that several uncontrollable factors could influence the performance of local governments. The following sections include a review of the DEA literature on the impact of population, unemployment, and income (household income and per capita income) on local governments' efficiency.

a) Population

Even though this study examined the impact of population density (number of inhabitants per square mile) on city governments, this section covers studies that examined both population size and population density on local governments' efficiency.

Increasing population growth entails more spending as a result of greater demand for municipal services (Bradbury et al., 1984; Ladd & Yinger, 1991; Ladd, 1992; and Ladd, 1994). This increased spending might contribute to municipal inefficiency, mainly among cities with a high population of individuals of low socioeconomic status. The reviewed literature (see Table 2) provides a mixed picture of the relationship between population or population density and efficiency. Six out of 15 studies that implemented DEA to examine the impact of population on efficiency found a negative relationship, five found a positive relationship, three found no relationship, and one found mixed results. More et al. (2005; population/United States cities), Afonso and Fernandes (2008; population density/Portuguese local governments), Loikkanen and Susiluoto (2005; population/Finnish cities), Coffe and Geys (2005; population/Flemish municipalities), Geys and Moese (2009; population density/Flemish municipalities), Woodbury and Dollery (2004; population density/Australian local governments), and Worthington (2000; population/New South Wales library services) showed that a large population or high population density was negatively associated with the efficiency of the city services included in their studies. De Borger and Kerstens (1996; population density/Belgian local governments), Balaguer-Coll et al. (2007; population/Spanish municipalities), Benitoa et al. (2007; population density/Spanish municipalities), and Hauner (2008; population density/Russian local governments) found a positive relationship between population or population density and efficiency. Other studies showed no impact of population or population density on the efficiency of local governments providing particular services. For example, Lorenzo and Sanchez (2007; street-lighting service in Spanish towns) and Nyhan and Martin (1999b; policing services in United States) showed no significant impact of population density and population, respectively,

Table 2. List of the Empirical Studies Evaluating the Impact of Population on Local Governments

Author	Method	Findings
More et al. (2005)	DEA/Regression	Large population is negatively associated with efficiency.
Afonso & Fernandes (2008)	DEA/Regression	High population density is negatively associated with efficiency.
Loikkanen & Susiluoto (2005)	DEA/Regression	Large population is negatively associated with efficiency.
Coffe & Geys (2005)	Regression	Large population is negatively associated with efficiency.
Geys & Moese (2009)	Regression	High population density is negatively associated with efficiency.
Worthington (2000)	DEA/Regression	Large population is negatively associated with efficiency.
Woodbury & Dollery (2004)	DEA/Regression	High population density is negatively associated with efficiency.
Balaguer-Coll et al. (2007)	DEA/Regression	Positive effect on efficiency.
De Borger & Kerstens	DEA/Regression	Low population density leads to low efficiency.
Benitoa et al. (2010)	DEA/Regression	Population density is positively but not strongly correlated with efficiency.
Hauner (2008)	DEA/Regression	Positive effect of population density on efficiency in providing health services.

Author	Method	Findings
Lorenzo & Sanchez (2007)	DEA/Regression	No significant impact caused by population density.
Nyhan & Martin (1999b)	DEA	No significant impact of population on efficiency of police services.
Roca et al. (2007)	DEA/Regression	No impact of population density (with the exception of few municipalities).
Lim (2007)	DEA/Regression	Efficiency increases until the population number reaches 800,000.

on local government service efficiency. In addition, Roca et al. (2007) analyzed the efficiency of refuse-collection services in 73 municipalities in Spain. With the exception of a few municipalities, they found no impact of population density on efficiency. Lim (2007) examined the impact of population size on the efficiency of Korean cities. Lim's study showed that as the population size of Korean cities increased, the efficiency increased until the size of the population reached 800,000.

b) Unemployment

Unemployment is a proxy measure for social problems. Social problems caused by unemployment, such as poverty and crime, could have a negative impact on the efficiency of local government services. For example, high levels of social problems caused by significant rates of unemployment place high demand on services provided by local governments (e.g., housing and police services). This high demand on such services could render local governments inefficient.

The negative impact of unemployment on the efficiency of local governments has clear evidence in the literature (see Table 3). Most of the reviewed studies (n=8) found that unemployment negatively influences efficiency. Only three of the eight reviewed studies showed no impact of unemployment on the efficiency of local governments. Most of these studies utilized DEA to determine the efficiency of local governments and employed regression analysis to explain the impact of unemployment on efficiency. Studies that found negative relationships between unemployment and efficiency include Afonso and Fernandes (2008; Portuguese local governments), Loikkanen and Susiluoto (2005; Finnish cities), Revelli (2010; English local governments), Barros (2007; Lisbon, Portugal police service), and Barros (2007; Flemish municipalities). Coll et al. (2002; Spanish local governments), Geys and Moesen (2009; Belgian municipalities), and Garcia-Sanchez (2008; Spain, solid-waste collection) found no significant impact of unemployment on efficiency.

Table 3. List of the Studies Evaluating the Impact of Unemployment on the Efficiency of Local Governments

Author	Method	Findings
Afonso & Fernandes (2008)	DEA/Regression	Negatively influences efficiency
Loikkanen & Susiluoto (2005)	DEA/Regression	Negatively influences efficiency
Revelli (2010)	Regression	Negatively influences performance
Barros (2007)	DEA/regression	Negatively influences efficiency (police service)
Coffe & Geys (2005)	Regression/DEA	Unemployment has a strong negative effect on the municipality’s surplus (surplus was positively related to cost efficiency)
Coll et al. (2002)	DEA/regression	No significant effect on efficiency

Geys & Moesen (2009)	Regression	Does not relate to efficiency/inefficiency
Garcia-Sanchez (2008)	DEA/regression	No significant impact of unemployment on efficiency (Spanish municipalities/solid-waste collection)

c) Income

Median household income can be a proxy measure for local governments' economic condition (Jang, 2006). As Nyhan and Martin (1999b) pointed out, higher median income implies a greater tax base and larger revenues. Lower resource availability (e.g., taxes and revenues) could contribute to local governments' inefficiency. The literature on the impact of income (household or per capita) on efficiency is mixed. For example, Lim (2007; Korean local governments), Afonso and Fernandes (2008; Portuguese local governments), and Loikkanen and Susiluoto (2005; Finnish cities) showed that a high income level is negatively associated with efficiency. De Borger and Kerstens (1996) examined the impact of income level (among other factors) on 589 local Belgian governments' efficiency in providing social, educational, and recreational services. Average income was found to have a negative impact. Four studies showed different results. Two of these four studies showed that income had no impact on efficiency, and the other two found that it had a positive impact. Coffe and Geys (2005; Flemish municipalities) and Geys and Moesen (2009; Belgian municipalities) found no statistically significant impact of

Table 4. List of the Studies Evaluating the Impact of Income on the Efficiency of Local Governments

Author	Method	Findings
Lim (2007)	DEA/Regression	Negatively associated
Afonso & Fernandes (2008)	DEA/Regression	Negatively associated

Loikkanen & Susiluoto (2005)	DEA/Regression	Negatively associated
De Borger & Kerstens (1996)	DEA/Regression	Negatively associated
De Borger et al. (1994)	DEA/regression	Negatively associated
Geys & Moesen (2009)	Regression	No impact
Coffe & Geys (2005)	DEA/Regression	No statistically significant impact
Hauner (2008)	DEA/Regression	Positively impacts efficiency

income level on the efficiency of local governments. Both Hauner (2008; Russian local governments) and Benitoa et al. (2007; Spanish municipalities) found a positive relationship between income level and efficiency. However, Benitoa et al. indicated that the positive impact was insignificant. Table 4 includes a list of these studies.

V. Summary

The increasing interest in performance measurement is evident in the literature on local governments. Using performance measures to estimate the efficiency of local governments is a common approach to evaluating their performance. In addition to using ratio and regression analysis, several studies used frontier analysis (e.g., DEA) to estimate the efficiency of local governments. In contrast to ratio and regression analysis, DEA can identify the overall performance of best and worst practices of service providers. Many studies evaluated the impact of economies of scale and uncontrollable variables on the performance of local governments. The outcomes of these studies indicated that economies of scale are not evident among local governments and that unemployment and income are negatively associated with efficiency. The impact of population density on local governments was inconclusive; some studies found that higher population density had a negative impact, but others found that it had a positive or negligible impact.

CHAPTER THREE: RESEARCH DESIGN

I. Conceptual framework

The conceptual framework for this study (see Figure 1) explains how the impact of both uncontrollable factors and economies of scales were determined in the study. The impact of each uncontrollable variable on efficiency was assessed by incorporating them individually in DEA. Economies of scale were evaluated based on the ratio of the efficiency scores obtained from the constant returns to scale (CC) model and the variable returns to scale (BCC) model.

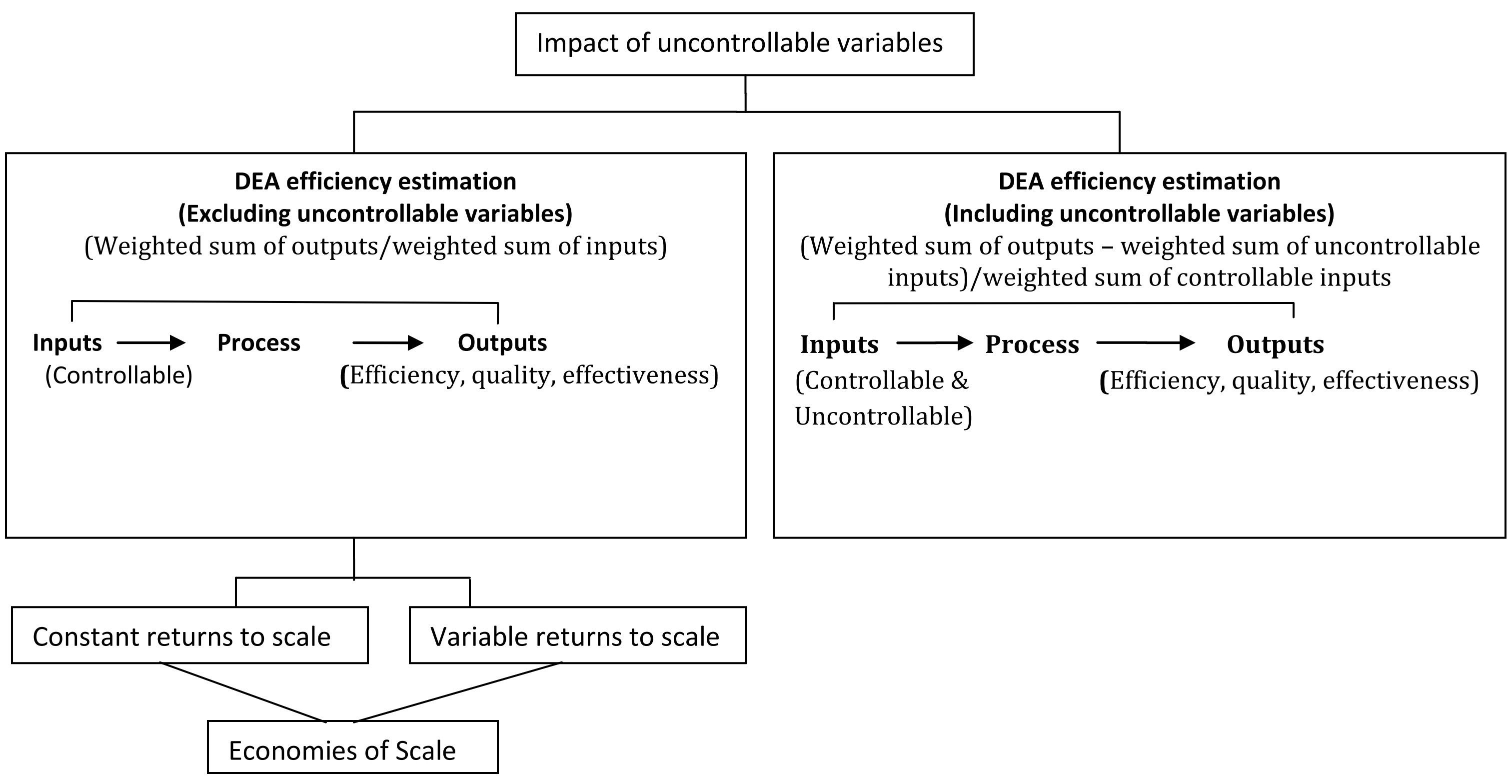

Figure 1. Conceptual framework: estimation of the impact of uncontrollable variables and economies of scale.

II. Research questions

The research questions for this study are divided into two sections. The first section includes three questions related to the impact of uncontrollable factors on the efficiency of city governments. These factors are population density, unemployment, and household income. The literature review section discussing the impact of population on the efficiency of local governments included studies examining the effect of both population and population density on local governments' efficiency. To incorporate the impact of city size (geography), this research examined the impact of population density (number of inhabitants per square mile) on city governments. The second section of research questions relates to economies of scale in city governments.

a) Research questions related to uncontrollable factors

1) Does population density impact the relative efficiency of local governments?
2) Does unemployment impact the relative efficiency of local governments?
3) Does household income impact the relative efficiency of local governments?

b) Research questions related to economies of scale

4) Do economies of scale exist in local governments?

III. Methodological approach: Data envelopment analysis (DEA)

Data envelopment analysis is a linear programming model designed to estimate the relative efficiency of decision-making units (DMUs). A DMU can be any organization (government or private) that converts, through a process, inputs to outputs. DEA has been widely used to measure the efficiency of schools, human-service agencies, court systems, and health-care providers (Nyhan & Martin, 1999). Based on the frontier methodology of Farrell (1957), DEA was introduced by Charnes, Cooper, and Rhodes (1978) and later developed by Banker, Charnes, and Cooper (1984). DEA measures efficiency by identifying the relative best performers (the most efficient DMUs) and calculates the efficiency of all other DMUs against those best performers. To do so, DEA assigns mathematical optimal weights to all inputs and outputs by placing maximum weight on variables where a DMU compares favorably and minimum weight where a DMU compares unfavorably (Nyhan & Martin, 1999). Once the efficiency of all DMUs has been calculated, DEA assigns them scores between 0 and 1, where 1 is the highest efficiency score and 0 is the lowest efficiency score. DEA can handle multiple inputs and outputs of different types (continuous, ordinal, and categorical), as well as different units (dollars, FTEs, and test scores) and objectives (outputs, outcome, and quality) (Nyhan & Martin, 1999). In addition to its ability to accommodate multiple inputs (independent variables) and outputs (dependent variables), DEA can accommodate both controllable input and uncontrollable input variables.

Two basic DEA models are demonstrated in Figure 2. The linear line resembles the envelopment surface for the constant returns to scale model (CRS or CCR) of Charnels, Cooper, and Rhodes (1978); the convex line resembles the envelopment surface for the variable returns to scale (VRS or BCC) model of Banker et al. (1984). As Banker explained, constant returns to scale are represented by a straight-line relationship between input and output. Variable returns to scale are represented by a curved-line relationship that increases more steeply than a straight line in the case of increased returns to scale and less steeply than a straight line in the case of decreased returns to scale (Norman & Stocker, 1991). In terms of measuring efficiency, the constant returns to scale (CCR) model assumes that organization size does not affect relative efficiency; however, the variable returns to scale (BCC) model assumes that organization size does affect relative efficiency (Martin, 2002). These assumptions can be explicated by the different relationships between inputs and outputs in each model, which Norman and Stocker (1991) explained. In the case of the CCR model, the relationship between outputs and inputs is constant: Doubling the inputs will lead to the same doubling of the outputs. In the case of the BCC model, however, this relationship is varied (for example, in the case of decreasing returns to scale, doubling input may lead to less doubling output).

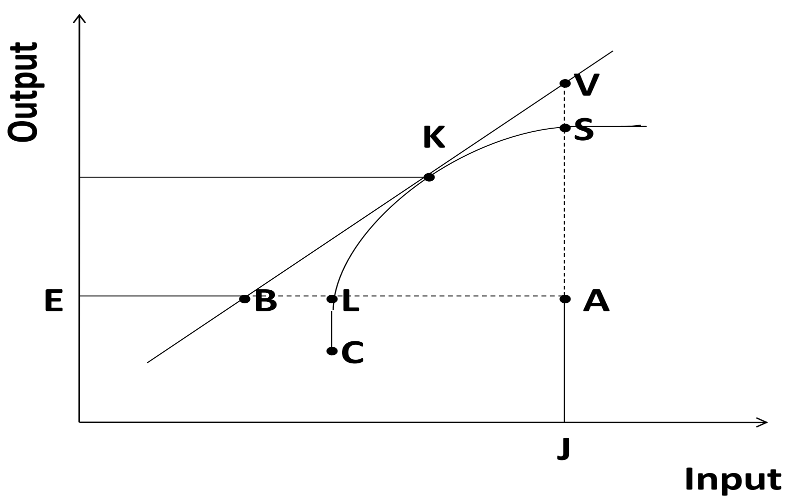

Figure 2. DEA frontier plot (adapted from Norman & Stoker, 1991).

DMUs are determined to be scale efficient when the ratio of CCR (overall technical efficiency)/BCC (pure technical efficiency) is equal to 1. This ratio represents scale efficiency. When this ratio is less than 1, scale inefficiency is due either to increased returns to scale (which leads to economies of scale) or decreased returns to scale (which leads to diseconomies of scale). When a proportional increase in all inputs leads to a higher-than-proportional increase in the single output, increased returns to scale occur, and when it results in a less-than-proportional increase in the single output, decreased returns to scale take place (Cooper et al., 2007).

In Figure 2, DMUs C, L, K, and S, identified on the frontier line of the VRS model, represent the best performance. In other words, these DMUs have the highest efficiency scores (the output to input ratio equals 1). DMUs that are not on the frontier are considered less efficient. For example, point A in Figure 1 resembles a DMU that is less efficient than DMUs on the frontier line. Beside the CCR and BCC classifications, DEA models are classified based on orientation. While input orientation assumes that the DMUs have more control over input consumption, output orientation assumes that DMUs have more control over output production and maximization. For example, under the CCR model the efficiency measure of DMU A would be the ratio of JA/JV, maximizing the output given the input (output-oriented), and EB/EA, minimizing the input given the output (input-oriented). These ratios are equal. Under the BCC model (for example, decreasing returns to scale), efficiency measure for organization A would be JA/JS, maximizing output given input (output-oriented), and EL/EA, minimizing input given the output (input-oriented). Appendix A presents the mathematical explanation of the basic DEA model.

In addition to these basic models, several enhancements have been added to the DEA methodology that allow further analysis, such as incorporating uncontrollable factors to estimate changes in efficiency scores. The basic models explained above assume that all inputs and outputs are discretionary and under managerial control. In real situations, many environmental or uncontrollable variables (inputs) impact the estimated efficiency. The mathematical treatment of uncontrollable inputs is explained in detail in Charnes et al. (1994). Appendix A also includes the mathematical formulation for including uncontrollable factors.

IV. Data sources

Working with local government professionals such as city and county managers, department heads, and other service-area specialists, the Center for Performance Measurement (CPM) at the International City/County Management Association (ICMA) has assisted cities, towns, counties, and other local government entities in the United States and Canada in gathering and reporting comparative performance measurement data in 15 different services areas (ICMA's CPM, 2009). Appendix B shows these service areas and the performance measures of efficiency, quality, and effectiveness included in the study. In addition to these performance measures, the 2009 annual CPM report included many demographic variables such as population density, household income, and rate of unemployment. These variables were also included in the study as uncontrollable variables.

V. Summary

This study sought to answer four research questions. The first three questions pertain to the impact of population density, unemployment, and household income on local governments' (i.e., cities') efficiency. The fourth question is related to economies of scale in local governments. To answer these questions, this study utilized data envelopment analysis (DEA). DEA is a powerful tool that can implement multiple indicators of efficiency while simultaneously controlling for several uncontrollable factors. In addition to assessing the technical efficiency, DEA can estimate scale efficiency to determine the influence of economies of scale on local government performance. Using the annual ICMA data of performance measures, the study evaluated the impact of both economies of scale and uncontrollable factors on the relative efficiency of local governments by applying data envelopment analysis.

CHAPTER FOUR: METHODOLOGY

The first section of this chapter discusses the hypotheses for the study, which were derived from the literature review. The second, third, and fourth sections discuss the selection of the unit of analysis, service areas, and variables (input, uncontrollable, and output) utilized to conduct the study. The applications of data envelopment analysis are explained in the fifth section, which covers both the selection of DEA models and the incorporation of uncontrollable variables in the analysis. Section 6 of the chapter focuses on the data analysis to determine the impact of economies of scale and uncontrollable factors (population density, unemployment, and household income) on the performance of the selected city governments. Both the limitations of data envelopment analysis and the limitations of ICMA data are discussed in section 7.

I. Hypotheses

Population growth leads to more spending as a result of higher demand for municipal services (Bradbury et al., 1984; Ladd & Yinger, 1991; Ladd, 1992; and Ladd, 1994). This increased expenditure might contribute to municipal inefficiency, particularly within cities with low incomes and tax revenues. In addition, the literature has documented the negative relationship between population density and efficiency (Afonso & Fernandes, 2008; Geys & Moese, 2009; and Woodbury & Dollery, 2004). Unemployment rates and median income are proxy measures for social problems and resource availability. As Nyhan and Martin (1999b) pointed out, higher median income and population imply a greater tax base and revenues; conversely, low median income could be a proxy indicator of several social problems (e.g., poor levels of education, overcrowded living conditions, and the like). In addition to indicating limited resource availability, these social problems could negatively impact the efficiency of local governments. For example, a high crime rate and high housing demands (as a result of several social problems) could negatively impact the efficiency of police services and housing services, respectively. As noted above, no clear empirical evidence exists to confirm that economies of scale are more common in bigger cities than in smaller cities. In fact, several studies have shown that the opposite is true (Moore et al., 2005; Nyhan & Martin, 1999b; Rouse & Putterill, 2005; Hughes & Edwards, 2000).

Given the above discussion, the hypotheses of this research were as follows:

H1: Economies of scale do not exist in local government services.

H2: Population density is negatively associated with relative efficiency.

H3: Unemployment rate is negatively associated with relative efficiency.

H4: Household income is negatively associated with relative efficiency.

II. Selection of unit of analysis (cities)

The International City/County Management Association annual reports contain comparative performance data for participating governments in the United States and Canada. These local governments include counties, cities, towns, and villages. The ICMA provides participating local governments with templates and definitions for the data to be collected, guaranteeing consistency and similarity among the measures they provide. To ensure homogeneity among the decision-making units (DMUs), only U.S. cities (146) were considered in this study. Appendix C includes a list of the cities included in the study for each service area. Because of data limitations, the number of cities included in the analysis of each service area was not necessarily the same. For example, 48 cities were included in the DEA models (BCC and CCR) that determined the scale efficiency of police services. Of these 48 cities, 14 included data from both the 2007 and 2008 fiscal years, 19 included data from fiscal year 2008 only, and 15 included data from fiscal year 2007 only. To conduct the same analysis for the parks-and-recreation service area, 64 cities were included in the data set. Data for both fiscal years 2007 and 2008 were included from 30 cities, but fiscal year 2007 data included only 19 cities and fiscal year 2008 data included only 15 cities. In addition, the ICMA performance measures for the refuse-collection service area for fiscal years 2008 and 2007 differed. For this reason, data for this service were included from the annual report of fiscal year 2008 only. Appendix C includes the list and the total number of cities included in the study for each service area.

III. Selection of service areas

Table 5 shows the 12 service areas covered in the analysis. Including several service areas in this analysis assisted the researcher in understanding how the impact of uncontrollable variables and economies of scale on the efficiency of local governments varies among these service areas. Policing, fire, library, fleet management, parks and recreation, and roads maintenance were among the most commonly studied services (Appendix D). These service areas were included in this study. In addition to these services, others are less commonly included in the literature of performance measurement in local governments. Housing, information technology, code enforcement, and facility management are examples of such service areas. These service areas were also included in this study.

IV. Variables selection

a) Input variables

Norman and Stoker (1991) identified inputs as internal (controllable) and external (uncontrollable) factors (to DMUs) that either assist with or deter the production of outputs. In this study, the input for each analysis was selected based on the above identification. In addition to municipal general funds and expenditures, the ICMA provides data pertaining to expenditures, revenues, or funding that local governments utilize to provide the necessary services in their individual areas. Because the DEA analysis for this study was conducted for individual services provided by city governments, including municipal general funds and expenditures as an input was not appropriate (it would have been, had one DEA been conducted for multiple service areas). For this reason, data pertaining to expenditures, revenues, or funding related to the selected service areas were used as inputs. Table 5 below shows the selected input variable that was included in the analysis for each service area. Expenditures were included as an input variable in the analysis of the efficiency of most of the services. These services were code enforcement, fire, fleet management, facilities management, highway and road, information technology, library, police, refuse collection, and risk management. As shown in Table 5, expenditures for some of the services were expressed by several metrics. For example, expenditures for services such as code enforcement, police, and fire were expressed as per capita quantities, while expenditures for services provided by library, fleet management, and risk

Table 5. Input Variable Included in the Analysis for Each Service Area

Input Variable
Code Enforcement
Expenditures per capita
Fire Services
Total fire personnel and operating expenditures per capita
Fleet Management
Average fleet maintenance expenditures per vehicle: all vehicles and heavy equipment
Facilities Management
Total operating and maintenance expenditures for all maintained facilities
Highway and Road
Road rehabilitation expenditures per capita (total lane miles)
Housing
Total funding for new and rehabilitated low- to moderate-income housing units and home ownership per capita
Information Technology
Central IT operating and maintenance expenditures
Library
Operating and maintenance expenditures per registered borrower
Parks and Recreation
Net parks and recreation revenue per capita—excluding golf expenditures and revenues
Police Services
Total operating and maintenance expenditures charged to the police department per capita.
Refuse Collection
Operating and maintenance expenditures for refuse collection per refuse-collection account
Risk Management
Expenditures for workers' compensation per jurisdiction FTE

management were expressed as per borrower, vehicle, and FTE amounts, respectively. Data related to expenditures were not available for two service areas (parks and recreation and housing). Instead, net parks and recreation revenues per capita (excluding golf) and total funding (for new and rehabilitated low- to moderate-income housing units and home ownership) per capita were used as the input variable for parks and recreation and housing services, respectively. In each service area, the selected input variable was related to the selected outputs. Expenditures (operating and maintenance of a service), revenues (from parks and recreation) and funding (for housing) involved information about financial investment in staff, equipment, and facilities, all necessary factors for the process of local governments to achieve their outputs.

Level of spending, explained by expenditures, is frequently employed in efficiency studies on local governments (Moore & Nolan, 2005; Worthington, 2000; Athanassopoulos & Triantis, 1998; Afonso & Fernandes, 2008; and others). It is also commonly used as a controllable input in data envelopment analysis (explained in the next section) when evaluating the relative efficiency of local governments. In addition, expenditures are used by GASB’s service efforts and accomplishments reporting (Nyhan & Martin, 1999b) and appear frequently in the DEA literature of local governments (Appendix D). Other DEA efficiency studies on local governments have in fact used number of employees as an input variable. Number of employees was excluded from this study as an input variable for two reasons. First, it could be correlated with employees’ salaries, which were included in the level of spending. Second, many local governments outsource services to contractors. The selection of uncontrollable input variables will be discussed in the next section.

b) Uncontrollable input variables specification

Appendix D includes a list of uncontrollable (nondiscretionary) variables included in DEA studies. Some of these variables include population (Moore et al., 2005; Afonso & Fernandes, 2008; Loikkanen & Susiluoto, 2005; Lim, 2007; and others), city size (Moore et al., 2005; Nyhan & Martin, 1999b), household income (De Borger & Kerstens, 1996; Loikkanen & Susiluoto, 2005 and Eeckau, Tulkens & Jamar, 1993), unemployment rate (Loikkanen & Susiluoto, 2005), and others.

Population is among the most commonly included uncontrollable variables in the literature on DEA implementation used to evaluate variables' impacts on public-provision efficiency. Population is an uncontrollable factor that may impact revenues (taxes), resource availability, and the amount of government services available (Nyhan & Martin, 1999b). Because city size (geography) can have either a positive or a negative impact on efficiency, this study utilized population density (number of inhabitants per square mile). For example, longer response time in big cities could lead to lower efficiency scores pertaining to police, fire, and rescue services. On the other hand, big cities could have higher efficiency scores than smaller cities because they have more land area for parks and recreation activities.

Socioeconomic factors such as low income, high poverty levels, and high unemployment rates could have a negative impact on efficiency measures as a result of high levels of crime and other social problems. While median household income and unemployment rate were included in this study as uncontrollable variables, poverty level was excluded because low income could be a proxy factor of poverty.

Table 6 below lists the uncontrollable variables included in this study. Population density, median household income, and unemployment rate (%) were the uncontrollable variables selected for evaluation of their impact on the efficiency of city services in the United States. These variables are included in the ICMA annual report as demographic characteristics of the participating cities.

Table 6. List of Uncontrollable Variables

Uncontrollable Variables
Population density (number of inhabitants/square mile)
Median household income
Unemployment rate (%)

c) Output variables

The selected output variables for data envelopment analysis need to be measurable quantities that reflect aspects of achievement in supporting the DMUs' objectives (Norman & Stoker, 1991). Appendix D lists several studies that have utilized output variables to evaluate local government efficiency using DEA. Multiple output performance measures related to several service areas were included as output variables. Some of these studies included output variables that reflected efficiency measures such as percentage of road surface and water services (Lim, 2007), effectiveness measures such as response time for medical services (Moore et al., 2005) and quality measures such as manufacturing value added to the cities (Kim, 1992). Table 7, below, shows all the output variables included in the study. All of these selected output variables represent performance measures that are related to the selected service areas. Some of these performance measures are indicators of efficiency, such as "total square feet of facilities operated and maintained per total city square miles" (facilities management) and "registered borrowers as a percentage of service-area population" (library). Other selected output variables are indicators of quality, such as "response time for nonemergency repairs" (facilities management) and "response time in minutes to top-priority calls" (police). Other output variables reflect indicators of effectiveness such as "fire-personnel injuries with time lost per 1,000 incidents" (fire) and "paved lane miles assessed in satisfactory or better condition as a percentage of total paved lane miles assessed" (highway and road). Table 7 lists the indicators for the selected output variables. In addition, detailed definitions of all variables are included in Appendix E.

Table 7. List of the Output Variables Included in the Study

Variables	Indicator
Code Enforcement	
Rates of voluntary compliance (as a percentage of all cases initialed in FY 07&08)	Effectiveness
Rates of induced compliance through administrative/judicial action as a percentage of cases initiated in FY 07&08	Effectiveness
Facilities Management	
Response time: nonemergency repairs	Quality
Total square feet of facilities operated and maintained/total city square miles	Efficiency
Fire Services	
Residential structure fires per 1,000 residents	Efficiency
Fire-personnel injuries with time lost per 1,000 incidents	Quality
Arson clearance rate	Effectiveness
Fleet Management	
Hours billed as a percentage of hours available	Efficiency
Total vehicles and equipment maintained	Efficiency
Highway and Road Maintenance	
Percentage of lane miles that are paved	Efficiency

Variables	Indicator
Paved lane miles assessed in satisfactory or better condition as a percentage of total paved lane miles assessed	Quality
Housing	
Number of low- to moderate-income households that received public financial assistance to purchase homes	Efficiency
Number of low- to moderate-income housing units constructed, converted, rehabilitated, or purchased with public financial and nonfinancial assistance per 1,000 residents	Efficiency
Information Technology	
Ratio of workstations to total jurisdiction employees	Efficiency
Applications problem resolution/repair: percentage corrected within 24 hours	Effectiveness
Library	
Registered borrowers as a percentage of service-area population	Efficiency
Material acquisition expenditures as percentage of total expenditures	Efficiency
Patron internet usage per terminal	Efficiency
Parks and Recreation	
Number of recreation/community centers per 1,000 residents	Efficiency
Number of athletic fields (multiuse and singles), including tennis courts, basketball courts, and swimming pools, per 1,000 residents	Efficiency
Police Services	
Response time in minutes to top-priority calls: total (from receipt of call to arrival, in minutes)	Quality
Juvenile arrests for part II drug abuse offenses as a percentage of total arrests for UCR part II drug offenses	Efficiency
Percentage of UCR part I crimes cleared	Effectiveness
DUI arrests per 1,000 residents	Effectiveness
Risk Management	
Percentage of claims that proceeded to litigation	Effectiveness
Number of workers-compensation claims per 100 jurisdiction FTEs	Quality
Refuse Collection	
Residential refuse collected per account per capita (in pounds)	Efficiency

V. Applications of DEA

a) Selection of the DEA model

This study applied both DEA models (BCC and CCR) to determine scale efficiency. Under the CCR model, the efficiency results for both input and output orientations were the same (Afonso & Fernandes, 2008). The decision regarding which orientation of the BCC model the analyst should employ depends on which variables (inputs or outputs) the DMUs have more control over, the objectives/functions of the DMUs, and the market (competitive versus monopolistic) they operate in. This decision also depends on the dynamics of the DEA process (Ozbek, 2007). Using input orientation can help determine if the municipal-service delivery can efficiently be achieved at the given level of outputs and at a smaller or minimal scale (i.e., with fewer expenditures, revenues, or funds). The input orientation for both the CCR and BCC models was selected assuming that DMUs/municipalities have more control over the selected inputs for this study (e.g., they can reduce expenditures to optimize efficiency, but they cannot control the number of registered borrowers of library books and other materials, the tons of waste collected, or the general liability claims they process). Balaguer-Coll et al. (2007) suggested that the application of input orientation is the most suitable approach to evaluating municipal efficiency. They also assumed that local governments have the ability to control their inputs while considering the outputs as exogenous variables. Barros and Athanassiou (2004) stated that "in competitive markets, the DMUs are output oriented" and "in monopolistic markets, the DMUs are input oriented." Worthington and Dollery (2000) used input orientation to evaluate the efficiency of the local government of New South Wales, Australia. Their selection was based on the assumption that local governments consider outputs to be exogenous and retain more control over the level of inputs (expenditures and staff). They also argued that because of the restrictions on revenue increases and the obligation to cap rates, input minimization is the proper local government objective. Ganley and Cubbin's (1992) selection of input orientation (input minimization) to evaluate the efficiency of local education authorities in the United Kingdom was based on the argument that local governments' objectives emphasize inputs more because inputs are more open to scrutiny than outputs.

Because of the technical limitations of DEA, the input orientation must be selected. As Pastor (1996, as cited by Ozbek, 2007) indicated, neither DEA formulation (CCR or BCC) accepts negative or zero values for both input and output variables. The data utilized in this study included zero values for some of the output variables (e.g., arson clearance rate, rate of induced compliance, and general liability claims per 10,000 residents served). These values needed transformation (e.g., adding 0.1 to all values provided by all DMUs). As indicated by Ozbek (2007), in cases where output variables need such transformation, the input orientation of the BCC model must be selected. Several studies have employed the input-orientation approach to evaluate local government efficiency. Balaguer-Coll and Tortosa (2007; local governments in Spain), Pestieau and Tulkens (1990; Belgian local authorities), Sanchez (2009; Spanish transport authorities), Ruggiero (1996; New York state school districts), and Stastna and Gregor (2010; Czech municipalities) applied the input-orientation approach to evaluate efficiency in their studies.

b) Incorporating uncontrollable variables

In DEA studies, many approaches exist for addressing uncontrollable variables. In the one-stage approach, uncontrollable variables are either included as controllable variables (under the assumption that because they are uncontrollable, their impact is meaningless for the decision-making process) or treated as uncontrollable variables in the DEA model (a more meaningful approach); in the latter case, their impact on efficiency scores is then observed. In the multistage approach, efficiency scores obtained from the basic DEA models are regressed against the uncontrollable variables, and the new (predicted) efficiency scores are calculated. The primary purpose of incorporating uncontrollable variables in the DEA (as in the one-stage approach) is to exclude their excesses and slacks from the objective function of the computed efficiency scores. Following application of the one-stage approach, the impact of each uncontrollable variable on efficiency measures was assessed by individually including them in this study.

VI. Data analysis

a) Determination of the impact of economies of scale

The efficiency scores from both the BCC and CCR models are obtained using DEA Solver Pro, the software for conducting DEA. To determine scale efficiency, the ratio of CCR to BCC must be calculated (Coelli, 1996). Municipalities with a scale efficiency equal to one are considered to be scale efficient and operating at constant returns to scale. Municipalities with scale-efficiency measures not equal to one are operating at either increasing or decreasing returns to scale. To investigate the nature of the scale inefficiency of these municipalities, efficiency scores obtained from a DEA model assuming non-increasing returns to scale (NIRS) must be computed. The NIRS DEA model is a linear program conducted by DEA Solver Pro that determines a frontier allowing only for non-increasing returns to scale (Coelli, 1996). Efficiency scores obtained from the NIRS model are compared to the efficiency scores obtained from the BCC model. Municipalities are operating at decreasing returns to scales when their NIRS efficiency scores are equal to the BCC efficiency scores and are operating at increasing returns to scale when their NIRS efficiency scores are not equal to the BCC efficiency scores. In this study, the total number of municipalities operating at constant, increasing, and decreasing returns to scale in each service area was calculated. The existence of economies of scale or diseconomies of scale in the selected service areas was determined by the number of cities operating at increasing returns to scale or decreasing returns to scale, respectively. For example, a high number of municipalities operating at increasing returns to scale in one of the service areas offered evidence of the existence of economies of scale in municipal-service delivery in that particular service area.

b) Determination of the impact of uncontrollable factors

The efficiency scores obtained from the BCC model were compared to the efficiency scores obtained from the modified BCC-uncontrollable model (incorporating uncontrollable variables). Similarly to the BCC model, the BCC-uncontrollable model was conducted under the assumption of variable returns to scale and the inclusion of uncontrollable variables (as uncontrollable inputs) into the calculation of the new efficiency scores. Across all the service areas, each uncontrollable variable was included and compared individually to the basic BCC model. For each service area, the mean of the efficiency scores obtained from both the BCC and

BCC-uncontrollable models was calculated. Also, for each service area, the number of efficient governments (efficiency score equal to 1) was compared for both models. To determine whether or not the two means were significantly different (i.e., to test for the proposed hypotheses), a repeated measure of analysis of variance (ANOVA) was conducted. A p-value of 0.05 or less indicated a significant difference between the mean of the two measures.

VII. Limitations

a) Limitations of data envelopment analysis

Data envelopment analysis is a powerful tool for assessing and comparing the performance of service providers; however, it has some limitations that require consideration before its use. First, DEA is a nonparametric extreme-point technique that lacks statistical indicators to capture noise such as measurement error. The ICMA data-cleaning process includes statistical outlier checks, automated logic checks, and comment review (review of any comments related to the data to ensure consistency and accuracy) (ICMA annual reports, 2008 & 2009). Second, the number of variables included in the DEA is limited by the number of DMU studies being investigated. A small number of DMUs could lead to biased efficiency scores. As Nyhan and Martin (1999) explained, including too many variables in the analysis with a limited number of DMUs results in an increase in the proportion of efficient (best-practice) providers and leads to a decline in the explanatory value of the analysis. To avoid this problem, researchers have recommended that a minimum of four cases (DMUs) per variable (input and output) be included in the analysis (Martin, 2002). To increase the number of DMUs, this study pooled data from two years (2007 and 2008). Treating the same DMU (local government) that provided data for

2007 and 2008 as two different units (DMU7 and DMU8) increased the sample size. For example, conducting the analysis for the police service area by including data from two fiscal years, 2007 and 2008, increased the sample size from 29 (FY 2007 only) to 62. This approach is similar to window analysis, a common application in DEA. The basic principle of the analysis is to treat each DMU as a different unit through each window when conducting DEA. The third limitation of DEA is that while it can estimate relative efficiency (relative comparisons), it cannot compare absolute efficiency (theoretical maximum comparison). Because the purpose of this study was to investigate the impact of uncontrollable factors and economies of scale on local governments' performance (relative efficiency), absolute-efficiency measures were not necessary. The fourth limitation is that input and output selection should be based on valid casual relationships.

b) Limitations of ICMA data

According to the ICMA report (2009), some jurisdictions did not provide data for all the performance indicators, either because they were not responsible for a particular service or because they did not collect the requested data. DEA does not permit missing data, and for that reason local governments with missing data (i.e., performance measures) were dropped from the study. As stated before, performance variables are selected based on their ability to indicate efficiency, quality, and effectiveness. Variables from either two or one of these classified performance indicators were selected to be included in each analysis.

VIII. Summary

This chapter contained seven sections. The first section discussed the hypotheses for this study. The hypotheses of this research, which were based on the outcomes of previous studies discussed in the literature review section, suggested the presence of a negative relationship between efficiency and uncontrollable variables and theorized that no economies of scale exist in city governments. The second, third, and fourth sections dealt with the selection of the unit of analysis, service areas, and variables (input, output, and uncontrollable) included in the study. Based on the reviewed literature and the data provided by the ICMA, variables were selected and identified. The last three sections of this chapter discussed the application of the DEA models, the approach to conducting the analysis in order to answer the proposed questions and test the hypotheses, and, finally, the possible limitations of the method and the data utilized in the study.

CHAPTER FIVE: DATA ANALYSIS, RESULTS, AND FINDINGS

I. Data preparation

The data included in this research were gathered from the ICMA's annual reports for fiscal years 2007 and 2008, with the exception of the refuse-collection service area, for which data were collected only from the 2008 ICMA annual report. The refuse-collection performance measures detailed in the ICMA annual reports for these two fiscal years were scaled differently. For this reason, only data from the most recent year (2008) were included.

Because DEA cannot be conducted if any values are missing, DMUs or local governments with missing variables were dropped from the analysis. Also, to avoid any decline in the explanatory value of the DEA, a minimum of four DMUs per variable (input and output) were confirmed in each analysis (the reason for this was explained in chapter 4 under the Limitations section).

Once the data were collected and examined for any entry errors, transformation, for some variables, was conducted before the analysis. For example, because DEA models accept only positive values, a variable with a 0 value was transformed to a positive number by adding 0.1 to all the values included in that particular variable.

Also, the DEA model assumes that an increase in any input variable will not lead to a decrease in any output variable. This relationship between input variables and output variables in the DEA model is referred to as the *isotonic principal* (Ozbek, 2007). As Ozbek (2007) explained, in DEA models an increase in the input variables must be joined with an increase in the output variables. For example, an increase in the total operating and maintenance expenditures charged to the police department per capita (the input variable) is assumed to lead to an increase in the percentage of UCR part I crimes cleared. In this case the isotonic relation assumed by the DEA model is satisfied. To meet this requirement, other variables in the ICMA data had to be transformed before conducting the analysis. An example of these variables is the response time in minutes to top-priority calls (police-service area). In this case, an increase in the response time to top-priority calls was not a favorable indicator of performance. To resolve this issue and at the same time meet the requirement of DEA models, the value of this variable was inverted or reversed (i.e., the reciprocal of the value was calculated).

As stated before, the ICMA data-cleaning process includes statistical outlier checks, automated logic checks, and reviewing of any comments related to the data to ensure consistency and accuracy (ICMA annual reports 2008 & 2009). No further data cleaning was conducted before the analysis.

II. Descriptive analysis of input, output, and uncontrollable variables

This section includes the basic information about the input, output, and uncontrollable data included in this study. As shown in Tables 8, 9, and 10, the basic descriptive analysis included the number of city governments (N), the mean, the minimum, the maximum, and the standard deviation of the data variables. The number of city governments included varied among the service areas. Local governments included in the analysis of each service area were not necessarily the same. Table 8 below shows the mean of the input variable, which consisted of funding for housing services, revenues from parks and recreation, and expenditures for the rest of the indicated service areas. As provided by the ICMA annual report, the input variable, expenditures, was expressed as a per capita unit in some service areas (code enforcement, fire,

Table 8. Descriptive Analysis of the Input Variable of All Service Areas

Input Variables	N	Minimum	Maximum	Mean	Std. Deviation
Code enforcement					
Expenditures per capita	65	1.57	37.95	9.7205	7.41
Fire services					
Total fire personnel and operating expenditures per capita	35	72.66	288.59	140.50	49.50
Fleet management					
Average fleet maintenance expenditures per vehicle: all vehicles and heavy equipment	51	165.00	8830.00	3978.96	1646.18
Facilities management					
Total operating and maintenance expenditures for all maintained facilities	42	138937.00	33617227.00	3745570.71	7137968.79
Highway and road					
Road rehabilitation expenditures per capita (total lane miles)	94	2.96	91.27	31.6	19.16
Housing					
Total funding for new and rehabilitated low- to moderate-income housing units and home ownership per capita	39	0.10	615.69	70.44	111.26
Information technology					
Central IT operating and maintenance expenditures	48	54884.00	21811163.00	4215183.38	5729879.456
Library					
Operating and maintenance expenditures per registered borrower	80	8.60	3756.00	93.98	415.17
Parks and recreation					
Net parks and recreation revenue per capita, excluding golf expenditures and revenues	95	5.02	114.01	46.75	22.93
Police services					
Total operating and maintenance expenditures charged to the police department	62	90.08	169820.00	2951.07	21539.87

Input Variables	N	Minimum	Maximum	Mean	Std. Deviation
per capita.					
Refuse collection					
Operating and maintenance expenditures for refuse collection per refuse collection account	30	22.50	193.50	80.26	46.36
Risk management					
Expenditures for workers' compensation per jurisdiction FTE	32	9.71	3241.27	986.42	667.95

and highway and road), while it was expressed per vehicle for fleet management and per registered borrower for library services. In only two service areas, facilities management and information technology, were expenditures not expressed by any metrics. This difference explains why the means of the expenditures of both the facilities-management and information-technology service areas were much higher. Many of the studies that utilized DEA to estimate the relative efficiencies of local governments used expenditures as an input variable (Appendix D). Some of these studies implemented the input variable, expenditure, using the per capita metric, while others did not use any. For this reason, the analysis in this study was conducted without changing or standardizing the input variable (by removing the metrics). Also, because information about the number of vehicles (fleet management) was not provided, it was impossible to standardize the input variable for this service area.

Table 9 shows large variations among city governments in some of the performance measures and small variations in others under the same service area. For example, under the fire-service area, the standard deviation of the performance measure “arson clearance rate” (26.83) is

Table 9. Descriptive Analysis of the Output Variables of All Service Areas

Output Variables	N	Minimum	Maximum	Mean	Std. Deviation
Code enforcement					
Rates of induced compliance through administrative/judicial action as a percentage of cases initiated in FY 2008	65	0.10	20.20	5.04	5.34
Rates of voluntary compliance (as a percentage of all cases initiated in FY 2008)		0.20	102.90	61.57	32.29
Fire services					
Arson clearance rate	35	0.10	100.10	26.41	26.83
Fire-personnel injuries with time lost per 1,000 incidents		0.26	1.00	0.69	0.21
Residential-structure fires per 1,000 residents served		0.25	1.85	0.83	0.39
Fleet Management					
Hours billed as a percentage of hours available	51	0.10	756.00	1068.12	1769.91
Total vehicles and equipment maintained		18.16	90.70	64.57	16.17
Facilities Management					
Total square feet of facilities operated and maintained/total city square mile	42	12.44	183095.56	24356.36	31528.68
Response time: nonemergency repairs		0.10	12.00	2.76	2.57
Highway and Road					
Percentage of lane miles that are paved	94	94.90	100.00	99.52	0.91
Paved lane miles assessed in satisfactory or better condition as a percentage of total paved lane miles		24.20	100.00	79.94	17.36
Housing					
Number of low- to moderate-income households that received public financial assistance to purchase homes/1,000 residents	39	0.01	2.06	0.23	0.37
Number of low- to moderate-income housing units constructed, converted, rehabilitated, or purchased with public financial and nonfinancial assistance /1,000 residents		0.01	6.41	1.444	1.54

Output Variables	N	Minimum	Maximum	Mean	Std. Deviation
Information Technology					
Ratio of workstations to total jurisdiction employees	48	0.31	1.38	0.80	0.20
Applications problem resolution/repair: percentage corrected within 24 hours		0.86	100.00	65.86	23.70
Library					
Registered borrowers as a percentage of service-area population	80	22.20	144.30	67.08	24.46
Material acquisition expenditures as a percentage of total expenditures		5.38	43.53	13.88	4.82
Patron internet usage per terminal		553.30	7734.00	2312.6	976.09
Parks and Recreation					
Athletic fields (multiuse and singles), including tennis courts, basketball courts, swimming pools/1,000 residents	95	0.6	2.70	1.07	0.58
Recreation and community centers per 1,000 residents		0.10	0.37	0.051	0.07
Percentage of park acreage that is developed		7.80	100.00	62.41	27
Police Services					
Percentage of UCR part I crimes cleared	62	5.98	100.00	55.64	21.21
Juvenile arrests for part II drug abuse offenses as a percentage of total arrests for UCR part II drug offenses.		0.02	0.37	0.09	0.06
DUI arrests per 1,000 residents.		0.06	1.03	0.26	0.20
Response time in minutes to top priority calls: total (from receipt of call to arrival in minutes).		0.07	0.58	0.18	0.10
Refuse Collection					
Residential refuse collected per account per capita (in pounds)	30	0.10	0.15	0.04	0.04
Risk Management					
Percentage of claims that proceeded to litigation	32	0.10	75.10	6.02	14.74
Number of workers-compensation claims per 100 jurisdiction FTEs		1.24	22.97	10.29	4.96

much higher than that of the performance measure “fire-personnel injuries with time lost per 1,000 incidents” (0.21). This observation manifested in most of the selected service areas. In general, the data in Table 9 indicate some degree of variation in performance among the selected city governments. This variation in performance might be related to the impact of uncontrollable variables and the scale of operation.

Table 10 shows a descriptive analysis of the uncontrollable variables included in the study. Compared to the number of DMUs in Tables 8 and 9, the number of city governments (DMUs) for each analysis (service area) has changed. For instance, the initial number of the city governments included to implement the DEA models (BCC and CCR) to estimate the scale efficiencies of the parks-and-recreation service area dropped from 95 to 88 (population density), 82 (household income), and 80 (unemployment). Because of the limited availability of data, some of the DMUs or local governments were dropped from the analysis to estimate the impact of uncontrollable variables. The results shown in Table 10 indicate that some degree of variation exists in population density, median household income, and the unemployment rate under each service area among the selected cities. Including cities with various degrees of uncontrollable variables enabled the researcher to understand these variables’ impact on efficiency.

Table 10. Descriptive Analysis of Uncontrollable Variables of All Service Areas

Service Area	N	Minimum	Maximum	Mean	Std. Deviation
			Population Density		
Code Enforcement	60	3.30	9280.00	2289.20	1575.46
Fire Services	31	636.10	4193.00	2262.37	974.74
Fleet Management	50	3.30	37310.00	3635.92	5467.55
Facilities Management	41	3.30	33631.00	3869.84	5213.80

Service Area	N	Minimum	Maximum	Mean	Std. Deviation
Highway and Road	87	316.60	33661.00	3281.35	3940.49
Housing	38	316.60	28449.00	3590.82	4645.53
Information Technology	47	894.00	26819.00	3437.02	4966.34
Library	71	3.30	37093.00	3383.19	5169.23
Parks and Recreation	88	3.30	53868.00	3920.24	7267.67
Police Services	62	404.00	37093.00	3082.35	4560.43
Refuse Collection	30	404.00	9473.90	2251.63	1689.51
Risk Management	32	744.00	11672.00	3069.09	2454.24
Median Household Income					
Code Enforcement	54	29047.00	123099.00	56261.31	18165.19
Fire Services	30	37375.00	87942.00	53289.13	12852.66
Fleet Management	45	29883.00	92778.00	53377.42	12794.87
Facilities Management	38	35736.00	83618.00	52843.89	12400.65
Highway and Road	81	8652.80	128516.00	55130.40	19208.90
Housing	37	25142.00	92492.00	50902.16	15565.97
Information Technology	44	28630.00	92492.00	55418.75	18046.24
Library	68	20847.00	82269.00	50161.62	13045.19
Parks and Recreation	82	25142.00	944513.00	67247.52	100009.74
Police Services	59	28630.00	128516.00	56626.47	19620.43
Refuse Collection	28	35241.00	944513.00	88223.71	168571.76
Risk Management	31	29047.00	944513.00	84708.39	160849.64
Unemployment Rate					
Code Enforcement	51	1.00	10.50	4.80	1.90
Fire Services	30	1.00	16.00	5.21	2.97
Fleet Management	46	1.00	13.90	4.67	2.16
Facilities Management	34	0.10	13.30	5.54	2.64
Highway and Road	77	0.10	13.30	4.94	1.97
Housing	36	3.00	13.20	5.27	2.17
Information Technology	45	1.00	13.00	4.99	2.14
Library	65	0.10	10.10	4.80	1.85
Parks and Recreation	80	0.10	10.60	4.48	1.79
Police Services	53	1.00	13.00	4.50	1.91
Refuse Collection	27	2.40	13.20	4.92	2.26
Risk Management	25	2.00	14.00	4.76	2.44

III. DEA estimates of relative efficiency

Both DEA models—the constant returns to scale (CCR) model and the variable returns to scale (BCC) model—were implemented to estimate the relative efficiency of the city governments included in this study. The CCR model assumes that organizations (governments) are operating at constant returns to scale, and the BCC model presumes that organizations (governments) are functioning at variable returns to scale. In this study, the scale at which a city government was operating was explained by its level of spending to provide the services reflected in the performance measures (outputs). For example, the scale of operating and maintaining police services was explained by the total operating and maintenance expenditures charged to the police department per capita. Total funding for new and rehabilitated housing units and home ownership per capita was another example of the scale at which city governments operated to provide housing services (e.g., providing financial and nonfinancial assistance for purchasing, constructing, converting, or rehabilitating houses). All the input variables included in the study were indicators of the scale at which city governments were operating to provide the services related to the indicated performance measures (outputs). Several studies (see Table 1) included measures of spending (e.g., expenditures or costs) as an indicator of the scale at which local governments operated.

Table 11 illustrates the number of efficient DMUs (city governments) and the mean efficiency scores for each model (BCC and CCR). To determine whether the mean efficiency scores under both models varied significantly, a repeated measures analysis of variance (ANOVA) was conducted. Table 11 illustrates the F and P values obtained from the analysis of variance. The results show that the mean efficiency scores increased significantly under the variable returns to scale (BCC) model of all service areas ($p < 0.05$). The number of efficient DMUs (efficiency score equal to 1) under the BCC model increased significantly (more than doubled) in most of the service areas. This significant increase in the mean efficiency score (under the BCC model) indicates that the scale at which local governments operate does affect relative efficiency.

Table 11. DEA Estimates of Relative Efficiency

		CCR Model	**BCC Model**	**ANOVA**
Service Area	N	Number of Efficient DMUs Mean (Technical Efficiency Scores)		**P** **F**
Risk Management	32	2 0.09	5 0.29	0.002 11.87
Fleet Management	51	3 0.30	8 0.55	0.000 113.3
Facilities Management	42	3 0.25	5 0.35	0.000 16.80
Information Technology	48	1 0.17	9 0.35	0.000 17.24
Fire Services	35	6 0.59	9 0.70	0.000 40.46
Police Services	62	5 0.64	17 0.74	0.000 27.71
Refuse Collection	30	1 0.28	4 0.52	0.000 40.09
Parks and Recreation	95	4 0.31	9 0.37	0.000 18.55
Library	80	1 0.23	4 0.27	0.000 23.81
Housing	39	2 0.23	7 0.30	0.030 5.08
Highway and Road	94	1 0.16	4 0.22	0.000 93.05
Code Enforcement	65	3 0.34	12 0.43	0.000 22.89

IV. Determination of returns to scale

The scale-efficiency scores were calculated based on the efficiency scores of both models. The scale-efficiency scores were obtained from the ratio of the efficiency scores of the CCR model to the efficiency scores of the BCC model (CCR/BCC). Table 12 shows the percentage of local governments that are experiencing increased returns to scale (IRS), decreased returns to scale (DRS), or constant returns to scale (CRS) as computed by the DEA Solver Pro software. Table 12 also lists the mean scores of scale efficiency. The mean of the scale-efficiency scores was calculated for local governments found to be operating at increasing returns to scale, decreasing returns to scale, and constant returns to scale. As illustrated in Table 12, in seven service areas the percentage of city governments operating at decreasing returns to scale was higher than the percentage of those operating at increasing returns to scale. These seven service areas are risk management (50.0%:12.50%), fleet management (92.60%:0.00%), information technology (70.84%:2.08%), police (74.0%:18.0%), parks and recreation (48.42%:47.37%), housing (38.50%:20.50%), and highway and road (98.94%:0.00%). In only one of these service areas (parks and recreation) was the mean of the scale-efficiency scores of local governments operating at decreasing returns to scale higher than the mean of the scale-efficiency scores of local governments operating at increasing returns to scale (because none of the local governments was found to be operating at increasing returns to scale in the fleet-management and highway-and-roads service areas, this ratio was not determined). In the other five service areas, the results show a higher percentage of local governments operating at increasing returns to scale than decreasing returns to scale. These service areas are facilities management (57.14%:23.81%), fire services (71.40%:11.40%), refuse collection (86.66%:6.67%), library

Table 12. Estimate of Scale Efficiency and Determination of Returns to Scale

Service Area	N	IRS	DRS	CRS
		Returns to scale (%) Mean (Scale-efficiency Scores)		
Risk Management	32	12.50 0.54	50 0.17	37.5 1.00
Fleet Management	51	0.00 NA	92.60 0.47	7.40 1.00
Facilities Management	42	57.14 0.71	23.81 0.52	19.05 1.00
Information Technology	48	2.08 0.73	70.84 0.45	27.08 1.00
Fire Services	35	71.40 0.77	11.40 0.89	17.20 1.00
Police Services	62	18.00 0.90	74.00 0.86	8.00 1.00
Refuse Collection	30	86.66 0.52	6.67 0.49	6.67 1.00
Parks and Recreation	95	47.37 0.84	48.42 0.87	4.21 1.00
Library	80	46.25 0.91	26.25 0.77	27.50 1.00
Housing	39	20.50 0.87	38.50 0.72	41.00 1.00
Highway and Road	94	0.00 NA	98.94 0.74	1.06 1.00
Code Enforcement	65	43.08 0.66	30.77 0.82	26.15 1.00

IRS: Increasing Returns to Scale (experiencing economies of scale)
DRS: Decreasing Returns to Scale (experiencing diseconomies of scale)
CRS: Constant Returns to Scale (scale efficient)
Scale Efficiency = CCR/BCC

(46.25%:26.25%), and code enforcement (43.08%:30.77%). In three of these service areas (facilities management, refuse collection, and library), the mean of the scale-efficiency scores of local governments operating at increasing returns to scale was higher than the mean of the scale-efficiency scores of local governments operating at decreasing returns to scale.

V. Determination of the impact of uncontrollable variables using DEA

This section explains the results of DEA to determine the impact of population density, household income, and unemployment rate on the relative efficiency of city governments. As illustrated in Tables, 13, 14, and 15, the results of the efficiency scores obtained from the BCC model were compared to the efficiency scores obtained from the modified DEA model that incorporated the impact of these uncontrollable variables (BCC-uncontrollable). By incorporating the impact of uncontrollable inputs, the modified DEA model (BCC-uncontrollable) calculated the new efficiency scores by taking the impact of uncontrollable variables into consideration (removing the amount of inefficiency caused by the uncontrollable variable). The higher efficiency scores obtained from the BCC-uncontrollable model (compared to the BCC model) indicated that the uncontrollable variables exerted a suppressing impact. Analysis of variance (ANOVA) was used here to compare the variability in mean efficiency scores (BCC versus BCC-uncontrollable models). The dependent variable was the efficiency score, and the independent variable was the type of model (BCC vs. BCC-uncontrollable). The results of ANOVA reveal whether a significant difference exists between the mean efficiency scores of the two models. A significant level (p value) of less than or equal to 0.05 indicates a significant difference between the mean efficiency scores obtained from the two models. In addition, a large F value designates greater variability between the efficiency scores of the two models. In addition to the number of efficient DMUs and the mean of the efficiency scores, both the p value and the F value were obtained to determine the significance of the impact of these uncontrollable variables.

a) Determination of the impact of population density on efficiency

The results in Table 13 show the mean of the efficiency scores and the number of efficient (efficiency score equal to one) city governments under both DEA models. These results indicate that both efficiency scores and the number of efficient DMUs increased once population density was controlled for in the BCC-uncontrollable model. The increase in the number of efficient city governments was significant (the number more than doubled) in some of the selected service

Table 13. Determination of the Impact of Population Density on Efficiency

Service Area	N	BCC	BCC-Uncontrollable	ANOVA
		Number of Efficient DMUs Mean (Efficiency Scores)		P F
Risk Management	32	5.00 0.29	10.00 0.55	0.000 23.85
Fleet Management	50	8.00 0.55	11.00 0.65	0.000 21.94
Facilities Management	41	5.00 0.36	9.00 0.46	0.003 10.09
Information Technology	47	9.00 0.35	13.00 0.44	0.002 10.42
Fire Services	31	8.00 0.71	17.00 0.88	0.000 22.90
Police Services	62	18.00 0.74	22.00 0.79	0.001 12.53
Refuse Collection	30	4.00 0.52	9.00 0.65	0.000 15.61
Parks and Recreation	88	8.00 0.37	15.00 0.46	0.000 21.50
Library	71	4.00 0.28	10.00 0.42	0.000 32.41
Housing	38	7.00 0.30	8.00 0.35	0.050 4.20
Highway and Road	87	3.00 0.21	13.00 0.40	0.000 45.17
Code Enforcement	60	12.00 0.45	16.00 0.56	0.000 21.22

areas. Examples of these service areas are highway and road (3.0:13.0), risk management (5.0:10.0), fire services (8.0:17.0), refuse collection (4.0:9.0), and library (4.0:10.0). The results of the analysis of variance (ANOVA) indicated that the impact of population density was significant in all service areas. Table 13 lists the p values equal to or less than 0.05 for all service areas.

b) Determination of the impact of household income on efficiency

Table 14 depicts the results of DEA to determine the impact of household income on the relative efficiency of city governments in the selected service areas. After incorporating household income in the analysis, both the mean of the efficiency scores and the number of efficient city governments increased. The number of efficient city governments significantly increased in service areas such as facilities management (4.0:13.0), information technology (8.0:18.0), parks and recreation (7.0:16.0), library (4.0:9.0), highway and road (3.0:13.0), and code enforcement (12.0:24.0). As indicated by the results of the analysis of variance (ANOVA), the mean efficiency scores significantly increased in all of the designated service areas ($p < 0.05$).

c) Determination of the impact of unemployment on efficiency

The results of DEA in determining the impact of unemployment on the efficiency of city governments are shown in Table 15. The results show an increase in the mean of the efficiency scores and the number of efficient city governments after the inclusion of the unemployment rate

Table 14. Determination of the Impact of Household Income on Efficiency

Service Area	N	BCC	BCC-Uncontrollable	ANOVA
		Number of Efficient DMUs **Mean (Efficiency Scores)**		**P** **F**
Risk Management	31	5.00 0.29	9.00 0.46	0.002 11.50
Fleet Management	45	8.00 0.55	13.00 0.68	0.000 40.12
Facilities Management	38	4.00 0.34	13.00 0.63	0.000 36.17
Information Technology	44	8.00 0.33	18.00 0.54	0.000 22.28
Fire Services	30	8.00 0.72	12.00 0.79	0.005 9.11
Police Services	59	16.00 0.74	22..00 0.80	0.000 25.51
Refuse Collection	30	4.00 0.52	6.00 0.57	0.000 15.80
Parks and Recreation	82	7.00 0.37	16.00 0.53	0.000 54.48
Library	68	4.0 0. 28	9.00 0.43	0.000 40.07
Housing	37	7.00 0.31	11.00 0.49	0.000 16.49
Highway and Road	81	3.00 0.21	13.00 0.34	0.000 24.95
Code Enforcement	60	12.00 0.46	24.00 0.65	0.000 22.53

in the analysis. Out of the 12 service areas, 7 showed a significant increase in the number of efficient city governments. These service areas are risk management (4.0:8.0), facilities management (5.0:11.0), information technology (8.0:17.0), refuse collection (4.0:10.0), parks and recreation (7.0:21.0), library (3.0:11.0), and highway and road (2.0:6.0). At a confidence level of 95.0%, the results showed that the impact of unemployment on the relative efficiency of all the selected local governments was significant (p <0.05).

Table 15. Determination of the Impact of Unemployment on Efficiency

Service Area	N	BCC	BCC-Uncontrollable	ANOVA
		Number of Efficient DMUs **Mean (Efficiency scores)**		**P** **F**
Risk Management	25	4.00 0.31	8.00 0.54	0.001 13.34
Fleet Management	46	7.00 0.54	12.00 0.75	0.000 66.57
Facilities Management	34	5.00 0.40	11.00 0.57	0.000 20.27
Information Technology	45	8.00 0.35	17.00 0.49	0.001 11.50
Fire Services	20	8.00 0.72	11.00 0.79	0.011 7.44
Police Services	53	15.00 0.77	24.00 0.82	0.001 13.3
Refuse Collection	30	4.00 0.52	10.00 0.69	0.000 22.10
Parks and Recreation	80	7.00 0.38	21.00 0.55	0.000 46.40
Library	65	3.00 0.28	11.00 0.53	0.000 98.10
Housing	36	6.00 0.28	10.00 0.36	0.001 13.37
Highway and Road	77	2.00 0.20	6.00 0.29	0.000 15.79
Code Enforcement	51	11.00 0.47	19.00 0.62	0.000 17.90

VI. Research findings

a) Determination of the existence of economies of scale in local governments

The results discussed in the previous section indicate that the scale at which city governments operate (measured by the level of spending) affects relative efficiency. The significant increase in the mean efficiency scores under the BCC (variable returns to scale) model compared to the mean efficiency scores under the CCR (constant returns to scale) model explains this finding. The results also show that returns to scale in local governments depend on the types of services they provide. The same is true in regard to the existence of economies of scale. Local governments operating at increasing returns to scale are experiencing economies of scale, and local governments performing at decreasing returns to scale are experiencing diseconomies of scale. In five service areas (facilities management, fire services, refuse collection, library, and code enforcement), economies of scale were more evident than diseconomies of scale; a higher percentage of city governments was found to be experiencing economies of scale in these service areas. In two service areas, fleet management and highway and roads, no evidence of economies of scale (increasing returns to scale) was found. In the other five service areas (risk management, information technology, police, parks and recreation, and housing), diseconomies of scale manifested; a higher percentage of city governments experienced diseconomies of scale. The measure of scale-efficiency scores (obtained from the ratio CCR/BCC) suggests that, in general, local governments experiencing diseconomies of scale are more likely to be less scale-efficient than those experiencing economies of scale. As shown in Table 12, this finding was evident in seven service areas (risk management, facilities management, information technology, police, refuse collection, library, and housing).

b) Impact of uncontrollable variables

As explained by Ozbek et al. (2010), incorporating uncontrollable variables in the DEA model removes "the amount of inefficiency" attributable to them. The difference in efficiency scores (BCC-uncontrollable – BCC) accounts for the amount of inefficiency caused by the uncontrollable variables (Ozbek et al., 2010). Comparing the two models, the presence of higher efficiency scores under the BCC-uncontrollable model (the modified BCC model incorporating uncontrollable variables) indicates that the uncontrollable variable exerts an overall suppressing impact on the efficiency scores.

1) Impact of population density on efficiency

Consistent with the findings of other research reviewed previously, the results of this research confirm that population density negatively impacts the relative efficiency of local governments. The findings indicate that population density significantly impacts the efficiency of local governments in the twelve service areas selected for this research. The impact of population density on city governments' efficiency was manifested in the lowered mean efficiency scores under the BCC model. Once population density was included in the DEA BCC-uncontrollable model, a significant increase in the mean efficiency scores emerged. This increase in efficiency scores shows that population density wields an overall suppressing impact on the efficiency scores. Results pertain to the number of efficient city governments (relative efficiency score equal to 1) reveal that the type of services provided by city governments is related to the impact of population density on relative efficiency. This finding was demonstrated by a doubling of the number of efficient city governments in particular service areas (highway and road, risk management, fire, refuse collection, and library) and not in others.

2) Impact of household income on efficiency

The impact of household income on local governments' efficiency was also examined. The findings show that household income significantly impacts the relative efficiency of city governments across all twelve service areas. This negative impact was found to be related to the lowered mean efficiency scores under the BCC model. Particular service areas, such as facilities management, information technology, parks and recreation, library, highway and road, and code enforcement, demonstrated significant increases in the number of efficient city governments once the impact of household income was included. Similarly to the findings of the impact of population, this finding shows that the impact of household income on the relative efficiency of city governments is related to the type of services provided.

3) Impact of unemployment on efficiency

The impact of unemployment on the efficiency of local governments is evidenced in the literature; the majority of the studies addressing this area found that unemployment negatively influences efficiency. The findings of this study support these previous studies. The unemployment rate demonstrated a negative impact on relative efficiency (demonstrated in the lowered mean efficiency scores under the BCC model). Once unemployment rate was included in the analysis (BCC-uncontrollable), a significant increase in the mean efficiency scores in all twelve service areas emerged. The impact of unemployment on the number of efficient city governments manifested clearly in service areas such as risk management, facilities management, information technology, refuse collection, parks and recreation, library, and highway and road.

VII. Summary

Once the variables included in the study were identified, data were collected from ICMA annual fiscal reports for 2007 and 2008 (the data pertaining to the refuse-collection service area were obtained from the 2008 annual report only). Before starting the analysis, the data were prepared and descriptive analysis was conducted to ensure that the data were ready. The results discussed in this chapter indicate that the scale at which city governments operate, indicated by the level of spending (e.g., expenditures, revenues, or funding), affects relative efficiency. Although the results confirm that the scale at which local governments operate affect their efficiency, the findings show no consistent pattern of returns to scale across the examined service areas. In fact, the results present a mixed picture. In five service areas (facilities management, fire services, refuse collection, library, and code enforcement), a higher percentage of local governments was found to be functioning at increasing returns to scale (experiencing economies of scale). In two service areas, fleet management and highway and roads, the results show no evidence of increasing returns to scale (i.e., economies of scale) among local governments. And in five service areas (risk management, information technology, police, parks and recreation, and housing), a higher percentage of local governments was found to be operating at decreasing returns to scale (i.e., experiencing diseconomies of scale). The findings also show that, in seven service areas (risk management, facilities management, information technology, police, refuse collection, library, and housing), local governments operating at increasing returns to scale are also more scale-efficient than local governments operating at decreasing retunes to scale. In only three service areas (fire services, parks and recreation, and code enforcement) was the opposite found to be the case. A consistent pattern was found in the findings pertaining to the impact of population density, household income, and unemployment on the relative efficiency of city governments. The results indicate that population density, unemployment, and household income significantly impacted the relative efficiency of local governments in the twelve service areas indicated in this research. This negative impact contributed to the lowered efficiency scores demonstrated in the findings of this research.

CHAPTER SIX: CONCLUDING REMARKS

I. Contribution to the body of knowledge

Investigating the impact of economies of scale and uncontrollable factors on the performance of local governments, particularly cities in the United States, has not been a focus of performance measurement research. A review of the literature suggests that only three studies—Moore and Segal (2005), Nyhan and Martin (1999b), and Gorman and Ruggiero (2008)—have investigated efficiency among city governments in the United States. Only Moore and Segal (2005) included several service areas in their study. Both Nyhan and Martin's (1999b) and Gorman and Ruggiero's (2008) studies examined the police service area only. To evaluate the relative efficiency of 46 U.S. cities, Moore and Segal (2005) utilized DEA and included data (input and output variables) from 11 service areas. They examined the impact of uncontrollable variables such as population change, city size (square miles), average temperature and precipitation, and others on efficiency. Their study showed the impact of these factors on the efficiency of the 46 cities in general. The study did not explain whether or not that impact was different among the 11 service areas they examined. Scale efficiency was investigated in only five of the 11 service areas (parks, police, street, transit, and library). Similarly to the work of Moore and Segal (2005), this study contributed to the literature of performance measurement of local governments by investigating the impact of uncontrollable factors and economies of scale on the performance of city governments in the United States. However, this research also addressed major shortcomings in the literature by examining the impact of uncontrollable factors and economies of scale in 12 individual service areas in city governments (because the impact of uncontrollable variables and economies of scale could vary among service areas). This research also included service areas never before examined. These service areas were code enforcement, facilities management, fleet management, information technology, and risk management.

Several studies have utilized DEA to evaluate performance and efficiency in local governments. DEA is a powerful tool that can employ multiple indicators of performance and, at the same time, control for several uncontrollable factors. This research contributed to the body of knowledge regarding DEA applications in performance measurement. In addition to performance evaluation including indicators of efficiency, effectiveness, and quality, this research implemented many DEA applications to examine the impact of economies of scale and uncontrollable factors on the performance of city governments.

II. Policy implications: The impact of uncontrollable variables on performance

Despite the increased interest in performance measurement among local governments (Chan, 2004; Melkers & Willoughby, 2005; Ammons & Rivenbark, 2008), several factors still affect its adoption and implementation. One of the most common obstacles to adopting performance measurement in local governments is the concern that performance information might reveal negative results (Dusenbury, Liner, & Vinson, 2000; Government of Alberta, 2001; Hatry, 2006). Ammons and Rivenbark (2008) identified factors that impact the use of performance measurements among municipalities. Anxiety regarding the impact of variables such as population, economies of scale, and others that influence benchmarking results is one of these factors. Reluctance to use performance measures for the purpose of benchmarking is caused by a lack of confidence in controlling for such factors (Ammons & Rivenbark, 2008). According to the authors, these benchmarking comparisons with other municipalities can be used as a “management report card” and hence an assessment tool to gauge local government officials’ good or poor performance. The type of measures collected is another factor impacting their use in local governments (Ammons & Rivenbark, 2008). Ammons and Rivenbark (2008) argued that performance-measurement systems that rely on using “high order measures” (e.g., efficiency, effectiveness, and quality) are designed to satisfy a broad view of accountability to the media, citizens, and elected officials. This view of accountability “extends beyond the raw workload counts into dimensions of service efficiency, quality, and effectiveness” (314). The authors concluded that collecting and relying on such measures play major roles in the possibility of utilizing performance measurement to improve operations.

The Poister and Strieb (1999) study indicated that the principal motivation of city governments to use performance measurement is making better management decisions. These important decisions are related to strategic management and planning, budgeting, programs evaluation, and other management process. Another study by Rivenbark and Kelly (2006) showed that one of the several uses of performance measures among municipalities is budgetary decision making. Their review of many national surveys indicated that municipalities use performance measures or information in budget deliberations, particularly for new or expanded budget requests. Linking performance data to the decision-making process requires high credibility and accuracy in its utilization. Inaccurate use of performance measures could lead to wrong decisions about efficiency determination or performance evaluation. The results of the present study confirm this finding. Efficiency among the selected local governments (in 12 service areas) is underestimated when the uncontrollable variables of population density, household income, and unemployment rate are not taken into consideration. Efficiency scores were significantly increased once these factors were incorporated in the efficiency analysis. With an accurate utilization of performance measures, managers and supervisors in local governments can distinguish between deficiencies resulted by their operation and deficiencies caused by factors beyond their control and, hence, make better management decisions. Decision made about reducing the budget of police, fire or other services for poor performance (or low efficiency scores) without considering the negative impact of population density are based on wrong assumptions.

This research provides local government officials with new systematic and practical approaches to utilizing the performance measures they collect. Using data envelopment analysis will enable local governments to assess their performance/efficiency by utilizing the multiple and different types of measures (e.g., high-order measures such as efficiency, effectiveness, and quality) they collect and rely on. In addition to performance/efficiency evaluation, this research offers a new approach to controlling factors that influence performance evaluation. It is true that officials in municipalities cannot directly control the (uncontrollable) factors that interfere with their performance. However, controlling for their impact gives officials a far more accurate estimation of their municipalities' performance and hence can eliminate fear or anxiety about benchmarking or comparison with other local governments. Introducing such methods will encourage more local governments to invest in performance-measure collection and utilization.

Accurate performance evaluation can aid budgetary decision making; accountability to the media, citizens, and elected officials; benchmarking; and performance improvement.

III. Policy implications: The impact of economies of scale on performance

As indicated by Wendell Cox of Demographia (2008), one of the factors behind local governments' consolidation is the commonly held view among local government leaders that a bigger local government is better. The author referred to this view as the "bigger-is-better theory of government efficiency" (2). Proponents of bigger local governments argue that larger jurisdictions can achieve economies of scale and lower their costs and thereby improve their efficiency. Cox (2008) concluded that there is no evidence to support this view. In fact, Cox asserted that consolidated jurisdictions increased their spending as a result of stretching their services beyond the needs of users. The study also found that consolidation of local governments led to higher costs, citizens' detachment from their jurisdictions, and the ability of special interest groups such as labor unions and political contributors to exert more influence. Benton and Gamble (1984) examined the impact of the consolidation of Florida's Jacksonville and Duval counties on property-tax revenues, total expenditures, and public-safety expenditures. The results of their study showed that both taxes and expenditures increased after consolidation. Selden and Campbell (2000) examined both the short-term and long-term impacts on expenditures of consolidating Georgia's Athens and Clarke counties. The results of their study showed an increase in overall operating expenditures as a result of the consolidation; however, expenditures related to administrative and leisure services declined over a 6-year period. Leland and Thurmaier (2005) examined 12 cases of 30-year-old consolidations in the United States. The purpose of their analysis was to determine the factors behind both failed and successful attempts at consolidation. Their study found no evidence that efficiency, effectiveness, or equity were factors in successful consolidation attempts. The authors argued that civic elites, supported and funded by the business community, were the major factors behind successful attempts at local governments' consolidations.

Although no strong evidence points to the existence of economies of scale in local governments, some efforts toward consolidation are still occurring. This research examined the existence of economies of scale among city governments' service areas. The results indicate that the existence of economies of scale among city governments could depend on the type of service being offered. While economies of scale were more evident in service areas such as facilities management, fire services, refuse collection, library, and code enforcement, diseconomies of scale were more apparent in service areas such as risk management, facilities management, information technology, police, parks and recreation, housing, and highways and roads. These results suggest that different service areas in local governments could be functioning at different scales of operation. In order to find the optimal scale of operation, local officials need to consider individual services in their analysis. Supporting collaborative efforts among local governments in particular services found in this study to be experiencing economies of scale (e.g., fire services, refuse collection, library, facilities management, and code enforcement) might prove a better approach than the comprehensive consolidation or amalgamation of local governments.

As a result of the recent economic meltdown (2008), local governments are facing serious challenges and are forced to find new ways to provide their services at efficient scales. Decisions about budgeting and the application of funding therefore need to be as accurate as possible.

Understanding how economies of scale and uncontrollable variables impact their estimation of efficiency will assist city governments' officials in making more efficient decisions and applications. This research provides city governments with a practical approach for determining scale efficiency and/or examining economies of scale in their service areas.

IV. Summary and conclusions

Performance measurement has evolved from a simple tool for accountability and budgeting to a more useful means of determining efficiency and thereby making meaningful decisions. In spite of this noticeable development in performance measurement, empirical evidence is still limited regarding its utilization for efficiency determination and for evaluating the impact of economies of scale and uncontrollable factors on local governments' performance. Assessments made about the efficiency of local government services without taking these factors into consideration may be inaccurate. The purpose of this study was to evaluate the impact of scale economies and uncontrollable factors on the relative efficiency of U.S. municipal service delivery. To do so, both data envelopment analysis (DEA) and analysis of variance (ANOVA) were applied.

To determine the impact of economies of scale and uncontrollable factors on local governments' performance, this research started by asking whether population density, unemployment, and household income impact local governments' relative efficiency and whether economies of scale exist in local governments or not. Based on the reviewed literature, the research hypothesized that economies of scale are not evident in local governments and that a negative relationship exists between efficiency and the suggested uncontrollable variables. The findings of this research indicate that these uncontrollable variables significantly impact the relative efficiency of local governments. This negative impact is associated with the lowered efficiency scores observed in the findings. The findings also suggest that the existence of economies or diseconomies of scale in local governments depends on the type of services they provide. No evidence of economies of scale (increasing returns to scale) was found in two service areas: fleet management and highway and roads. Five service areas (facilities management, fire services, refuse collection, library, and code enforcement) did demonstrate economies of scale. In the rest of the service areas (risk management, information technology, police, parks and recreation, and housing) a higher percentage of local governments were found to be experiencing diseconomies of scale.

In conclusion, this study shows that uncontrollable variables such as population density, unemployment, and household income significantly impact the relative efficiency of local governments. Moreover, the findings indicate that these uncontrollable variables are associated with poor relative efficiency. The results also suggest that different service areas in local governments may operate at different scales of operation.

V. Limitations of the study

Two main limitations apply to this study. The first limitation is related to the performance variables included in each analysis. The second limitation pertains to the subjects' (city governments') size/number and uniqueness. Because of these two limitations, the findings presented in this dissertation may not be generalized to all city governments. First, the findings of this study are based on output variables of performance in each service area, and these variables are limited to a particular service. For example, the findings pertaining to highway and road maintenance are based on the performance variables that focus on services linked only to paving roads and exclude other variables associated, for example, with road cleanliness or citizen satisfaction with their government's road services. In addition, some of these variables focused mainly on a single indicator of performance to the exclusion of others. For example, the variables pertaining to parks and recreation, fleet management, and housing services in the analysis are indicators of efficiency only. Because of limited data availability, other important indicators of performance (e.g., effectiveness and quality) were excluded from these analyses. Second, because only a small number of cities were included in each analysis and all are located in the United States, the findings may not be generalized beyond those selected U.S. cities. Additional similar studies need to be conducted in the United States and other countries to confirm this study's findings. The limited availability of data, which were provided by cities participating with the ICMA, and the methodological restrictions inherent to DEA utilization contributed to these limitations.

VI. Recommendations

This research examined the impact of economies of scale and uncontrollable variables (population density, household income, and unemployment) on the relative efficiency of city governments. The outcome of this study raises some suggestions for both local government officials and researchers. This section highlights recommendations from the study relevant to both local government officials and policymakers, as well as recommendations for future follow-up research.

a) Recommendations from the study

As more local governments become involved in collecting data to measure their performance, it becomes imperative to utilize new systematic and practical methods to exploit these data in supporting the decision-making process. In addition, assessments of the efficiency of local government services may be incorrect if they are made without taking uncontrollable factors such as population density, unemployment, and household income, as well as economies of scale, into consideration. In addition to introducing new methods for efficiency determination, this research provides local government officials with a new approach to evaluating the impact of uncontrollable variables and economies of scale on efficiency. Because budgetary decision-making; accountability to the media, citizens, and elected officials; benchmarking; and performance improvement will be conducted based on accurate performance evaluation, more local governments will be encouraged to collect performance measures.

The findings in this study suggest that population density, unemployment, and household income significantly impact the relative efficiency of city governments. This impact was found to be associated with suppressed relative efficiency. The findings also indicate that the impact of economies of scale on city governments' performance depends on the type of service being provided. In addition to making more meaningful decisions, recognizing and considering the impact of these factors on city governments' performance can eliminate managers' and staffs' unnecessary fears or resistance caused by worries that performance-measuring data collection and utilization could hold them accountable for factors beyond their control.

b) Recommendations for future research

The outcome of this study clarifies some suggestions for future research. These recommendations are based on the limitations of the study mentioned in the previous section. Small sample size was one of the study's limitations. To create a more accurate overall assessment of the impact on efficiency of uncontrollable factors and economies of scale, additional studies that include a larger number of city governments in the analysis should take place. In addition, this study sought to assess the impact of the mentioned factors on city governments in the United States only. Conducting similar research pertaining to city governments in other countries will clarify whether the findings in this research are unique to city governments in the United States or apply to city governments in other nations as well. Another limitation of this study was related to the limited number/type of performance variables (outputs) included in each analysis. Further studies that include more diverse performance variables in the analysis of similar service areas will provide a better understanding of how uncontrollable factors and economies of scale impact city governments' efficiency.

APPENDIX A: MATHEMATICAL FORMULATION OF DEA

Basic efficiency measure:

The basic efficiency measure calculated by the DEA can be derived from the simple ratio of the sum of weighted outputs to weighted inputs. For example, compared with other units, the formula of the efficiency of unit A is as follows:

$$\text{Max e(A)} = \frac{\sum_{j=1}^{s} \boldsymbol{wjyjA}}{\sum_{i=1}^{r} \boldsymbol{vixiA}}$$

Subject to:

$$\frac{\sum_{j=1}^{s} \boldsymbol{wjyjm}}{\sum_{i=1}^{r} \boldsymbol{vixim}} \leq \mathbf{1} \text{ , m = 1,.....n}$$

$$wj \geq 0; j = 1 \ldots\ldots, s$$

$$vi \geq 0; i = 1, \ldots\ldots, r$$

Where:

Max e (A) is the maximum possible efficiency of unit A,

wj and *vi* are the weighted value of S outputs represented by *yj* and r inputs represented by *xi*

respectively, and

m is the number of DMUs.

If this ratio of the unit A is less than one, the units with a ratio value of one are considered a reference for unit A.

The linear programming primal formulation (Charnes et al., 1978):

To simplify the above formula, the denominator (weighted sum of inputs) can be maximized or constrained to one. This can be done by multiplying both *wj* and *vi* by a constant to give the following linear programming (LP) formula:

Max eA = $\sum_{j=1}^{s} \boldsymbol{wjyjA}$ **(weighted sum of outputs)**

Subject to:

$$\sum_{i=1}^{r} \boldsymbol{vixim} - \sum_{j=1}^{s} \boldsymbol{wjyjm} \geq \mathbf{0} \; ; \boldsymbol{m} = \mathbf{1}, \ldots, \boldsymbol{n}$$

$\sum_{i=1}^{r} \boldsymbol{vixiA} = \mathbf{1}$ **(The weighted sum of inputs constrained)**

$$\mathbf{Wj} \geq \mathbf{0}; \boldsymbol{j} = \mathbf{1}, \ldots, \boldsymbol{s}$$

$$\mathbf{Vi} \geq \mathbf{0}; \boldsymbol{i} = \mathbf{1}, \ldots.. \boldsymbol{r}$$

Once the reference set of DMUs with maximum efficiency has been identified, DEA calculates the efficiency measures for the other, less efficient DMUs by measuring their deviation from their evaluated reference sets.

Uncontrollable Inputs:

$$\textbf{Max e(A)} = \frac{\sum_{j=1}^{s} \boldsymbol{wjyjA} - \sum_{l=1}^{f} \boldsymbol{dlolA}}{\sum_{i=1}^{r} \boldsymbol{vixiA}}$$

$$wj \geq 0; j = 1 \ldots.., s$$

$$vi \geq 0; i = 1, \ldots..., r$$

$$dl \geq 0; l = 1, \ldots..., f$$

l = uncontrollable inputs (represented by dl)

v = controllable inputs (represented by vi)

w = outputs (represented by wj)

Linear programming:

$$\textbf{Max e(A)} = \sum_{j=1}^{s} \boldsymbol{wjyjA} - \sum_{l=1}^{f} \boldsymbol{dlolA}$$

Max e(A) = (weighted sum of outputs – weighted sum of uncontrollable inputs)

Subject to:

$$\sum_{i=1}^{r} \boldsymbol{vixim} + \sum_{l=1}^{f} \boldsymbol{dlolm} - \sum_{j=1}^{s} \boldsymbol{wjyjm} \geq \mathbf{0}\ ; \boldsymbol{m} = \mathbf{1}, \ldots., \boldsymbol{n}$$

$$\sum_{i=1}^{r} \boldsymbol{vixiA} = \mathbf{1}$$

$$wj \geq 0; j = 1 \ldots.., s$$

$$vi \geq 0; i = 1, \ldots..., r$$

Source: Norman and Stoker, 1991

APPENDIX B: SUMMARY OF SOME CPM PERFORMANCE MEASURES

Outputs (Performance-related Measures)		
Effectiveness	**Quality**	**Efficiency**
Code Enforcement		
Case closure rates	Number of elapsed calendar days from first report of complaint until inspector's first inspection	Number of proactive code-enforcement activities
Facilities Management		
Repair requests per 100,000 square feet maintained	Minutes from receipt of call to arrival	Total repair hours
Fire and EMS		
Percentage of total fire calls with response time of or under five/eight minutes from dispatch to arrival on the scene	EMS responses time: Average time from dispatch to arrival on scene for calls requiring an ALS response (lights and sirens)	Rescues and recoveries performed per 10,000 residents served
Fleet Management		
	Internal Customer Satisfaction: Quality of fleet maintenance	Total vehicles and equipment maintained by central fleet management
Highway and Road Maintenance		
Paved lane miles assessed in satisfactory or better condition as a percentage of total paved lane miles assessed	Citizen ratings of street sweeping	
Housing		
Number of new units completed as a percentage of units needed	Average number of calendar days from application for rehabilitation assistance to completion of rehabilitation work	Total housing units provided with public financial and nonfinancial assistance during reporting period
Information Technology		
Network problem resolution/repair (percentage	Internal customer satisfaction (General IT services, quality of	Help desk calls (resolved at time of call, within 24 hours, and

Outputs (Performance-related Measures)		
corrected within 24 hours)	service, telephone services overall satisfaction)	within 48 hours)
Library Services		
Circulation rates	Citizen rating of library services	Library visitation rates
Parks and Recreation		
Percentage of park acreage that is developed	Citizens' ratings of overall satisfaction with parks and recreation	Developed park acreage
Police services		
Crime rate	Response time in minutes to top-priority calls Citizens' ratings of safety in business areas during the day/citizens' ratings of safety in their neighborhood after dark	Number of unified crime reports cleared
Refuse and Recycling		
Tons of recyclable material collected as a percentage of all refuse and recyclable material collected	Citizens' ratings of residential recycling services/citizens' ratings of refuse-collection services	Total tons of refuse collected/disposed of
Risk Management		
	Internal customers' overall satisfaction	Risk-management training hours per FTE (by risk management staff and total)

Sources: ICMA annual reports (2008 and 2009)

APPENDIX C: LIST OF THE CITIES INCLUDED IN THE STUDY (2007 & 2008)

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Addison, IL		08									08	
Albany, OR				07&08				07&08				
Alpharetta, GA							08	07&08				
Anchorage, AK					07							
Arlington, TX						07&08		07&08	07&08		07&08	08
Austin, TX		07&08			07&08			07&08	07&08	07&08	08	
Bedford, MA									07		07	
Bellevue, WA	07&08			07&08		07&08		07&08		07&08	07&08	
Bothell, WA			07									
Bowling Green, KY	08			08				08			07&08	07&08
Bridgeport, CT			07&08						07&08		07&08	

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Broken Arrow, OK					08							
Cartersville, GA	07&08	08				07	08		07&08		08	08
Casa Grande, AZ						08	08		08			
Casper, WY	07&08	07&08			07&08	07	08	07&08		07&08	07&08	07&08
Centennial, CO						07						
Chandler, AZ	07				(08)	07			07&08		07&08	
Charlottesville, VA								07			07	
Chesapeake, VA		(08)			(08)				07&08			
Clayton, MO	07	(08)	(08)	(08)		07&08		07			07	
Collinsville, IL	(08)				07&08	07&08					07&08	
Colorado Springs, CO					07							
Coral Springs, FL				07				07&08			07	

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Corvallis, OR		07				08				07&08	07&08	
Cumberland, MD								07&08		08		
Dallas, TX		08	07&08	07&08	08	07				07&08	07&08	07
Danvers, MA											07	
Davenport, IA									07&08	07&08		
Dayton, OH				07		07						
De Kalb, IL						08					08	
Decatur, GA	07&08		07&08				08					
Des Moines, IA				07&08	07		08	07	07&08	08	08	
Dublin, OH	08					08	08					
Duncanville, TX		08	08		08	07&08	08	08	07&08			07&08
E. Providence, RI									07			

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Elgin, IL				08				08		07&08	07	
Englewood, CO	07&08		07&08					08	07	08		
Eugene, OR	07&08					07&08					07&08	
Evanston, IL		07						07				07
Fairfield, OH		08										08
Farmers Branch, TX		07&08		08	07		08		08		08	07&08
Farmington, NM		07						07	07			
Fishers, IN				07&08	08	07		07&08				
Fort Collins, CO				08	08	08		08			08	07&08
Fort Worth, TX		07							07			
Gardner, KS											07&08	
Gilbert, AZ	07					07		07				08

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Golden, CO			07					07			07	
Goodyear, AZ										08	08	
Grain Valley, MO			08	08							07	08
Grandview, MO	08					08		07				08
Hampton, VA	08				08	08	08	08	08			08
Henderson, NV				08	07	08		07&08				07&08
Hermiston, OR								08				
Highland Park, IL						07						
Highland, IL											07&08	
Hopewell, VA								07&08				
Howard, WI							08	07&08			08	
Johnson City, TN						08		07&08				

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Kennesaw, GA			08									
Kennewick, WA	07					07						
Kirkwood, MO						08		07&08				
Las Cruces, NM									07	07		
Leawood, KS												08
Lebanon, NH									08			
Lexington, MA									07&08			
Lombard, IL		07										07
Long Beach, CA	07	07&08					08		07&08	08	07	
Longmont, CO		07&08					08		07&08	07		
Longview, TX					07							
Loveland, CO		(08)				07&08	08	07&08	07&08	08	07&08	08
Loveland, OH												08

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Lynchburg, VA	07	07&08		07&08		07&08	08	07&08	07&08			
Lynnwood, WA		07				07&08					07	
Marietta, GA		07										
Maryland Heights, MO												07
Matanuska-Susitna, AK		08	08					08	08			08
McAllen, TX		07						07	07			
McHenry, IL			08	07&08							07	
Mesa, AZ			08	07				07&08		07		08
Mission, KS												07
New Albany, OH			07									07&08
Newport News, VA								07&08	07&08			
N. Las Vegas, NV			07&08					07&08	07&08			

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
N. Richland Hills, TX				08	08	08					07	07&08
Oak Park, IL	07	(08)	(08)							07	07&08	
O'Fallon, IL									08		07&08	
Oklahoma City, OK				07	07	07		07&08		08	07&08	
Olathe, KS		07&08	08	07&08		08	08	07&08		07	07&08	08
Overland Park, KS	07	08		08		08					07&08	
Palm Coast, FL			07&08	07&08				08			07	07&08
Pasco, WA		07&08										07&08
Peachtree City, GA								07	07			07
Peoria, AZ		08					08	07&08	07&08		07&08	08
Peoria, IL			07						07			
Phoenix, AZ		07&08			07	08		07&08	07&08	07&08		07&08

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Plano, TX				07			08		07&08			07&08
Plant City, FL	08		08	07&08	07&08	07	08	08	07&08			08
Pleasant Hill, MO						08		08				
Portland, OR					07					08		08
Portsmouth, VA									08			
Queen Creek, AZ		08	07&08					08				07&08
Raymore, MO						07&08		07&08				07&08
Reno, NV								08			07&08	
Richland, WA		07&08		07			08	07	07&08	07		08
Richmond Heights, MO		08	08	08	08	08					07	
Richmond, VA			08	07&08					07&08			
Riverside, MO								07				

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Rock Hill, SC	07						08			08		
Rockford, IL			07&08		08		08	07		07&08	07&08	
Rowlett, TX			07			07			07		07	
Salem, OR								07	07&08		08	08
San Antonio, TX									07&08		08	07&08
Santa FE, NM									07			07
Savannah, GA		07&08					08			07&08	07	07&08
Schaumburg, IL	08	08		07&08							07	
Shawnee, KS				08	07&08			08			08	
Shoreline, WA											08	
Shorewood, IL	08						08	08				
Sioux City, IA		08							07&08	08		08
Sioux Falls, SD		08	08			07&08			08		07&08	

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Siouxland, SD									07			
Smyrna, GA					07	08	08	07&08	07&08		08	
Sparks, NV						07&08						
St. Cloud, MN								07&08			07	
State College, PA									08		07	
Sterling Heights, MI			07						07	07		
Surprise, AZ	08				08	08	08	08			08	
Suwanee, GA	08					07&08		07&08			07&08	07
Tacoma, WA			7			08	08				07	07
The Colony, TX			08				08		08			
Thornton, CO							08				08	
University Park, TX		7						08				07&08

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
University Place, WA								08			07&08	
Urbandale, IA				07&08		07	08	07&08	07&08			
Vancouver, WA			07								07&08	
Virginia Beach, VA										07		
Waunakee, WI											07	
W. Jordan, UT			07					07				
Westminster, CO			07&08		07&08			07&08	07		07&08	
White House, TN	08											
Williamsburg, VA				07&08		07&08		08	07&08			
Windsor, CO		07&08	08								08	
Winter Garden, FL						07		07&08			07	07
Woodbury, MN				07&08						08	08	

(Cities)	RM	FM	FCM	IT	FS	PS	RC	PR	LS	HS	HR	CE
Yuma, AZ		08		07								
Total	32	51	42	48	35	62	30	95	80	39	94	65

RM: Risk Management
FM: Fleet Management
FCM: Facilities Management
IT: Information Technology
PS: Police Services
RC: Refuse Collection
CE: Code Enforcement
HR: Highway and Road
HS: Housing Services
LS: Library Services
FS: Fire Services
PR: Parks and Recreation

Sources: ICMA annual reports (2008 and 2009)

APPENDIX D: SUMMARY OF EMPIRICAL STUDIES EVALUATING MULTIPLE FUNCTIONS OF LOCAL GOVERNMENTS' EFFICIENCY USING DEA

Author(s)	Service Areas	Input/s	Output/s	Uncontrollable Variables
Moore, Nolan, & Segal, 2005	1. Policing 2.Water 3. Fire and rescue 4. Library 5. Fleet 6. Parks and recreation 7. Street maintenance	1. Number of full-time equivalent 2. Staff/employees/sworn officers for more than one service 3. Building and parks budget 4. City budget for EMS operations, water operation, street operations 5. Number of libraries and branches 6. Operating expenditures per capita 7. Number of (police) vehicles in peak services 8. Fuel	1. Square feet of city building space available 2. Reported response time for medical services (minutes) 3. Number of civilian fire deaths: total fire losses (millions) 4. Number of vehicles in fleet 5. Number of library registrations, total number of visits; collection turnover ratio 6. Acres of park space in use 7. Crime index for city (for all types of crime dealt with by police) 8. Number of citizens served 9. Miles of streets serviced 10. Annual vehicle miles: annual revenue vehicle miles 11. Number of citizens served: volume of water produced (millions of gallons per day)	1. Average precipitation 2. Average temperature 3. Population change 5. State and local tax revenue per capita 6. Average snowfall 7. Local government share of total statewide government employees 8. City size (square miles)
Worthington, 2000	1. Financial and corporate 2. Library 3. Environmental 4. Planning and regulatory 5. Recreation 6. Community	1. Full-time equivalent 2. Physical expenses in dollars 3. Capital expenses in dollars 4. Average municipal salary 5. Ratio of physical expenditures /current assets 6. Average interest rate paid on borrowed funds	1. Population 2. The number of properties receiving DWMS, sewerage and water services 3. The length of urban sealed roads 4. The length of rural sealed roads 5. The length of rural unsealed roads 7. General purpose grants as a percentage of total revenue	

Author(s)	Service Areas	Input/s	Output/s	Uncontrollable Variables
	7. Domestic waste management 8. Sewerage 9. Water supply 10. Road		8. The debt service ratio 9. The level of current assets	
Athanassopoulos & Triantis, 1998	1. Electricity 2. Social 3. Recreation (parks) 4. Street lighting and cleaning 5. Pollution treatment	Operating costs (expenditures) 1) Services 2) Salaries 3) Maintenance 4) Materials (excluding investments)	1. Actual households (population consumption of electricity) 2. Built-up area 3. Heavy industrial area 4. Average house area (wealthy vs. poor) 5. Average size of industrial site	
Afonso & Fernandes, 2008	1. Social programs 2. Educational (Library) 3. Cultural programs 4. Sanitation 5. Territory organization 6. Roads infrastructures maintenance	Total municipal expenditures per inhabitant	1. Local inhabitants > or equal to 65 years old, in percentage of the total resident population 2. School buildings per capita 3. Corresponding school-age inhabitants. 4. Number of library users in percentage of the total resident population 5. Water supply 6. Number of licenses for building construction 7. Length of roads maintained by the municipalities/total resident population	1. Purchasing power 2. Population with secondary education 3. Population with tertiary education 4. Distance to capital of district 5. Population density 6. Population variation

Author(s)	Service Areas	Input/s	Output/s	Uncontrollable Variables
Eeckau, Tulkens, & Jamar, 1993	1. Social 2. Educational 3. Road maintenance 4. Policing	Total current expenditures	1. Total population 2. Share of age group with more than 65 years in total population 3. Number of subsistence beneficiaries 4. Number of students in primary school 5. Municipal roads' surface 6. Number of local crimes	1. Local tax rates 2. Educational level of the adult population 3. Per capita incomes and wealth of citizens 4. Per capita block grant 5. Number of coalition parties
De Borger & Kerstens, 1996	1. Social 2. Educational 3. Recreational	Total current expenditures	1.Total population 2. Share of age group with more than 65 years in total population 3.Number of unemployment subsidy beneficiaries 4.Number of students in primary school 4. Leisure areas and parks surface	1. Local tax rates 2. Level of education 3. Per capita block grant 5. Income
Prieto & Zofio, 2001	1.Water supply 2. Sewerage and cleansing of residual waters 3. Paving and lighting 4. Sporting and cultural equipment	Budgetary expenditure (estimation)	1. Potable water 2. Domestic waste collection 3. Road surface area 4. Lighting street points 5. Cultural and sportive infrastructure 6. Parks	

Author(s)	Service Areas	Input/s	Output/s	Uncontrollable Variables
Loikkanen & Susiluoto, 2005	1. Educational 2. Library 3. Health 4. Social services	Total expenditures	1. Children's day care centers 2. Children's family day care 3. Open basic health care 4. Dental care 5. Bed wards in basic health care of the handicapped 6. Comprehensive schools (hours of teaching) 7. Senior secondary schools(hours of teaching) 8. Municipal libraries (total loans)	1. Peripheral location 2. Income level 3. Population 4. Unemployment 5. Diverse service structure 6. Share of services bought from other municipalities 7. Share of costs covered by state grant 8. Reduced efficiency in first years after the end of matching grant era in 1993
Lim, 2007	1.Water 2. Sewage 3. Street 4. Social 5. Parks and recreation 6.Cultural	1. Per capita expenditures in 2005 and 2001 years 2. Citizens per capita 3. Public employees in the 2005 and 2001	1. Per capita revenue 2. Percent water services 3. Percent of sewage services 4. Percent of road surface 5. Number of social welfare facilities 6. Number of public parks 7. Number of cultural facilities	1. Population 2. Population density 3. Degree of consolidation 4. Degree of competition 5. Total number of public employees
Sung-Jong, 1992	Manufacturing of several products.	Capital: total value of tangible fixed assets of an industry Labor: annual average employment of an industry.	Manufacturing value added of a city: derived by subtracting direct production cost (includes raw martial cost, fuel, water, electricity, and purchased services) from the value of gross output	

Author(s)	Service Areas	Input/s	Output/s	Uncontrollable Variables
Worthington & Dollery,2002	Planning and regulatory function	1. Planning and regulatory expenditure 2. Legal expenditure 3. Full-time equivalent staff	1. Number of BAs (building applications)determined *2.* Number of DAs (development applications)determined	1. Population growth rate *2.* Development index 3. Heritage (environmental) sensitivity 4. Non-residential building activity *5.* Population distribution *6.* Non-English speaking background

APPENDIX E: DEFINITIONS OF ALL VARIABLES INCLUDED IN THE STUDY

Variables	Type/Indicator	Definition
Expenditures, funding, or revenues	Input	Expenditures, revenues, and funding involve information about financial investment in staffs, equipments, and facilities—all necessary factors for the process of local governments to achieve their outputs. The ICMA annual report provides data pertaining to expenditures of service areas expressed by several metrics: per capita, user, facility, vehicles, or employee. For example, in service areas such as code enforcement, fire, highway and roads, police, and refuse collection, data related to expenditures were expressed as per capita. For other service areas such as fleet management, library, and risk management, the selected input variable, expenditures, was expressed as per vehicle, borrower, and FTE, respectively. Input variable expressed as funding and revenues per capita was selected in the analysis relevant to housing and parks and recreation, respectively.
Density (population/square mile)	Uncontrollable	Total number of jurisdiction population divided by jurisdiction size in square miles.
Median household income	Uncontrollable	The income level at which half of the households (15 and above) earn below and the other half earn above (US Census Bureau).
Unemployment rate	Uncontrollable	Percentage of unemployment in jurisdiction.

Variables	Type/Indicator	Definition
Code Enforcement		
Rates of voluntary compliance (as a percentage of all cases initialed in FY 07&08)	Output/Effectiveness	The total number of cases brought into voluntary compliance divided by the total number of cases initiated in FY 2007/2008. Violation types include housing, zoning, dangerous building, nuisance, and other.
Rates of induced compliance through administrative/judicial action as a percentage of cases initiated in FY 07&08	Output/Effectiveness	The total number of cases brought into compliance through administrative or judicial action divided by the total number of cases initiated in FY 2007/2008. Violation types include housing, zoning, dangerous building, nuisance, and other.
Facilities Management		
Response time: nonemergency repairs	Output/Quality	Nonemergency (repair) response time (time to customer sites) in days.
Total square feet of facilities operated and maintained/total city square	Output/Efficiency	This measure includes information about the size of facilities (includes administration office, warehouse industrial, 24-hour dorm, health care, library, recreation/community center, detention and other) operated and maintained.
Fire Services		
Residential structure fires per 1,000 residents	Output/Efficiency	The total number of incidents jurisdiction responded to (including those in which fire was out on arrival).
Fire-personnel injuries with time lost per 1,000 incidents	Output/Quality	Injuries with time lost resulting from structure fires, nanostructure fires, and non-fire incidents compared with the total number of fire and non-fire incidents.
Arson clearance rate	Output/Effectiveness	The investigation clearance rate of arson incidents.

Variables	Type/Indicator	Definition
Fleet Management		
Hours billed as a percentage of hours available	Output/Efficiency	The percentage of hours billed (which comprise straight-time hours charged to work orders by fleet maintenance employees whose time is considered billable) to the number of hours available (includes total on the job hours and paid leave hours for all fleet maintenance employees whose time is considered billable. Paid leave and nonproductive time—e.g., breaks, cleanup, meetings, and training—are included).
Total vehicles and equipment maintained	Output/Efficiency	Workload measure includes information about the quantity of vehicles and equipments (EMS vehicles, light vehicles, solid-waste packers, buses, medium-duty vehicles, heavy-duty vehicles, heavy equipment, police vehicles, and fire apparatus) maintained by FM.
Highway and Road Maintenance		
Percentage of lane miles that are paved.	Output/Efficiency	Paved lane miles include all paved road surfaces for which the jurisdiction is responsible, including travel lanes, turn lanes, parking lanes, bike lanes, and shoulders. Drainage ways or alleys are excluded. Bike, walking, and other recreation trails that are not part of the roadway are also excluded.
Paved lane miles assessed in satisfactory or better condition as a percentage of total paved lane miles assessed.	Output/Efficiency	Provide information about road condition assessed using standardized assessment systems.

Variables	Type/Indicator	Definition
Housing		
Number of low- to moderate-income households that received public financial assistance to purchase homes	Output/Efficiency	Low- or moderate-income households are those households at or below 80% of the area median income. Public financial assistance includes funds from CDBG, HOME, tax increment, revenue bond, and general fund money controlled by the jurisdiction. It includes direct subsidies, tax abatement, and fee waivers. It does not include low-income-housing federal tax credits.
Number of low- to moderate-income housing units constructed, converted, rehabilitated, or purchased with public financial and nonfinancial assistance during the reporting period/1,000 residents	Output/Efficiency	Number of low- to moderate-income housing units that were repaired or improved during reporting period per 1,000 residents.
Information Technology		
Ratio of workstations to total jurisdiction employees	Output/Efficiency	Total number of intelligent workstations and dumb terminals divided by the number of jurisdiction employees. This measure provides information about the number of computers provided for public services.
Applications problem resolution/repair: percentage corrected within 24 hours	Output/Effectiveness	Indicates the effectiveness of jurisdiction's IT in repairing/correcting application problems within 24 hours.

Variables	Type/Indicator	Definition
Library		
Registered borrowers as a percentage of service-area population	Output/Efficiency	All registered borrowers, regardless of where they live.
Material acquisition expenditures as percentage of total expenditures	Efficiency/Effectiveness	The selection and acquisition of library material can often be a factor in customer satisfaction as well as circulation rates. Library materials include hard-copy materials as well as online resource materials (e.g., online databases and online information services).
Patron internet usage per terminal.	Output/Efficiency	The patron usage, in number of times accessed, of publicly accessible internet terminals per library internet terminal. This measure provides some information about the public availability and use of internet resources in a jurisdiction.
Parks and Recreation		
Number of recreation and community centers per 1,000 residents	Output/Efficiency	Includes the total number of all recreation and community centers provided by local governments.
Number of athletic fields/1,000 residents	Output/Efficiency	Includes multiuse and singles, tennis courts, basketball courts, and swimming pools
Police Services		
Response time in minutes to top-priority calls: total (from receipt of call to arrival (in minutes)	Output/Quality	From receipt of call to dispatch: from when the telephone call first comes in until a unit is dispatched and from dispatch to arrival on scene.

Variables	Type/Indicator	Definition
Police Services		
Juvenile arrests for part II drug-abuse offenses as a percentage of total arrests for UCR part II drug offenses	Output/Efficiency	UCR (Uniform Crime Report) part II drug violations are state/local offenses related to the unlawful possession, sale, use, growing, and manufacturing of narcotic drugs.
Percentage of UCR part I violent crimes cleared	Output/Effectiveness	UCR (Uniform Crime Report) part I violent crimes include murder, rape, robbery, and aggravated assault. The percentage was calculated by dividing the number of UCR part I violent crimes cleared by the number of the number of UCR part I crimes reported.
DUI arrests per 1,000 residents	Output/Effectiveness	The measure provides information about the number and level of DUI offenses in a jurisdiction. Arrests include all processing through arrest, citation, or summons.
Risk Management		
Percentage of claims that proceeded to litigation	Output/Effectiveness	Worker's compensation claims proceeded to litigation divided by the total worker compensation claims.
Number of workers compensation claims per 100 jurisdiction FTEs	Output/Quality	The percentage of employees filing new worker's compensation claims during the fiscal year.
Refuse		
Residential refuse collected per account per capita (in pounds)	Output/Efficiency	Total pounds of refuse collected from residential accounts during the data reporting period.

Sources: ICMA (Comparative Performance Measurement) annual reports (2008 & 2009)

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