This paper compares the behavior of special district governments to that of general purpose governments, using as an empirical example the performance of U.S. airports. We estimate a modified McFadden symmetric generalized cost function, specified to distinguish technical efficiency and allocative efficiency of airports governed by each institutional form. Using a unique data set on US airports, we find that special district governments have technical efficiency that is over 40% higher than airports operated by general purpose governments. This advantage, however, is almost entirely dissipated through over-payments to labor and for materials, so that the resulting cost advantage of special district airports is less than 5%. We interpret these results to suggest that the feedback process between residents and the government institution is centrally important.

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I. INTRODUCTION

This paper examines the preference structure of governmental units, in particular whether the actions of special districts, which are generally single purpose governments, differ systematically from those by a general purpose government. This is a crucial input into the discussion about the appropriate role for special districts. The traditional view is that special purpose governments are able to exploit specialization through improved technical efficiency, but general purpose governments may be more sensitive to citizen demands (Hooghe and Marks, 2003). Additionally, special districts may be a mechanism by which local jurisdictions cope with heterogeneity of preferences, thus achieving improvements in allocative efficiency (Alesina, Baqir, and Hoxby, 2004). To understand whether special districts are able to be of assistance in allocative or technical efficiency dimensions, however, first requires an assessment of the behavioral objectives of special districts (Oates, 2005). While there is substantial variation by category in how pervasive are special districts across the spectrum of locally produced publicly provided goods, US airports in the largest cities are operated by a combination of special districts and general purpose governments. About half of U.S. airports are operated by independent special district institutions (which we call authorities), while the other half are operated by traditional multipurpose local government (cities). This institutional difference thus affords us

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1 We wish to thank, without implicating, Robin Sickles, Janet Kohlhase, Albert Saiz and John Ashworth. We are grateful for the research support from a Small Grant from the University of Houston. We benefitted from comments at the Regional Science Association Meetings, the Public Choice Meetings, and from participants at a conference at the Tinbergen Institute.

2 There is no central information on airports, but our survey of the largest airports found that 47.2% were single purpose authorities, and 52.8% were general purpose cities (or other multiple purpose governments). The most recent changes are airports that have converted to authorities.
an opportunity to examine empirically whether the behavior of special districts accord with those of general purpose governments, and to explore the source of differences.

To estimate the impact of the institutional form of airport governance, we estimate a cost function specified to discern the behavioral differences between general purpose and special district governments. An advantage of our method is that we separately estimate relative efficiency on three key dimensions that might affect the behavioral decisions of airports; allocative efficiency (relative input usage), technical efficiency (overall cost minimization), and the rate of technical change. Allocative efficiency in the case of a cost function reflects the relative input usage conditional on input prices. For example, if authority governments have more autonomy than general purpose governments, they may over-pay (and/or under-use) their workers relative to opportunity costs as a way to distribute gains within the organization. Similarly, while the specialized authorities are assumed to have greater technical efficiency because of their concentrated focus, in fact the opposite may occur if there are not good feedback mechanisms from users of the airports to those in charge of operation. Technical change, or cost innovation, may vary between governmental form depending on how easy it is to change the way that decisions are made and actions taken. Fundamentally, we treat all three forms of (in)efficiency as resulting from institutional ‘as if’ tastes, in that we estimate systematic deviation from cost minimization that results from the actions of airport managers (Oates, 2005). The interesting question is therefore whether the institutional environment causes the choices of airport operators to vary in a systematic manner.

The important element in our cost function approach to airport efficiency is our ability to examine the source of behavioral differences between governmental form. The recent work of Oum, et. al. (2008) is one of the very few to examine efficiency differences in airports due to
ownership form, but does so only in the context of overall cost efficiency. Our study not only attempts to detail some of the sources of why ownership form might differ, but does so in the U.S. context which allows a sufficient sample size of each type of government form.\(^3\) The Oum, et. al. (2008) work of airports follows the tradition of the Data Envelope Analysis (DEA) of many recent papers by looking at the overall cost frontier.\(^4\) The advantage of estimating the cost function directly is that we examine whether inefficiencies arise from the specific way individual inputs are utilized, which might be expected to be a function of governmental form. For example, if special districts achieve technical efficiencies, but are more loosely monitored, it might be expected that the technical savings are consumed in some fashion by airport employees. As it turns out, our work finds that allocative efficiency is crucially important, because special districts are found to virtually dissipate their technical efficiency advantage through high shadow prices of labor and materials.\(^5\) The cost function methodology, therefore, allows us to examine the sources of the observed behavioral differences.

Special districts may or may not be superior to general purpose governments either on technical efficiency dimensions, allocative efficiency, or both. On the one hand, independent special district authorities are specialized institutions designed only to manage airports, and do so

\(^3\) Oum et. al. (2008) studies eight different ownership structures with 109 airports, including many of the privatization forms in Europe. We focus exclusively here on special district and general purpose governments.


\(^5\) As discussed below, materials include contracts external to direct airport employment.
in all but a few instances. Conversely, multipurpose governments administer airports along with many other public goods, e.g. roads, fire and police. The relative freedom of the independent authorities may result in more specialization, prompt decision-making, and flexibility in decisions related to worker employment and purchase of inputs. Airports operated by multipurpose governments (generally cities), even though operated by a separate department of aviation, nonetheless operate under the general constraints of the local government bureaucracy, including procurement rules, contracting, and personnel policies. Further, city airports are often required to use the resources of their local governments, such as fire and police. Thus a general purpose government might be expected to have a lower level of technical efficiency than an authority run airport, since its policies are not as focused on airport operations. Indeed, Oum, et. al. (2008) find that airports operated by special districts are more efficient than general publicly operated airports.

On the other hand, local governments are headed by elected officials who are expected to be more sensitive to voter demands than appointed officials. To the extent voter feedback is important, we would expect elected officials to show concern over the level of efficiency, and this concern may exceed that within special districts. This concern could be with general

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6 In our sample we have two authority governed airports which manage other properties. Jacksonville port authority manages Jacksonville sea port, and the Norfolk aviation authority manages an industrial park. Unfortunately, this sample is too small to test the distinction between multiple and single responsibility special districts drawn in Oum, et. al. (2008).

7 Airports operated by general purpose local governments are often operated under a separate enterprise fund. FAA rules bar state and local governments from transferring funds generated by airports to any other activity. Because of the law against explicit transfer, funds may be implicitly transferred in the form of higher charges for services provided by other departments of the respective local governments.

8 Of course there are variations in the governing structure of special district authorities. The most distinct subgroups within authority governed airports are port authorities, city authorities and county authorities. Port authorities operate multiple properties while the latter two are
technical efficiency, but also with allocative efficiency, in that distorted input use may affect airport management and user response. One way of framing the trade-off is that the focus of elected officials may depend on how important is the airport to residents (Mullin, 2008). Our estimates comparing the relative efficiency of airports operated by special district governance to general purpose governance therefore offers a view on whether airports are sufficiently important for voter feedback to keep the attention of directly elected officials. If important, the objective function of the city operated airports may be consistent with maximizing local welfare by being technically efficient, while the independent special district authorities may be simply less concerned with minimizing costs conditional on output. Conversely, if there are no political advantages to improved technical efficiency, it may not be surprising that airport employees consume the gains created by the streamlined governmental form.

This paper looks at three aspects of efficiency using a unique panel data set of airport finances from a sample of the largest 100 airports from the decade immediately following airline de-regulation. While somewhat dated, the data have the advantage of covering a period when airlines significantly altered their behavior, and thus desired complementary changes in airport operations. Our three separate measures of efficiency allow a close examination of the trade-offs in how governance affects operations, comparing the expected efficiency improvement of special districts against the potentially greater concern of general purpose governments. We find that closely tied to their respective local governments. In our sample San Francisco, Omaha, Harlingen (TX) airports are governed by city authorities (i.e., authorities with substantial dependence on the city governments). Reno, Cincinnati and Fort Lauderdale airports are operated by county authorities. Data for the largest port authority operated airports, e.g., JFK, La Guardia, Newark, Seattle, San Diego were unfortunately unavailable for the study for a variety of unrelated reasons.

9 We attribute such behavior to tastes, which could include for example on-the-job leisure consumption by managers.

10 For detailed discussion on different components of overall efficiency see Färe et al (1985).
special district authority operated airports are 40.3% more technically efficient than general purpose city government operated airports. This is a large difference, and certainly shows where pressure arises to create special district governments. Conversely, however, we find that the special district government airports act so that the shadow price for labor and materials is much higher than for general purpose government airports. These two results are about balanced, leaving total costs per flight less than 5% lower for special district airports.

Section II of the paper presents our modified generalized cost function, where we allow shadow prices to vary depending on the governance form. The generalized cost function has a significant advantage over DEA analysis, because rather than assume input prices have no role, we can separately examine allocative efficiency based on relative input usage. Additionally, we estimate a technical efficiency cost parameter, and a technical change parameter, also dependent on the governance form. The other advantage the cost function confers is that it offers structure to identify the panel data estimates, as both the allocative and technical efficiency parameters are specified within the overall generalized cost function framework. Section III of the paper presents the unique data on airports and their finances, which contains both input quantities and prices. Section IV presents the empirical results, and Section V summarizes and concludes.

II. THE MODEL

Institutional design will be important to airport operations, and will be discernable, if the inherent objectives of the governments vary systematically with their institutional structure. Government objectives can be expected to vary depending on the degree of voter control, and the extent to which responsibility for the airport is diffused among other local governments. On the other hand, an alternative possibility is that airlines primarily control the airport, in which case
the form of government may be irrelevant to airport operations. 11 Our goal is to empirically
determine whether the degree of efficiency varies by government, and if possible, to discern the
extent to which objectives of the alternative governmental forms differs with their structure.

One key question of interest is whether observed differences in institutional behavior are
because of organizational preferences, or constraints. Strictly, our procedures cannot
differentiate between these alternative explanations. Anecdotal information, however, is
strongly suggestive that special district authorities operate in a less restrictive environment than
do city operated airports in a general purpose government. 12 Since the removal of constraints
should not impede efficiency, we therefore start the interpretation of our results from this
intuition. That is, if both types of government have as their objective the minimization of costs,
we should observe that authority operated airports are the more efficient organizational form.
This finding should be apparent in all three types of efficiency, technical, allocative, and
technical change. On the other hand, if we find that city operated airports are more efficient than
authority operated airports in any dimension, we will interpret such a result as indicative of a
distinction in the ‘as if’ expressed tastes of special district authority governments. And in fact,
under this interpretation the measure of tastes will be an under-estimate, because we will not
observe the increase in efficiency that would otherwise have occurred because some constraints
have been removed.

Thus our model is that airport managers maximize their utility subject to a production
function and several other constraints, including FAA regulations and the airlines. We assume

11 The natural tension between airlines and airports would be interesting to study, but is left to
future work.

12 The original inspiration for this research came from a commission that contemplated a change
in organizational form in Houston. The commission received testimony from several airports
consistent with the trade-off between fewer constraints, and a favored treatment of some inputs.
these external factors are equal across types of airports, however, and focus our attention on potential differences in objectives and internal constraints of the airport operators as influenced by governmental structure. Consistent with this discussion, an airport manager’s utility function could be specified, (following Migue and Belanger, 1974; and Orzechowski, 1977), as:

\[ U = U(S, X) \]

where \( U(.) \) describes the ‘as if’ preferences of the airport operator, \( S \) denotes surplus, and \( X \) is a vector of input usage. The surplus is defined by the difference between the value of the airport services (i.e., to the airlines, society) and the cost of producing those services. We assume that \( \partial U/\partial S \) is positive, implying that, ceteris paribus, airport managers want to maximize surplus and therefore minimize cost.\(^{13}\) As rational agents, however, they may also want some share of that surplus for themselves. One way to consume the surplus is that airport managers may derive utility by deviating from cost minimization, measured here through allocative efficiency to accomplish other objectives, like on-the-job consumption of leisure, or by spending more on a relatively favored input. Therefore \( \partial U/\partial X_i \) could be positive, negative, or zero depending on the specific input, captured in our estimation through allocative efficiency, or potentially through altered rates of technical change over time.

The specification in (1) illustrates the importance of examining the source of cost differences between special district authorities and general purpose governments. Analyses such as Zhang and Zhang (2003), for example, assume that all government operations have as their objective social welfare maximization. Our specification will examine the extent to which this is

\(^{13}\) Permanence of job, reputation etc. might depend on surplus maximization. See Zhang and Zhang (2003) on some of the important behavioral implications depending on the objective function.
a tenable assumption in at least one dimension, since our allocative efficiency measures will illustrate whether the organizational form affects decisions concerning inputs.

A. Non-Minimum Cost Function

The cost function we estimate is based on the Symmetric Generalized McFadden (SGM) cost function (Diewert and Wales, 1987). This functional form allows second order flexibility in output (Y), shadow prices (P*), control variables (Z) and time (t). The non-minimum aspects are that we estimate the input shadow prices for allocative efficiency, and an overall shift parameter for technical efficiency. Additionally, we allow differential rates of technical change due to organizational form.14

Output (Y) is measured here by the number of flights.15 We specify the cost function as depending on three inputs, labor (L), capital (K), and materials (M). Each of the inputs has a market price (P), as well as an associated shadow price (P*). Control variables Z, which are modeled to affect the quality of output, consist of the number of passengers and cargo weight.

Shadow prices are used here to examine the sources of any deviation from allocative efficiency, as they indicate the extent to which the decisions by the airport operators deviate from

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14 Atkinson and Cornwell (1994b) estimate allocative and technical efficiency parameters using a translog cost function. The SGM cost function we use here has the advantage of global concavity.

15 While the number of flights is at least partly dependent on airline behavior as well, flights are more subject to airport policies than are passengers to the extent traffic is a function of airline pricing. In any case, we include the number of passengers below as a control variable for the quality of output, Z. In general, flights are more associated with airport costs, and landing fees (the mechanism by which airlines generally share in airport costs) are generally calculated per flight, not per passenger. Allowing the number of passengers as a quality indicator incorporates some of the concerns in Oum, et. al. (2008), the distinction is which measure is more affected by airport actions.
allocating inputs efficiently relative to each other. The shadow prices are modeled proportionally to observed prices (Yotopoulos and Lau, 1971; Lovell and Sickles, 1983), as:

\[
(2) \quad P_i^* = k_i P_i
\]

where \( i \) indexes the three inputs, \( L, K, \) and \( M \). If the shadow price \( P^* \) is found not to equal the market price, then input \( i \) will be over (\( P_i^* < P_i \)) or under (\( P_i^* > P_i \)) utilized relative to the cost minimizing level, thus resulting in allocative inefficiency. We allow shadow prices to vary between general purpose city and special district authority operated airports through a dummy variable for institutional form. We normalize \( k_K \) to be unity and estimate \( k_L \) and \( k_M \). To ensure nonnegativity of \( k_L \) and \( k_M \) they are specified as (Kumbhakar, 1992):

\[
(3) \quad k_L = (1 + g_L + g_{LC} \times CITY)^2
\]

\[
(3) \quad k_M = (1 + g_M + g_{MC} \times CITY)^2
\]

where \( CITY \) is a dummy variable which is unity for the general purpose city administered airports and zero for the special district authority administered airports. The \( g_i \) parameters as estimated reflect the relative shadow prices for special district authorities, and the addition of the \( g_{IC} \) parameters allow us to estimate the shadow price for general purpose city airports.

Differences in technical efficiency may arise, as suggested in equation (1), if an airport manager has tastes over the overall level of surplus generated by the airport. Alternatively, however, the institutional form may impose additional constraints to those explicitly written here, for example contracting may have to go through the city government bureaucracy in
addition to the managerial controls at the airport itself.\textsuperscript{16} Both possibilities are modeled here through a technical efficiency parameter, \( b \), which we estimate to vary with institutional form.

Technical efficiency can be estimated by output technical efficiency, or by input technical efficiency (Färe and Lovell, 1978; Atkinson and Cornwell, 1994). Output technical efficiency characterizes an airport as failing to obtain maximum output from a given set of inputs. Input technical efficiency measures whether minimum inputs are used given output and the input mix. Since our empirical work is oriented towards input usage, we specify our model to estimate input technical efficiency. Reinforcing this view is that output, flights, is at least partially a choice variable of the airlines rather than the airport explicitly.\textsuperscript{17} The empirical distinction, as shown by Atkinson and Cornwell (1994a) and many others since, is that input technical efficiency specifies that total costs are scaled, so that:

\[
C (y_i, p_i/b_m) = \min_x \left\{ \frac{p_i}{b_m} (b_m x_i) / \left( f (b_m x_i) = y_i \right) \right\} = \left( \frac{1}{b_m} \right) C (y, p)
\]

where output is \( y \), \( p \) is the input price vector, and \( x \) is the input vector indexed by \( i \). We specify the technical efficiency parameter \( b \) to vary only by institutional form, \( m \). It estimates the relative efficiency of general purpose city government operated airports compared to those operated by special district authorities. If \( b_m \) is observed to be less than 1 for a specific governmental type \( m \), airports of that particular governmental type will have higher costs than the frontier. One implication of the input technical efficiency specification is that \( b_m \) can only be

\textsuperscript{16} For example, the extra constraints may be due to politicians monitoring of the behavior of airport employees.

\textsuperscript{17} With constant returns to scale, input and output technical efficiency are identical. We find that constant returns to scale is not rejected in our data, but the point estimate is 1.15. Thus the choice of input rather than output technical efficiency changes our results only very slightly, and not at all qualitatively.
estimated from the cost function itself, it is not identified in the individual input share equations. We specify the input technical efficiency parameter \( b \) to be a function of only the governmental organization form, so that:

\[
(5) \quad b_m = (1 + b_{\text{CITY}} \times \text{CITY})
\]

where \( \text{CITY} \) is a dummy variable equal to one if the airport is operated by a general purpose city government, and equals zero for special district authorities.

The SGM shadow cost function \( C^*(\cdot) \), incorporating both input technical efficiency (equation 5) and allocative inefficiency (equations 2 and 3) from shadow prices can be written as:

\[
(6) \quad C^*(\cdot) = \left(\frac{1}{b_m}\right) \left\{ g(P^*Y) + \sum_i b_i P_i^* + \sum_i b_{iy} P_i^* Y + \left(\sum_i b_{iyy} P_i^* \right) Y^2 \right. \\
+ \sum_i \sum_{j} (b_{iyt} + g_{it \text{city}} C_{\text{City}}) P_i^* t Y + \sum_i g_{it} P_i^* t + \left(\sum_i g_{itt} P_i^* \right) t^2 Y \\
+ \sum_i \sum_{j} d_{ijy} P_i^* Z_j Y + \left(\sum_i \sum_{j} d_{ij} P_i^* \right) Z_j Y \\
+ \sum_k \sum_{j} \left(\sum_i d_{ijk} P_i^* \right) Z_k Z_j Y \\
+ 2 \sum_k \left(\sum_i d_{ikt} P_i^* \right) Z_k Y
\]

with the \( i \) indexing the three inputs labor (L), capital (K), and materials (M), \( j \) and \( k \) index the two output quality measures \( Z_P \), the number of passengers, and \( Z_C \), the cargo tonnage. The shadow input prices \( P^* \) are a function of the observed input prices \( P \) as specified in (3), and are estimated to vary between general purpose city airports and special district authorities. Output \( (Y) \), the number of flights, has the technical efficiency parameter \( b \) subscripted by \( m \) to indicate
the parameter varies by institutional form. Technical change is estimated through the time trend variable t, we add a slope dummy to allow it to vary by governmental form.

The \( g(\cdot) \) function at the beginning of the equation describing the impact of input prices on total costs is defined as in Diewert and Wales by:

\[
(7) \quad g(P^*) = P^* S P^* / 2 \theta ' P^*
\]

where \( S \) is an 3x3 negative semi definite symmetric matrix of parameters to be estimated (they are the \( s \) parameters reported in Table 3), and \( \theta = (\theta_1, \ldots, \theta_3)' \) is a vector of nonnegative constants assumed to be exogenously given.\(^{18}\)

Estimation uses the conditional input demands obtained by applying Shephard’s Lemma to get:

\[
(8) \quad X_i(\cdot) = Y * \left\{ S^i P^* \theta ' P^* \ - \frac{\theta_i}{2} \left( \frac{P^* S P^*}{(\theta ' P^*)^2} \right) \right\} + b_i + b_{iy} Y + b_{iyy} Y^2 + (b_{ity} + g_{ity\text{ City}}) t Y \ + \ g_{it} t + g_{itt} t^2 Y + \sum_j d_{ijy} Z_j Y + \sum_j d_{ij} Z_j \ + \ \sum_k \sum_j d_{ijk} Z_k Z_j Y + 2 \sum_k d_{ikt} Z_k t Y
\]

where \( i \) indexes the three inputs. \( S^i \) is the \( i \)th row of the \( S \) matrix of parameters. The input demand equations contain all of the parameters of the cost function with the exception of the technical efficiency parameter \( b_m \), so they are estimated jointly with the cost function.

\(^{18}\) We use the sample means for each input to ensure invariant elasticity estimates as recommended by Diewert and Wales (1987).
To further illustrate potential differences in governance structure, in addition to allowing
the shadow prices to vary by government type, we allow the rate of technical change to vary by
government type. We do so by specifying a slope dummy variable for city operation \( g_{\text{City}} \), the
coefficient on the linear time trend of the input demand function.

An important caveat to our specification of the efficiency consequences of governmental
form is that we do not necessarily estimate the optimal governmental form. For example, some
countries have allowed private operators to run their airports, but there are no U.S. airports with
this governmental form. Our efficiency estimates are based on the relative performance of
general purpose city compared to special district authority airports, and the relative choices
between labor and materials compared to capital. An important advantage of our cost function
specification, however, is that the impact of governmental form is identified by the structure of
our specification. That is, technical efficiency is represented by the first parameter (\( b_m \)) in the
total cost equation (6), allocative efficiency by the shadow price terms (\( P^* \) from equations (2)
and (3)) in the total cost and input demand equations (8), and the technical change distinction by
the organizational form dummy \( g_{\text{City}} \) on \( t \). This structure within the cost function framework also
identifies the efficiency parameters in a panel data estimation framework outside of simply the
fixed effects in the panel.

III. Data and Estimation

The unique data set was constructed primarily from three major sources. The first is
individual airport financial statements from the years 1979, the first year of airline de-regulation,
through 1992. The second is the FAA statistical handbook. The third source is the 1987 General
Information Survey published by Airport Operators Council International (AOCT). In addition to these three, other sources have been utilized as described below.

The centerpiece of the data is the data on airport finances. Since it is not centrally collected, the only source is the financial statements for each individual airport. We contacted the largest 100 airports in terms of the annual total number of enplaned revenue passengers as reported by the 1988 FAA Statistical Handbook (annual).\textsuperscript{19} Annual financial reports from 1970 through 1992 were requested, though we only use the data for the post de-regulation period. A total of 78 airports responded with varying amounts of data.

Among the major airports that did not provide data despite repeated requests are: 1) San Diego, 2) St. Louis, 3) Pittsburgh, 4) Boston Logan and 5) San Juan Airport. Data from many airports could not be used because data on some crucial variables were not reported. For example, data on all three New York Port Authority operated airports (i.e., JFK, La Guardia, Newark) could not be used because they did not report data on labor expenses separately from other operating expenses. Among other major airports that provided financial statements for at least two years but for which the data were not usable are Miami International, Denver International, Seattle International, Phoenix International, Baltimore Washington International, Honolulu, San Jose, Oakland, Portland (OR) New Orleans and Buffalo airports.

Many airports could not provide data for the entire sample period. Among the 23 airports which provided data for at least 20 years, a few airports did not report observations on labor expenses for a number of years. For example, Cincinnati airport reported its labor expenses only during the period 1972-75. For Charlotte Airport labor expenses could not be separated from other expenses for the years after 1987. Some airports provided data for some years with gaps in between. For example, Atlanta airport provided data for all years from 1982 to 1991 and then

\textsuperscript{19} Revenue passengers are defined by the FAA as the passengers who pay for their trip.
provided data for 1978-1979, but omitted 1980 and 1981. The final data set used in this study consists of an unbalanced panel of 52 airports and 462 observations. The airports, their ranking by FAA on the basis of passenger volume, the type of administration, and the number of observations for each of them is presented in Table 1.

The key variable for our purposes is the type of governmental structure. General purpose governmental structures that manage airports include cities, counties and states. In the current sample of 52 airports, we have classified 25 airports as being administered by general purpose governments in the latest sample year, i.e., 1992. Among this group 18 were administered by city government, 6 airports by county governments and only Anchorage airport by the state of Alaska. Among the major US airports Baltimore-Washington International (BWI) and all airports in Hawaii including Honolulu International are state administered. Neither of these two airports are able to be included in the sample. A few airports which have been classified as city-operated in this study enjoy a large degree of independence in administration. In our work, if the top airport executive is appointed by an independent commission or board we classify that airport as a special district authority administered airport, otherwise it is classified as a general purpose government airport. Using this criterion, airports are classified under the two groups on the basis of information from the individual airport’s financial report and telephone conversations with airport officials. For example, Philadelphia International airport has been classified as a city operation, even though the aviation department is overseen by an Airport Advisory Board whose members are not city bureaucrats. In the case of Los Angeles, the overseeing authority is an airport commission which reviews airport operations although the daily operations are run by the city aviation department.

The financial statements for all the airports used in this study except for Milwaukee Mitchell and Columbia (SC) are audited by well-known accounting firms. A typical financial

\[20\]
The General Information Survey is a publication on the physical attributes (i.e., number of runways, gates) of airports published by the Airport Operators Council International (AOCI). Most airports used in the study are members of AOCI. This source also provides information on contractual services used by the airports, e.g., whether an airport uses contractual labor to provide fire or security services. This information was used to adjust airport’s expenditure on in-house labor, as contractual labor is classified as materials expenditures.

Data on labor expenses is taken from the financial statements. Because some airports use contractual labor more than others, their in-house labor expenses appear less than the other airports. Since the AOCI survey lists which airports use contractual labor for what services, adjustments have been made in the labor expenses of those airports. The price of labor is taken from the average city government wages of the cities where the airports are located. We assume that although the wage rate may not be the true wage rate for airport labor, variations in the city government wages represent variations in wage rates of the airport employees. Since allocative inefficiency is assumed to be a function of the form of government, any systematic difference in

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18

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21 For example, all airports receive FAA grants to build their runways, and thus must abide by FAA strictures prohibiting funds from being directly transferred to other city departments.

22 We use enplaned revenue passengers, the subset of all the enplaned passengers who pay for their travel, as our measure of passengers for the output quality variable.
the wages of authorities from that of the city operated airports should be captured by the coefficient of the city dummy that is associated with the shadow price of labor.

Materials expenses are also taken from the financial reports. Material expenses are defined as all operating expenses other than labor, including utilities, contractual services and miscellaneous expenses. The price of materials is constructed by a weighted index of price indices of several items that generally account for the operating expenses net of labor. The items and the sources of the price indices are given in Table 2. The relative weights for the sub components of materials are taken from the Omaha airport’s relative utilization ratios for each sample years, which has a very detailed breakdown of the expenditure categories for every year in the sample.23

Capital expenditure is assumed to be equal to current total revenue minus current total operating expenses, since airports are constrained to be zero-profit institutions. Admittedly, this assumption is important and not free from error, but we are compelled by two reasons besides its tractability in the absence of airport investment series data. First, we have no reason to expect this error to be nonrandom with respect to government form. Second, airports are often challenged in court by airlines for overcharging, since the landing fees paid by airlines are adjusted to achieve the zero profit constraint. That is, due to the watchdog nature of the self-interested airlines, it is plausible that the zero-profit constraint is binding.

Since airports are mainly constructed of runways and terminals, a weighted average of the Federal Highway Administration’s construction price index and office building construction price index was used as the acquisition price of capital. The relative weights of terminals and

23 We have no independent method to verify this information, although Houston airport officials thought the breakdown looked “reasonable.”
runways were taken from Wells (1992). The price or opportunity cost of capital is taken from Moody’s AA grade municipal bond rates.

After defining the expenditure on the three inputs and constructing their prices, input quantities are calculated by dividing the total expenditure on inputs by their prices. Time is measured in years. All the variables are normalized to unity for Kansas International (MO), 1982.

A. The Estimating Equations

We estimate a slightly modified version of the SGM cost function using the input demands as in (8). First, as is common, we use costs and input levels divided by output to make the homoskedasticity assumption of the error term more plausible. Second, we delete the term that interacts quality (passengers and cargo) with time, and the higher order quality variables. Finally, we add fixed effect terms for each airport. The resulting system to be estimated by iterative non-linear seemingly unrelated regression consists of the cost per flight from (6) and the conditional input demand functions from (8) as:

\[
\frac{C^*}{Y} = \frac{1}{b_m} \{ g(P^*) + \sum \frac{b_i P_i^*}{Y} + \sum b_{iy} P_i^* + \left( \sum b_{iyy} P_i^* \right) Y + \sum \left( b_{iyt} + g_{itt} \right) P_i^* t + \sum g_{it} \frac{P_i^* t}{Y} \}
\]

\[
+ \left( \sum g_{itt} P_i^* \right) t^2 + \sum \sum d_{ijy} P_i^* Z_j
\]

\[
+ \sum j \left( \sum d_{ijk} P_i^* \right) \frac{Z_j}{Y} + \left( \sum d_{ikj} P_i^* \right) Z_k Z_j + \mu + \epsilon
\]

\[\text{Eq. (9a)}\]

---

24 Our panel of airport data is unbalanced, and in our view the cost of dropping observations was not worth the small loss in capturing fully flexible time variation. Sensitivity analysis shows the estimates are not particularly sensitive to alternative deletions.
\[
\frac{X_i}{Y} = \left\{ \frac{S^i P^*}{\theta^i P^*} - \frac{\theta_i}{2} \left( \frac{P^i S^i P^*}{(\theta^i P^*)^2} \right) \right\} + \frac{b_{i}^l}{Y} + b_{i y} + b_{i y y} Y + (b_{i w} + g_{i w c i} Y) t
\]

\[
+ g_{l t} \frac{t}{Y} + g_{l t t} t^2 + \sum_j d_{i j y} Z_j + \sum_j d_{i j} \frac{Z_j}{Y}
\]

\[
+ d_{i j k} Z_k Z_j + v_n + u
\]

(9b)

where i indexes the three inputs, j indexes the two quality measures, m indexes governmental form, \( \mu_n \) and \( v_n \) are the airport specific fixed effects terms, \( \varepsilon \) and \( u \) are the error terms, \( g(\mathbf{P}^*) \) is from (7), and the observation specific subscripts have been suppressed.

The effect of institutional form on airport behavior is calculated below based on simulating the effect of institutional change on the estimated cost function. That is, were an airport operated by a general purpose city government converted to a special district authority, three changes would occur. One, the input shadow prices for labor and materials would change. Second, the level of technical efficiency would change, and finally the rate of technical change over time would be altered. We simulate these changes below by setting the city dummy variable to zero in all three elements of the specification.

IV. Results

The estimation results of equations 9a and 9b for the parameters of the SGM cost function are presented in Table 3.\(^{25}\) We find that the detail in the cost function shows

\(^{25}\) Monotonicity is satisfied at every data point of the shadow cost function. Concavity of the cost function is satisfied globally since the estimated S matrix is negative semi-definite.
statistically significant regularity by governance type, and these differences are quantitatively important. Specifically, the shadow price terms, and the overall technical efficiency term, are significant and are found to vary by governance type. We see that the expected results of special district governments, that technical efficiency can be improved, is supported. But, the countervailing loss of general purpose government responsibility to the general population is also found, as virtually all of the technical gains appear dissipated by the special district authority input choices. These results are dependent on the generalized cost function estimates and specification of the efficiency terms, which allow their effects to be identified outside of the fixed effects terms.

The technical efficiency parameter from equation (9a) is $b_m$. The estimation results show that airports operated by general purpose city governments face overall costs per flight 40.1% (1/1-0.286) higher than an otherwise identical special district operated airport. This finding is important confirmation of the general expectation that special district operation allows an institutional structure to evolve that is considerably streamlined compared to that from general purpose governments. What is interesting about the finding, however, is to determine to whom the efficiency gains accrue. The allocative efficiency results, which reflect in part the tastes of the airport operators as in (1), provide the evidence.

The allocative efficiency parameters are the $g_L$ and $g_{LC}$ parameters describing the shadow price of labor, and the $g_M$ and $g_{MC}$ parameters describing the shadow price of materials, presented in the first two rows of Table 3 in the section of input specific estimates. Using

---

The standard statistical software we use is unable to calculate robust standard errors for our non-linear SUR system. Experimentation with linear single equation estimates suggests our normalization is relatively successful at limiting heteroskedasticity, as the robust standard errors are no more than 20% larger than the uncorrected errors. This difference would not change any of the statistical conclusions we reach in what follows.
equation 3, these estimates show that the shadow price of labor compared to capital (which is normalized to 1) for special district authorities is 0.97, and for materials compared to capital is 0.80. These shadow price terms, however, are quite different from those for the general purpose governments. The coefficient for the general purpose government shadow price of labor indicates the shadow price is 0.65, based on the coefficient on the city operation dummy variable of -1.79.\(^{27}\) Similarly, the shadow price of materials, based on the dummy variable for general purpose city operation estimate of -1.56, is 0.45.

Because the allocative efficiency shadow prices are less than one, the special district prices of 0.97 for labor and 0.80 for materials could be interpreted as saying that special districts are more efficient, since the shadow prices are closer to one than the estimates for general purpose city governments of 0.65 and 0.45 for labor and materials, respectively. On the other hand, it is possible instead that our shadow price estimates reflect the actual prices paid by the airport operators. One reason we support this interpretation is that our price data is collected in the same way for all airports, it is not based on actual airport wages or material costs. The wage data, for instance, are the average wages for general government workers in all fields. Similarly, the price data for materials, as summarized in Table 2, is a price index for a series of services.\(^{28}\) Only the total expenditure data is actually reported by each airport. Thus the shadow price terms we estimate may reflect actual prices paid by the airport operators, in which case it is the relative

\(^{27}\) The results in Table 4 use equation (3) so that \(k_L\) for labor is from \((1 - 0.016 - 1.79)^2\), and \(k_M\) for materials is from \((1 - 0.106 - 1.56)^2\).

\(^{28}\) In the case of both labor and materials we have no reason to believe that the degree of price mis-measurement varies depending on the governmental form.
prices between special district authorities and general purpose city governments that are important for understanding underlying behavior.\textsuperscript{29}

As presented in Table 4, our estimates show that the shadow price of labor relative to that for capital for special district authority operated airports is 49\% higher than it is for general purpose city operated airports. Similarly, the shadow price of materials for the special district authority operated airports is even more disparate, as authorities operate as if the materials price is 78\% higher. Differentially rewarding labor would be an outcome consistent with special district authorities receiving less scrutiny than general purpose city governments over their level of costs.\textsuperscript{30} The alternative interpretation is also possible, that general purpose city government operated airports over-employ labor compared to capital, and our estimates indicate that labor demand would fall by 1.6\% if general purpose city government airports were converted to special district authorities. Overpayment in the materials component can only be understood to the extent materials prices include contract labor, such as consulting or construction. Nonetheless, it is difficult to buy inputs (labor or materials) at prices below supply prices, and we believe the relative prices between the governmental structures are the appropriate way to interpret these results. In that case, the general purpose shadow prices reflect supply prices, and the special district authority governments are paying above the supply prices.

Conditional on this interpretation, an estimate of the relative cost differences can be derived by assuming the difference in the relative shadow prices between cities and authorities is

\textsuperscript{29} It is also consistent anecdotally, as several Houston airport employees (a city operated airport) all expressed a desire to work for the Dallas-Fort Worth airport (an authority) because of the relative wage premium.

\textsuperscript{30} This possibility is consistent with the lack of direct governmental oversight over independent authorities as discussed in the rent seeking literature (Krueger, 1974), although we do not have any direct data to support (or refute) the hypothesis. It is also interesting to speculate whether extra contract services reduce costs for airlines.
actually reflected in input prices. To determine the relative importance, therefore, Table 5 shows the simulated cost differences when general purpose city airports are converted to special district authorities. The first row presents the simulation results using the parameter estimates for the special district authorities for the shadow prices, but with the data of the general purpose city government airports. The second row combines the allocative efficiency results with the technical efficiency advantage of the special district authorities. As the final column shows, the technical efficiency advantage is almost completely offset by the price differential paid by special district authority airports. From the top of Table 3, the technical efficiency advantage of the special district authority airports is 40.1%. After accounting for the extra costs indicated by the shadow prices, the cost advantage of the special district authority airports is found to fall to only 4.98% per flight.

The cost advantage of the special districts is not found to grow relative to the general purpose governments over time. The three input specific time trends, the $g_{i1\text{CITY}}$ coefficients, are shown in Table 3 to have small magnitudes, and large relative standard errors. Thus the cost differences between special district and general purpose governments appear to be endemic to the institutional structure difference, rather than a result of continuous change over time. The lack of difference also suggests that both institutional forms are equally capable of adapting to technical changes pertinent to airports, consistent with the fact that both institutions exist simultaneously.

Table 6 presents the own and cross price input demand elasticities. The own price elasticities for each input are negative, and are estimated to be inelastic. This is roughly consistent with the allocative efficiency results, in that a higher shadow wage rate leads to reduced labor demand, but that total costs would still rise. The cross-price elasticities show that
the inputs are substitutes. The other aspect of note is that the generalized cost function does not require that the cross price elasticities be symmetric.

V. Summary and Conclusion

The goal of this paper is to compare special district government behavior to general purpose government behavior, with an emphasis on discerning where any differences might arise. The results we generate are based on a slightly modified generalized cost function estimated with panel data. The advantage of our approach is that the cost function structure aids in identification, as the technical efficiency parameter appears in only the cost function, while the allocative efficiency parameters function through the shadow input prices that are not only in the cost function, but the input demand functions as well.

Our estimated results arise from three sources in the context of cost functions for US airports, which are almost evenly divided between the two governmental forms. Our first finding is that a more focused institution definitely generates cost savings, as the technical efficiency level of special district airports is found to be significantly higher than it is for general purpose governments, and results by itself in a 40% cost advantage for the special districts. We also examine allocative efficiency, however, to see whether certain inputs are relatively favored in the allocation process. We find that special district authorities treat their labor as being 49% more valuable than general purpose city governments, and treat materials as 78% more valuable. We speculate that much of the cost difference is in actually paid wages and prices, as our price data is not specific to airports. If the entire shadow price is actually paid to airport inputs, the technical advantage of the special districts would be almost entirely dissipated, resulting in a final costs difference of less than 5% per flight. Neither the technical efficiency advantage of the
special districts, nor their cost dissipation evident in the shadow input prices appears to be changing over time, as we find no difference in the rate of technical progress between the special district or general purpose airports.

We believe this set of results illustrates that the objective function of a governing institution is crucial in predicting its behavior. Zhang and Zhang (2003) for example find that several of the important decisions (for example concerning concessions) in airports depend on the objective. Our work here has taken some of those decisions as fixed, which is a potential limitation. On the other hand, our work has shown how some of the distinctions in governmental form might matter for behavior. If the objective function of government were to maximize social welfare, removing bureaucratic constraints inherent in general purpose governments would be advantageous. This possibility is shown by the technical efficiency advantage of special district airports. On the other hand, if the bureaucratic constraints arise because of the difficulty in infusing a special district government with the correct (from the perspective of residents) objectives, then removing them may have unintended consequences. The advantage of the cost function we estimate bears this out, as we are able to show that the allocative efficiency of special districts is quite distinct from general purpose governments, and in a way that considerably increases the costs incurred by special districts. Rent seeking is one model consistent with the behavior observed in our model. One interpretation consistent with our results, however, is that it is difficult to monitor governmental activities, and that removing the ultimate responsibility of governmental output to a separate government entity is an important distinction affecting the behavioral of an organization.

Airports are an important part of the infrastructure of an urban area. As such, they have a series of unique attributes unlike other elements of city government, so it may not be surprising
if airport operators feel constrained by some of the general strictures on operation within a
general purpose government. On the other hand, city operated airports have at least the potential
of affecting voting outcomes for politicians in city government, including the mayor and city
council. Because airports are seldom at the forefront of political debate, they constitute an
interesting example as to whether the “threat” of voter scrutiny is an important element of
institutional design. In the context of Mullin (2008), it is unclear whether airports are
unimportant enough for institutional design to be determinative to the ultimate economic
outcomes. Some of the variance in airport importance arises in a competitive context, and Oum
et.al. (2008) attempt to incorporate airport competition in their work. The difficulty with doing
so is that in many areas, an entire region or even country is the relevant alternative. Nonetheless,
an interesting avenue for additional work would be to explore how competition (perceived or
real) affects the relative performance of alternative governmental forms.

Another interesting element, although not one we are able to fully analyze here, is that
airlines apparently do not completely ‘capture’ airport operations. That is, a null hypothesis is
that institutional organization would not affect airport operations, because of airline interests. If
airlines are able reap all of the gains to efficient airport operation, institutional organization
would be irrelevant to financial results. One implication of finding that the governmental form
affects airport operations is that airlines may face different cost structures depending on
governmental form. This finding is interesting in the context of Brueckner’s (2002) recent work
on airport congestion, which discusses how relatively large airlines will internalize many of the
congestion costs which they impose on travelers and other flights, although not other airlines.
Specifically, the incidence of the organizational costs may be primarily on the airlines depending
on the extent to which airports confer monopoly power.
The United States has not yet begun to explore privatizing airport operations. Thus the work presented here contrasts special district and general purpose government operation in more detail than Oum et al (2008), but is unable to include private operation. We believe the combination of our two studies illustrates the importance of the details of alternative institutional structures, whether special districts or privatized organizations. Specifically, creating focused institutions seems to have significant operational savings, with the caveat that less direct political supervision by those with ties to voters may change the objective function in important ways.
### TABLE 1
SELECTED CHARACTERISTICS OF AIRPORTS IN THE SAMPLE

<table>
<thead>
<tr>
<th>Airport Name</th>
<th>National Rank by Passengers</th>
<th>Administered By</th>
<th>Number of Obs (Yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago O'hare Int’l</td>
<td>1</td>
<td>City</td>
<td>14</td>
</tr>
<tr>
<td>Atlanta Hartsfield</td>
<td>2</td>
<td>City</td>
<td>11</td>
</tr>
<tr>
<td>Dallas Fort Worth</td>
<td>3</td>
<td>Authority</td>
<td>13</td>
</tr>
<tr>
<td>Los Angeles Int’l</td>
<td>4</td>
<td>City</td>
<td>5</td>
</tr>
<tr>
<td>San Francisco Int’l</td>
<td>6</td>
<td>Authority</td>
<td>3</td>
</tr>
<tr>
<td>Detroit Metro Wayne County</td>
<td>13</td>
<td>City</td>
<td>7</td>
</tr>
<tr>
<td>Minneapolis-St. Paul</td>
<td>15</td>
<td>Authority</td>
<td>13</td>
</tr>
<tr>
<td>Washington National</td>
<td>18</td>
<td>Authority</td>
<td>5</td>
</tr>
<tr>
<td>Houston Intercontinental</td>
<td>20</td>
<td>City</td>
<td>14</td>
</tr>
<tr>
<td>Las Vegas McCarran</td>
<td>21</td>
<td>City</td>
<td>14</td>
</tr>
<tr>
<td>Philadelphia Int’l</td>
<td>23</td>
<td>City</td>
<td>5</td>
</tr>
<tr>
<td>Charlotte Douglas Int’l</td>
<td>24</td>
<td>City</td>
<td>9</td>
</tr>
<tr>
<td>Memphis Int’l</td>
<td>25</td>
<td>Authority</td>
<td>4</td>
</tr>
<tr>
<td>Washington Dulles Int’l</td>
<td>26</td>
<td>Authority</td>
<td>5</td>
</tr>
<tr>
<td>Kansas City Int’l</td>
<td>30</td>
<td>City</td>
<td>13</td>
</tr>
<tr>
<td>Houston Hobby</td>
<td>32</td>
<td>City</td>
<td>13</td>
</tr>
<tr>
<td>Fort Lauderdale</td>
<td>33</td>
<td>City</td>
<td>5</td>
</tr>
<tr>
<td>Cleveland Hopkins Int’l</td>
<td>36</td>
<td>City</td>
<td>10</td>
</tr>
<tr>
<td>Nashville Metro</td>
<td>38</td>
<td>Authority</td>
<td>13</td>
</tr>
<tr>
<td>Chicago Midway</td>
<td>41</td>
<td>City</td>
<td>8</td>
</tr>
<tr>
<td>Indianapolis Int’l</td>
<td>45</td>
<td>Authority</td>
<td>13</td>
</tr>
<tr>
<td>Ontario, CA Int’l</td>
<td>47</td>
<td>City</td>
<td>5</td>
</tr>
<tr>
<td>West Palm Beach Int’l</td>
<td>48</td>
<td>City</td>
<td>6</td>
</tr>
<tr>
<td>Dayton Int’l</td>
<td>49</td>
<td>City</td>
<td>9</td>
</tr>
<tr>
<td>Albuquerque Int’l</td>
<td>51</td>
<td>City</td>
<td>3</td>
</tr>
<tr>
<td>Sacramento Metro</td>
<td>55</td>
<td>City</td>
<td>12</td>
</tr>
<tr>
<td>Columbus Int’l</td>
<td>57</td>
<td>Authority + City</td>
<td>5</td>
</tr>
<tr>
<td>Milwaukee Mitchell Int’l</td>
<td>58</td>
<td>City</td>
<td>11</td>
</tr>
</tbody>
</table>
TABLE 1 (cont.)

SELECTED CHARACTERISTICS OF AIRPORTS IN THE SAMPLE

<table>
<thead>
<tr>
<th>AIRPORT</th>
<th>NATIONAL RANK BY PASSENGERS</th>
<th>ADMINISTERED BY</th>
<th>NUMBER OF OBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reno Canon Int’l</td>
<td>59</td>
<td>Authority</td>
<td>13</td>
</tr>
<tr>
<td>Norfolk Int’l</td>
<td>60</td>
<td>Authority</td>
<td>2</td>
</tr>
<tr>
<td>Tucson Int’l</td>
<td>61</td>
<td>Authority</td>
<td>14</td>
</tr>
<tr>
<td>Oklahoma City Will Rogers</td>
<td>63</td>
<td>City</td>
<td>10</td>
</tr>
<tr>
<td>Syracuse Hancock Int’l</td>
<td>64</td>
<td>City</td>
<td>11</td>
</tr>
<tr>
<td>Jacksonville Int’l</td>
<td>65</td>
<td>Port Authority</td>
<td>2</td>
</tr>
<tr>
<td>Fort Myers Southwest Regional</td>
<td>69</td>
<td>Authority+City^b</td>
<td>12</td>
</tr>
<tr>
<td>Omaha Eppley</td>
<td>71</td>
<td>City Authority</td>
<td>13</td>
</tr>
<tr>
<td>Louisville Standiford</td>
<td>72</td>
<td>Authority</td>
<td>13</td>
</tr>
<tr>
<td>Anchorage</td>
<td>74</td>
<td>City</td>
<td>3</td>
</tr>
<tr>
<td>Birmingham Municipal</td>
<td>75</td>
<td>Authority</td>
<td>6</td>
</tr>
<tr>
<td>Richmond Int’l</td>
<td>77</td>
<td>Authority</td>
<td>14</td>
</tr>
<tr>
<td>Spokane Int’l</td>
<td>80</td>
<td>Authority</td>
<td>23</td>
</tr>
<tr>
<td>Sarasota-Bradenton</td>
<td>82</td>
<td>Authority</td>
<td>13</td>
</tr>
<tr>
<td>Des Moines</td>
<td>83</td>
<td>City</td>
<td>7</td>
</tr>
<tr>
<td>Colorado Springs Municipal</td>
<td>84</td>
<td>City</td>
<td>3</td>
</tr>
<tr>
<td>Charleston (SC) AFB Int’l</td>
<td>85</td>
<td>Authority</td>
<td>12</td>
</tr>
<tr>
<td>Wichita Mid-Continent</td>
<td>86</td>
<td>Authority</td>
<td>11</td>
</tr>
<tr>
<td>Portland (ME) Int’l Jetport</td>
<td>89</td>
<td>City</td>
<td>13</td>
</tr>
<tr>
<td>Columbia (SC) Metro</td>
<td>91</td>
<td>Authority</td>
<td>10</td>
</tr>
<tr>
<td>Savannah Int’l</td>
<td>92</td>
<td>Authority</td>
<td>8</td>
</tr>
<tr>
<td>Boise</td>
<td>93</td>
<td>City</td>
<td>4</td>
</tr>
<tr>
<td>Knoxville McGhee-Tyson</td>
<td>96</td>
<td>Authority</td>
<td>2</td>
</tr>
<tr>
<td>Harlingen Rio Grande Int’l</td>
<td>99</td>
<td>Authority</td>
<td>5</td>
</tr>
</tbody>
</table>

City indicates a general purpose government, while Authority indicates a special district government.

^a Three observations under general purpose city and two observations under special district authority.
^b Six observations under general purpose city administration and six observations under special district authority.
TABLE 2  
COMPONENTS OF THE MATERIALS PRICE INDEX

<table>
<thead>
<tr>
<th>SUBCOMPONENT</th>
<th>CLASSIFICATION</th>
<th>SOURCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel &amp; Utilities</td>
<td></td>
<td>CPI: Fuel and Utilities</td>
</tr>
<tr>
<td>Construction Materials</td>
<td></td>
<td>Engelman’s Heavy Construction Price Index</td>
</tr>
<tr>
<td>Outside Business Services</td>
<td></td>
<td>Service Price Index for State and Local Government Excluding Labor</td>
</tr>
<tr>
<td>Communications</td>
<td></td>
<td>CPI: Telephone Services</td>
</tr>
<tr>
<td>Insurance</td>
<td></td>
<td>GDP Deflator: Insurance</td>
</tr>
<tr>
<td>Office Supplies</td>
<td></td>
<td>GDP Deflator for Consumer Goods: Paper &amp; Stationary</td>
</tr>
<tr>
<td>Travel</td>
<td></td>
<td>GDP Deflator for Consumer Goods: Transportation</td>
</tr>
<tr>
<td>Trash</td>
<td></td>
<td>CPI: Refuse Collection</td>
</tr>
<tr>
<td>Water &amp; Sewer</td>
<td></td>
<td>CPI: Water &amp; Sewer</td>
</tr>
</tbody>
</table>
TABLE 3: Cost Function and Conditional Input Demand Parameter Estimates

<table>
<thead>
<tr>
<th>Parameter: Variable in equation (9a)</th>
<th>Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b_{\text{city}}$ Tech eff $^a$</td>
<td>1.401*</td>
<td>-</td>
</tr>
<tr>
<td>$s_{\text{LM}}$ Input prices $^b$</td>
<td>0.704*</td>
<td>0.167</td>
</tr>
<tr>
<td>$s_{\text{MK}}$ Input prices $^b$</td>
<td>0.526*</td>
<td>0.173</td>
</tr>
<tr>
<td>$s_{\text{KL}}$ Input prices $^b$</td>
<td>0.082</td>
<td>0.143</td>
</tr>
</tbody>
</table>

$^a$ Technical efficiency is reported from $1/(1+b_{\text{city}} \times \text{CITY})$, where $b_{\text{city}}$ is estimated to be -0.286 (0.056). Thus the general technical efficiency parameter $b$ from equation (5) is 1.401 ($1/(1-0.286)$). The estimate indicates airports run by general purpose city governments have costs 40.1% higher than those by otherwise identical special district authority operated airports.

$^b$ The parameter estimates here belong to the $S$ matrix in $g(P^*)$ in equation 7. The diagonal elements are derived from these estimates, such that $s_{LL} = -s_{LK} - s_{LM}$, $s_{KK} = -s_{LK} - s_{KM}$, $s_{MM} = -s_{LM} - s_{KM}$.

Input Equation Estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Var in (9a)</th>
<th>LABOR</th>
<th>MATERIAL</th>
<th>CAPITAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition of $P^*$ (eqn 3) -see Table 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$g_i$</td>
<td>$P^* , ^c$</td>
<td>-0.02 (0.06)</td>
<td>-0.11* (0.04)</td>
<td>-</td>
</tr>
<tr>
<td>$g_{iC}$</td>
<td>$P^\text{CITY} , ^c$</td>
<td>-1.79* (0.11)</td>
<td>-1.563* (0.080)</td>
<td>-</td>
</tr>
<tr>
<td>Institutional Variation in Technical Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$g_{i1 \text{city}}$</td>
<td>Time*City $^d$</td>
<td>-0.004 (0.004)</td>
<td>-0.005 (0.008)</td>
<td>0.002 (0.006)</td>
</tr>
<tr>
<td>Parameter</td>
<td>Var in (9a)</td>
<td>LABOR</td>
<td>MATERIAL</td>
<td>CAPITAL</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>----------------</td>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>$b_{iyt}$</td>
<td>Time$^d$</td>
<td>-0.06* (0.02)</td>
<td>-0.30** (0.05)</td>
<td>-0.10* (0.05)</td>
</tr>
</tbody>
</table>

**Remaining Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Var in (9a)</th>
<th>LABOR</th>
<th>MATERIAL</th>
<th>CAPITAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>$b_i$</td>
<td>$p_{i}/Y$</td>
<td>0.003 (0.003)</td>
<td>-0.08* (0.03)</td>
<td>-0.002 (0.002)</td>
</tr>
<tr>
<td>$b_{iy}$</td>
<td>$p_{i}$</td>
<td>0.74 (0.22)</td>
<td>1.38* (0.43)</td>
<td>-0.39 (0.39)</td>
</tr>
<tr>
<td>$b_{iyy}$</td>
<td>$p_{i}Y$</td>
<td>-0.32* (0.13)</td>
<td>0.36 (0.25)</td>
<td>0.05 (0.23)</td>
</tr>
<tr>
<td>$g_{it}$</td>
<td>$p_{i}Time/Y$</td>
<td>0.006* (0.001)</td>
<td>0.006* (0.003)</td>
<td>0.002 (0.002)</td>
</tr>
<tr>
<td>$g_{itt}$</td>
<td>$p_{i}Time^2$</td>
<td>0.002* (0.001)</td>
<td>0.01* (0.002)</td>
<td>0.006* (0.002)</td>
</tr>
<tr>
<td>$d_{ip}$</td>
<td>$p_{i}Z_{pass}$</td>
<td>0.92* (0.13)</td>
<td>2.49* (0.26)</td>
<td>1.87* (0.24)</td>
</tr>
<tr>
<td>$d_{ic}$</td>
<td>$p_{i}Z_{cargo}$</td>
<td>0.007* (0.004)</td>
<td>0.02* (0.006)</td>
<td>0.02* (0.006)</td>
</tr>
<tr>
<td>$d_{ip}$</td>
<td>$Z_{pass}p_{i}/Y$</td>
<td>0.14 (0.12)</td>
<td>-0.55* (0.23)</td>
<td>-0.11 (0.22)</td>
</tr>
<tr>
<td>$d_{ic}$</td>
<td>$Z_{cargo}p_{i}/Y$</td>
<td>-0.003 (0.006)</td>
<td>-0.02* (0.01)</td>
<td>-0.01 (0.01)</td>
</tr>
<tr>
<td>$d_{icp}$</td>
<td>$Z_{pass}Z_{cargo}p_{i}$</td>
<td>0.001 (0.001)</td>
<td>0.002* (0.001)</td>
<td>0.001 (0.001)</td>
</tr>
</tbody>
</table>

Notes:
ZP=passengers, ZC=cargo.
Pseudo adjusted $R^2$ for labor = .80, for capital = .77, and for materials = .80.

$^c$ Following equation (3), the shadow price $p_{i}^* = p_i(1 + g_i + g_{ic} CITY)^2$ for $i = L, M$, while the capital price is normalized to one.

$^d$ The impact of government structure on the rate of technical change is tested by $(b_{iyt} + g_{it} CITY * City) * Time$, see equation (9b).
**TABLE 4: Allocative Efficiency, estimated $k$ value**
(standard errors in parentheses)

<table>
<thead>
<tr>
<th>Governed by:</th>
<th>Labor</th>
<th>Capital (^1)</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>0.65 (0.12)</td>
<td>1.0</td>
<td>0.45 (0.09)</td>
</tr>
<tr>
<td>Authority</td>
<td>0.97 (0.06)</td>
<td>1.0</td>
<td>0.80 (0.04)</td>
</tr>
<tr>
<td>Authority/City(^2)</td>
<td>1.49</td>
<td>1.0</td>
<td>1.78</td>
</tr>
</tbody>
</table>

*\(k\) is the estimated difference between the observed price and the shadow price where \(P^* = kP\)
These estimates use the coefficient estimates of Table 3 for \(g_i\) and for \(g_{iC}\) (where \(i\) is labor, materials, and capital) in equations (3) (see text).

1 The shadow prices are relative to the price of capital.

2 The relative shadow prices are the ratio between the special district authority and general purpose city prices, see text.


**TABLE 5**
Changes in Input Demands and Total Costs
if General Purpose City Operated Airports Were Transferred to
Special District Authorities
(standard errors in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Labor</th>
<th>Capital</th>
<th>Material</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allocative Efficiency¹</td>
<td>-1.63%</td>
<td>8.87%</td>
<td>-9.01%</td>
<td>40.3%</td>
</tr>
<tr>
<td></td>
<td>(1.69)</td>
<td>(2.92)</td>
<td>(3.88)</td>
<td>(12.68)</td>
</tr>
<tr>
<td>Combined Change²</td>
<td>4.74%</td>
<td>5.94%</td>
<td>-5.02%</td>
<td>4.98%</td>
</tr>
<tr>
<td></td>
<td>(1.69)</td>
<td>(2.92)</td>
<td>(3.90)</td>
<td>(6.81)</td>
</tr>
</tbody>
</table>

¹ Derived by calculating the predicted values of (2) on the data for city operated airports both using the estimated values of \(g_L\) and \(g_M\) and by substituting zeros for \(g_{LC}\) and \(g_{MC}\). When zero values are substituted for \(g_{LC}\) and \(g_{MC}\) we obtain the predicted values under special district authorities for allocative efficiency. The entries are the estimated change of the mean predicted values.

² In addition to using the special district input shadow prices, this also includes the special district technical efficiency estimate.
TABLE 6: Cross-Price and Own-Price(Shadow) Elasticities

<table>
<thead>
<tr>
<th></th>
<th>( P_L )</th>
<th>( P_K )</th>
<th>( P_M )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( L )</td>
<td>-.356 (.013)</td>
<td>.135 (.065)</td>
<td>.224 (.096)</td>
</tr>
<tr>
<td>( K )</td>
<td>.126 (.010)</td>
<td>-.194 (.058)</td>
<td>.083 (.035)</td>
</tr>
<tr>
<td>( M )</td>
<td>.225 (.076)</td>
<td>.106 (.034)</td>
<td>-.319 (.012)</td>
</tr>
</tbody>
</table>

Standard errors in parentheses. Elasticities are the unweighted mean of elasticities calculated by observation.
REFERENCES


