GENERAL PURPOSE OR SPECIAL DISTRICT GOVERNANCE?

TECHNICAL EFFICIENCY VS. RENT DISSIPATION IN AIRPORT FINANCES

Steven G. Craig*

James Airola**

and

Manzur Tipu***

*Department of Economics
University of Houston
Houston, TX 77204-5882
(713)-743-3812
scraig@uh.edu

** Monterey Institute of International Studies
460 Pierce Street
Monterey, CA 93943 USA
jairola@miis.edu
(831) 647-4140

***Department of Economics
East-West University
Dhaka, Bangladesh

ABSTRACT

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.

June, 2011

I. INTRODUCTION[1]

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).[2] This institutional difference thus affords us

[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.

[4] Among the recent DEA works are Gillen and Lall (1997), Adler and Berechman (2001), Martin and Roman (2001), Martin-Cejas (2002), Abbott and Wu (2002), Pacheco and Fernandes (2003), Pels et. al. (2003), Barros and Sampaio (2004), Holvad and Graham (2004), and Martin and Roman (2006).

[5] As discussed below, materials include contracts external to direct airport employment.

in all but a few instances.[6] 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.[7] 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.[8] This concern could be with general

[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.[9] 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.[10] 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 is 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:

$$U = U(S, X) \tag{1}$$

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

---

[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):

$$(3) \quad \begin{aligned} k_L &= (1 + g_L + g_{LC} * CITY)^2 \\ k_M &= (1 + g_M + g_{MC} * CITY)^2 \end{aligned}$$

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.[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.[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:

$$(4) \qquad C\,(y_i\,,\,p_i/b_m\,) = \min_{x}\,[\,(p_i\,/\,b_m\,)\,(b_m\ \mathbf{x_i}\,)\,/\,\,(\,f\,(b_m\ \mathbf{x_i}\,) = y_i\,]\ \ =\ \ (1/b_m\,)\,C\,(y\,,\,\mathbf{p}_i\,)$$

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

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

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:

$$b_m = (1 + b_{CITY} * CITY) \tag{5}$$

where 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*(A), incorporating both input technical efficiency (equation 5) and allocative inefficiency (equations 2 and 3) from shadow prices can be written as:

$$\begin{aligned} C^*(.) = {} & \left({}^{1}\!/_{b_m}\right)\{ g(P^*Y) + \sum_i b_i P_i^* + \sum_i b_{i\,y}\; P_i^*\, Y + \left(\sum_i b_{i\,y\,y} P_i^*\right) Y^2 \\ & + \sum_i \left(b_{i\,y\,t} + g_{i\,t\,City}\, City\right) P_i^*\, t\, Y + \sum_i g_{i\,t}\, P_i^*\, t + \left(\sum_i g_{i\,t\,t}\, P_i^*\right) t^2\, Y \\ & + \sum_i \sum_j d_{i\,j\,y}\, P_i^*\, Z_j\, Y + \sum_j \left(\sum_i d_{i\,j}\, P_i^*\right) Z_j \\ & + \sum_k \sum_j \left(\sum_i d_{\,ijk} P_i^*\right) Z_k Z_j Y \\ & + 2 \sum_k \left(\sum_i d_{i\,k\,t}\; P_i^*\right) Z_k\, t\, Y\} \end{aligned} \tag{6}$$

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)
$$g(P^*) = P^{*\,\prime} S\, P^* / 2\, \theta\,' P^*$$

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)
$$\begin{aligned} X_i(.) = \mathrm{Y} * & \left\{ \frac{S^i \boldsymbol{P}*}{\theta\,'\boldsymbol{P}^*} - \frac{\theta_i}{2} \left(\frac{\boldsymbol{P}^{*\,\prime} \boldsymbol{S}^i \boldsymbol{P}^*}{(\theta\,'\boldsymbol{P}^*)^2} \right) \right\} \\ & + b_i + b_{iy}\, Y + b_{iyy}\, Y^2 + (b_{iyt} + g_{it\,City}\, City)\, t\, Y \\ & + g_{it}\, t + g_{itt}\, t^2\, Y + \sum_j d_{ijy}\, Z_j\, Y + \sum_j d_{ij}\, Z_j \\ & + \sum_k \sum_j d_{ijk}\, Z_k\, Z_j\, Y + 2 \sum_k d_{ikt}\, Z_k\, t\, Y \end{aligned}$$

where i indexes the three inputs. S^i is the ith 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 $g_{t\ City}$, 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_{tCity} 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 (AOCI). 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).[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

[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.[20] 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] 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.

report contains some information on the administrative structure of the airport, a balance sheet and income statement along with some notes on accounting principles and variable definitions. Further, a research advantage of U.S. airports is that the Federal Airport Administration (FAA) imposes certain rules constraining the interaction between airports and other parts of the city government, so the institutional environment is relatively similar across airports.[21] The annual FAA statistical handbook has been used for data on number of flights and passengers and tons of cargo and mail.[22]

The General Information Survey is a publication on the physical attributes (i.e., number of runways, gates) of airports published by 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

[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 homoscedasticity 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.[24] 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:

(9a)
$$\frac{C*}{Y} = \frac{1}{b_m}\{g(P^*) + \sum_i b_i \frac{P_i^*}{Y} + \sum_i b_{iy} P_i^* + \left(\sum_i b_{iyy} P_i^*\right) Y + \sum_i (b_{iyt} + g_{itCity} City) P_i^* t + \sum_i g_{it} \frac{P_i^* t}{Y} + \left(\sum_i g_{itt} P_i^*\right) t^2 + \sum_i \sum_j d_{ijy} P_i^* Z_j + \sum_j \left(\sum_i d_{ij} P_i^*\right) \frac{Z_j}{Y} + \left(\sum_i d_{ikj} P_i^*\right) Z_k Z_j + \mu_n + \varepsilon$$

[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.

(9b)

$$\frac{X_i}{Y} = \left\{\frac{S^i \boldsymbol{P}*}{\theta\,'\boldsymbol{P}^*} - \frac{\theta_i}{2}\left(\frac{\boldsymbol{P}^{*\,\prime}\boldsymbol{S^i}\boldsymbol{P}^*}{(\theta\,'\boldsymbol{P}^*)^2}\right)\right\}$$

$$+ \frac{b_i}{Y} + b_{iy} + b_{i\,y\,y}\,Y + (b_{i\,y\,t} + g_{i\,t\,City}\,City\,)\,t$$

$$+ g_{i\,t}\,\frac{t}{Y} + g_{i\,t\,t}\,t^2 + \sum_j d_{i\,j\,y}\,Z_j + \sum_j d_{i\,j}\,\frac{Z_j}{Y}$$

$$+ d_{i\,j\,k} Z_k\, Z_j + v_n + u$$

where i indexes the three inputs, j indexes the two quality measures, m indexes governmental form, μ_n and v_n are the airport specific fixed effects terms, ε and u are the error terms, g (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.[26] 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

[26] 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.[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.[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

---

[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.

[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 $g_{i\,t\,CITY}$ 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 in not only 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

	NATIONAL RANK BY PASSENGERS	ADMINISTERED BY	NUMBER OF OBS (YRS)
Chicago O'hare Int'l	1	City	14
Atlanta Hartsfield	2	City	11
Dallas Fort Worth	3	Authority	13
Los Angeles Int'l	4	City	5
San Francisco Int'l	6	Authority	3
Detroit Metro Wayne County	13	City	7
Minneapolis-St. Paul	15	Authority	13
Washington National	18	Authority	5
Houston Intercontinental	20	City	14
Las Vegas McCarran	21	City	14
Philadelphia Int'l	23	City	5
Charlotte Douglas Int'l	24	City	9
Memphis Int'l	25	Authority	4
Washington Dulles Int'l	26	Authority	5
Kansas City Int'l	30	City	13
Houston Hobby	32	City	13
Fort Lauderdale	33	City	5
Cleveland Hopkins Int'l	36	City	10
Nashville Metro	38	Authority	13
Chicago Midway	41	City	8
Indianapolis Int'l	45	Authority	13
Ontario, CA Int'l	47	City	5
West Palm Beach Int'l	48	City	6
Dayton Int'l	49	City	9
Albuquerque Int'l	51	City	3
Sacramento Metro	55	City	12
Columbus Int'l	57	Authority + City[a]	5
Milwaukee Mitchell Int'l	58	City	11

TABLE 1 (cont.)

SELECTED CHARACTERISTICS OF AIRPORTS IN THE SAMPLE

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

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

SUBCOMPONENT CLASSIFICATION	**SOURCES**
Fuel & Utilities	CPI: Fuel and Utilities
Construction Materials	Engelman's Heavy Construction Price Index
Outside Business Services	Service Price Index for State and Local Government Excluding Labor
Communications	CPI: Telephone Services
Insurance	GDP Deflator: Insurance
Office Supplies	GDP Deflator for Consumer Goods: Paper & Stationary
Travel	GDP Deflator for Consumer Goods: Transportation
Trash	CPI: Refuse Collection
Water & Sewer	CPI: Water & Sewer

TABLE 3: Cost Function and Conditional Input Demand Parameter Estimates

Parameter: Variable in equation (9a)	Estimate	Standard Error
b_{city} Tech eff [a]	1.401*	-
s_{LM} Input prices [b]	0.704*	0.167
s_{MK} Input prices [b]	0.526*	0.173
s_{KL} Input prices [b]	0.082	0.143

[a] Technical efficiency is reported from $1/(1+b_{CITY}*CITY)$, where b_{CITY} is estimated to be -0.286 (0.056). Thus the general technical efficiency parameter b from equation (5) is 1.401 (1/(1-.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

Parameter	Var in (9a)	LABOR	MATERIAL	CAPITAL
Definition of P* (eqn 3) -see Table 4				
g_i	P* [c]	-0.02 (0.06)	-0.11* (0.04)	-
g_{iC}	P^*_{CITY} [c]	-1.79* (0.11)	-1.563* (.080)	-
Institutional Variation in Technical Change				
$g_{i\,t\,city}$	Time*City[d]	-0.004 (0.004)	-0.005 (0.008)	0.002 (0.006)

Parameter	Var in (9a)	LABOR	MATERIAL	CAPITAL
b_{iyt}	Time[d]	-0.06* (0.02)	-0.30** (0.05)	-0.10* (0.05)
Remaining Parameters				
b_i	P^*_i/Y	0.003 (0.003)	-0.08* (0.03)	-0.002 (0.002)
b_{iy}	P^*_i	0.74 (0.22)	1.38* (0.43)	-0.39 (0.39)
b_{iyy}	$P^*_i\ Y$	-0.32* (0.13)	0.36 (0.25)	0.05 (0.23)
g_{it}	P^*_i Time/Y	0.006* (0.001)	0.006* (0.003)	0.002 (0.002)
g_{itt}	$P^*_i\ \text{Time}^2$	0.002* (0.001)	0.01* (0.002)	0.006* (0.002)
d_{iPy}	$P^*_i\ Z_{Pass}$	0.92* (0.13)	2.49* (0.26)	1.87* (0.24)
d_{iCy}	$P^*_i\ Z_{cargo}$	0.007* (0.004)	0.02* (0.006)	0.02* (0.006)
d_{iP}	$Z_{pass}P^*_i/Y$	0.14 (0.12)	-0.55* (0.23)	-0.11 (0.22)
d_{iC}	$Z_{cargo}P^*_i/Y$	-0.003 (0.006)	-0.02* (0.01)	-0.01 (0.01)
d_{iCP}	$Z_{pass}*Z_{cargo}P^*_i$	0.001 (0.001)	0.002* (0.001)	0.001 (0.001)

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 $P_i^* = P_i(1 + g_i + g_{iC}\ \text{CITY})^2$ 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 $(b_{iyt} + g_{it\,city} * \text{City}) * \text{Time}$, see equation (9b).

TABLE 4: Allocative Efficiency, estimated *k* value

(standard errors in parentheses)

Governed by:	Labor	Capital[1]	Material
City	0.65 (0.12)	1.0	0.45 (0.09)
Authority	0.97 (0.06)	1.0	0.80 (0.04)
Authority/City[2]	1.49	1.0	1.78

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)

	Labor	Capital	Material	Total Cost
Allocative Efficiency[1]	-1.63% (1.69)	8.87% (2.92)	-9.01% (3.88)	40.3% (12.68)
Combined Change[2]	4.74% (1.69)	5.94% (2.92)	-5.02% (3.90)	4.98% (6.81)

[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

	P_L	P_K	P_M
L	-.356 (.013)	.135 (.065)	.224 (.096)
K	.126 (.010)	-.194 (.058)	.083 (.035)
M	.225 (.076)	.106 (.034)	-.319 (.012)

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

REFERENCES

Abbott, M. and S Wu (2002), "Total Factor Productivity and Efficiency of Australian Airports", The Australian Economic Review, Vol. 35, No. 3, 244-60.

Adler, N., Berechman, J., (2001), "Measuring airport quality from the airlines' viewpoint: an application of data envelopment analysis," Transport Policy, 8, 171-81.

Alesina, Alberto, Reza Baqir, and Caroline Hoxby, (2004), "Political Jurisdictions in Heterogeneous Communities," Journal of Political Economy, 112, April, 2004, 348-96.

Atkinson, S. E. Christopher Cornwell (1994a), " Estimation of Output and Input Technical Efficiency Using a Flexible Functional Form and Panel Data," International Economic Review, 35, 245-255.

_________, ______________________ (1994b), "Parametric Estimation of Technical and Allocative Efficiency with Panel Data", International Economic Review, 35, 231-243.

_________, _________ and R. Halvorsen (1984), "Parametric Efficiency Tests, Economies of Scale, and Input Demand in US Electric Power Generation," International Economic Review, 25, 647-662.

_________, ________________________ (1986), "The Relative Efficiency of Public and Private Firms in a Regulated Environment: The Case of Electric Utilities," Journal of Public Economics, 29, 281-294.

Baltagi, Badi (1995), Econometric Analysis of Panel Data, Wiley, Chicester, New York.

Baron, David and Roger Myerson (1982), "Regulating a Monopolist with Unknown Costs," Econometrica, 50(4), 911-30.

Barros, C.P., Sampaio, A., (2004), "Technical and Allocative Efficiency in Airports," International Journal of Transport Economics, 31 (3), 355-377

Bhagwati, J.N. and T.N. Srinivasan (1982), "The Welfare Consequences of Directly Unproductive Profit-Seeking (DUP) Lobbying Activities," Journal of International Economics, 13, 33-44.

Brueckner, Jan K. (2002), "Airport Congestion When Carriers Have Market Power," American Economic Review, 92, 1357-75.

Carlin, Alan and R.E. Park (1970), "Marginal Cost of Airport Runway Capacity," American Economic Review, 60, 310-319.

Chambers, R. G., Chung, Y. and Fare, R. (1998) "Profit, directional distance functions and Nerlovian efficiency," Journal of Optimization Theory and Applications, 95, 351–64.

Coert Engelsman International Ltd (1985), Engelsman's 1985 Heavy Construction Cost File, VNR, New York.

Daniel, Joseph (1995), "Congestion Pricing and Capacity of Large Hub Airports: A Bottleneck Model with Stochastic Queues," Econometrica, 63(2), 327-370.

Diewert, W. E. and T.J. Wales (1987), "Flexible Functional Forms and Global Curvature Conditions," Econometrica, 55(1) 43-68.

Eakin, B. Kelly and Thomas Kniesner (1988), "Estimating a Non-Minimum Cost Function for Hospitals," Southern Economic Journal, 583-97.

Fahad Khalil and Jacques Lawarree (1995), "Collusive Auditors,"American Economic Review, 58(2), 442-46.

Färe, R., S. Grosskopf and J. Logan (1985), "The Relative Performance of Publicly-Owned and Privately-Owned Electric Utilities," Journal of Public Economics, 26, 89-106.

Farber, S.C. (1989), "The Dependence of Parametric Efficiency Tests on Measures of Price of Capital and Capital Stock For Electric Utilities," The Journal of Industrial Economics, 38(2), 199-213.

Gillen D.W. and Lall A., (1997), "Developing measures of airport productivity and performance: An application of data envelopment analysis" in Proceedings of the Aviation Transport Research Group Conference, Vancouver, Canada.

Grosskopf, S and K. Hayes (1993), "Local Public Sector Bureaucrats and Their Input Choices," Journal of Urban Economics, 33, 151-166.

Holvad, T., Graham, A., (2004), "Efficiency Measurement for UK Airports: an Application of Data Envelopment Analysis," Empirical Economics Letters, 3(1), 29-39

Hooghe, Liesbet, and Gary Marks, (2003) "Unravelling the Central State, but How? Types of Multi-Level Government," American Political Science Review, 97, May, 2003, 233-243.

Jorgenson, Dale W. (1989), "Capital as a Factor of Production," in Dale Jorgenson and Ralph Landau eds, Technology and Capital Formation, Cambridge, MA., MIT Press.

Krueger, A.O. (1974), "The Political Economy of the Rent Seeking Society," American Economic Review", 64, 291-303.

Kumbhaker, Subal C. (1992), "Allocative Distortions, Technical Progress, and Input Demand in U.S. Airlines: 197-1984," International Economic Review, 33(3), 723-737.

Littlechild, S.C. and G.F. Thompson (1977), “Airport Landing Fees: A Game Theory Approach,” Bell Journal of Economics, 8, 186-204.

Lovell, C. A. K. and R. C. Sickles (1983), “Testing Efficiency Hypothesis in Joint Production: A Parametric Approach,” Review of Economics and Statistics, 65, 51-58.

Lau, L.J. and P.A. Yotopoulos (1971), “A Test for Relative Efficiency and an Application Indian Agriculture,” American Economic Review, 61, 94-109.

Martin, J.C., Roman, C., 2006, “A Benchmarking Analysis of Spanish Commercial Airports: A Comparison between SMOP and DEA Ranking Methods,” Networks and Spatial Economics, 6 (2), 111-134

Martin, J.C., Roman, C., 2007, “Political Opportunists and Mavericks ? A Typology of Spanish Airports,” International Journal of Transport Economics, 34 (2), 245-269

Martin-Cejas, R.R. (2002), “An Approximation to the Productive Efficiency of the Spanish airports network through a deterministic cost frontier”, Journal of Air Transport Management, 8, 233-238

Migue, J. and G. Belanger (1974), “Toward a General Theory of Managerial Discretion,” Public Choice, 27-43.

Morrison, S.A. (1987), “The Equity and Efficiency of Runway Pricing”, Journal of Public Economics,” 34, 45-60.

Mullin, Megan (2008), “The Conditional Effect of Specialized Governance,” American Journal of Political Science, 52, 125.

Oates, Wallace (2005), “Towards a Second Generation Theory of Fiscal Federalism,” International Tax and Public Finance, 12, 349-73.

Oum, Tae H., Jia Yan, and Chunyan Yu (2008), “Ownership Forms Matter for Airport Efficiency: A Stochastic Frontier Investigation of Worldwide Airports,” Journal of Urban Economics, forthcoming.

Orzechowski, W. (1977), “Economic Models of Bureaucracy: Survey, Extensions and Evidence,” in Borcherding, T. (ed.), Budgets and Bureaucrats: The Source of Government Growth, Duke Univ. Press, Durham, 229-259.

Pacheco, R.R. Fernandes, E. (2003), “Managerial Efficiency of Brazilian Airports,” Transportation Research A, 37 (8) 667-680

Pels E., 2000. Airport Economics and Policy, Ph.D. Dissertation, #222 Tinbergen Institute Research Series, The Netherlands.

Sickles, Robin C., David Good and Richard Johnson (1986), "Allocative Distortions and the Regulatory Transition of the U.S. Airline Industry," Journal of Econometrics, 33, 143-63.

Transportation Research Board (1990), Special Report 226: Airport System Capacity: Strategy and Choices. Washington D.C.: National Research Council.

Tullock, G, (1967), "The Welfare Cost of Tariffs, Monopolies and Theft," Western Economic Journal, 5.

Wells, Alexander T. (1992), Airport Planning and Management. Tab Books, McGraw-Hill, Blue Ridge Summit, PA. .

Zhang, Anming and Yimin Zhang (2003), "Airport Charges and Capacity Expansion: Effects of Concessions and Privatization," Journal of Urban Economics, 53, 54-75.