Institute for Illinois Public Finance
UNIVERSITY OF ILLINOIS SPRINGFIELD

U.S. STATE BUDGET EFFICIENCY: WHERE DO STATES STAND?

Arwi Srithongrung Kriz, DPA
Research Fellow, Institute for Illinois Public Finance, University of Illinois at Springfield

Working Paper 19-02

December 2019

I. INTRODUCTION

In 2016, total sub-national expenditures for state and local governments were $3.51 trillion, of which 48% were state government expenditures ($1.69 trillion), and the rest were local government expenditures ($1.82 trillion) (U.S. Census, 2019). State governments are significant providers of essential services such as higher education, transportation, health, and welfare; they also engage in important aspects of income redistribution and economic stabilization (Musgrave, 1969). There is significant variation in how much state governments as well as the functions on which they spend it.

For total spending, in 2016, Alaska, Hawaii and Delaware ranked first, second and third in terms of per capita state expenditures: $13,929, $8,443, and $8,311, respectively. Meanwhile, Nevada, Georgia and Florida spend the least per capita state at $3,699, $3,460, and $3,273 respectively. States also allocate their budgetary resources differently across functions. For example, in 2016, most of Minnesota's direct expenditure was for public welfare (42%) followed by education (18%) and transportation (6%). Meanwhile, the majority of Utah's direct expenditure went to education (31%) followed by public welfare (21%) and transportation (5%). Interestingly, North Dakota spent about equally on welfare and education program (25% and 22%, respectively); its transportation program, (17%) is the largest among all 50 states' transportation spending.[1]

The academic literature is mixed in explaining why state budget allocation varies. Various observers propose that budget allocation depends on external factors (e.g., history, geography, and demographics), internal factors (policy priorities, generosity of service levels, eligibility rules for social services), or tax policy (Urban Institute, 2019).

Since state governments play a significant role in providing public service provision and there is much variation in how much and how dollars are spent, it is critical for policy practitioners, citizens, and academics to understand how public resources are utilized before deciding whether changes (i.e., budget cuts or increases) are needed. Also, understanding state spending profiles and economic efficiency may be helpful for future studies to shed some light on the causes and consequences of budget allocation patterns.

This study evaluates state government performance efficiency and identifies the sources of inefficiency in eight state government service functions, using state budget and performance data from 2016. The eight service functions include:

- higher education;
- elementary and secondary education;
- welfare;
- health and hospital;
- safety;
- environment;
- transportation; and

[1] All figures calculated from U.S. Census Bureau (2019).

- other state infrastructure.

We investigate state performance efficiency and its sources using a mathematical programming technique called Data Envelopment Analysis (DEA). DEA has been used in over 3,000 peer-reviewed academic journal articles to evaluate relative performance efficiency by governments at both international and sub-national levels. DEA is superior to the more commonly used technique of ratio calculations using cost data drawn from state annual comprehensive financial reports (CAFR) in that multiple inputs and outputs can be incorporated into a performance efficiency model. DEA is more suitable for public service production in which multiple goals and missions result in multiple outputs for each function. According to Sherman and Zou (2006), ratios can provide beneficial managerial information about efficiency; however, they are incapable of accommodating multiple inputs and outputs when relative weights for inputs and outputs are not known. Further, they cannot be used to detect the reasons why inefficiency exists.

In this study, we define efficiency as the ratio of (weighted) output to (weighted) input; compared to another jurisdiction, a government with a higher ratio of output per input reflects relatively greater efficiency. If a government achieves the highest possible output per unit of input, they have reached a state of "absolute efficiency" or "optimal efficiency," and it is impossible to be more efficient without new technology or changes in the production process (Sherman and Zou, 2006, p. 52). Therefore, we measure efficiency as a relative concept, as in benchmarking.

Drake and Simpler (2002, p.1861) define technical inefficiency (sometimes called X-inefficiency) as the excessive use of inputs in the production of outputs. In this study, we evaluate technical efficiency (both short-and long-run) first for the states. Once we measure technical efficiency, we next examine the concept of scale economy. Scale economy refers to the size of the production process in a state. Hypothetically, if state A uses 500 sheets of paper to save information of its driver license applicants while state B uses 250 sheets for the same number of applicants, holding other factors constant, the source of inefficiency for state A is diseconomy of scale since its inputs are twice that of state B while its outputs are equal. Therefore, its production scale is too large. State A can consider cutting back the amount of paper used. Alternatively, it can use an electronic solution; with these technical changes, they can reduce the scale of production.

In addition to technical efficiency, economic and allocative efficiencies can be other sources of overall inefficiency. These types of efficiencies relate to input prices and the use of inputs given their prices, and thus, they look at the cost of service. Economic or price efficiency refers to the least *cost* per output unit. Note that economic and allocative efficiency focuses on "input costs" while technical efficiency focuses on "input volume." To continue the drivers' license example, State A chooses to cut physical inputs instead of changing technology and uses 250 papers, equal to those of State B. However, State A may still not achieve efficiency if it purchases copy paper at higher prices than State B. The difference in the prices of inputs creates economic inefficiency.

Allocative efficiency involves the use of an input mix given prices. According to Drake and Simpler (2002, p.1861), allocative inefficiency is the failure to utilize the cost-minimizing input bundle given input prices and the levels of outputs. Continuing our example, given the higher input price of paper for State A, they should shift their input mix to contain higher amounts of other inputs and less paper. They can add other inputs or change their processes to deemphasize the use of paper.

It is clear from this example that solely using cost per unit as an efficiency measure provides no clue to public managers why the public service cost is higher or lower than other governments or why it changes over time. DEA can provide that context. It can facilitate public managers to examine accounting and performance information to differentiate among scale, technical, economic, and allocative efficiency. Knowing the sources of inefficiency can help public decision-makers to target productivity improvement efforts better. Further, the results of a DEA can be used to examine the impacts of state government budgeting practices such as performance-based budgeting.

The rest of this paper is organized as follows. The next section discusses the background of the study, including DEA concepts, methods, and examples from the academic literature. The third section presents data, results, and discussion for all 50 states. The last section provides the conclusion and limitations of the study.

II. LITERATURE REVIEW

State governments are major service providers for higher education, transportation, health, and welfare; these functions are important income redistribution and stabilization (Musgrave, 1969). As mentioned above, state governments use different allocations for their budgetary resources not only in terms of per capita total spending but also in allocation across functions. The existing academic literature fails to explain the reasons for variation in budget allocations. Some work has found that budget allocations depend not only on external factors such as history, geography, and demographics but also on internal factors like policy priorities, generosity of service levels, and eligibility rules for social services, and on tax policy (Urban Institute, 2019). Understanding the efficiency of state spending may be helpful for future studies in explaining the causes and consequences of budget allocation patterns.

a. DEA and Other Methods of Efficiency Analysis

DEA is one of several methods that can be used to systematically assess the efficiency of organizations. DEA is superior to parametric methods (such as economic growth accounting, cost accounting estimation and Stochastic Frontier Analysis (SFA)) in three ways. First, DEA is more flexible. It does not require a functional form in evaluating efficiency; specifying functional form requires good knowledge regarding internal and external factors affecting efficiency (Smith & Street, 2005; Charnes, Cooper, Lewin, Seiford, 1994). To date, there have been very few studies identifying managerial, policy and economic factors contributing to efficiency in public service. Therefore, the type of information needed to specify a functional form does not exist. DEA is more practical specifying a model with only the outputs and inputs available for the sample (Smith & Street, 2005).

Second, DEA can evaluate efficiency using multiple outputs. In parametric methods, the dependent variable needs to be a single output. In DEA, each decision-making unit (DMU) is evaluated based on its own combination of outputs, inputs, and priorities. This characteristic is especially important to evaluate efficiency in the public sector since governments have multiple goals including both efficiency and equity, unlike those of the private sectors where profit is an ultimate goal.

Last, DEA builds the efficient frontier based on actual inputs and outputs of DMUs. In the parametric models, the efficient frontier is based on sample average inputs and outputs. Therefore, it is possible that none of the DMUs in a parametric model have a mix of inputs and outputs that lie on the frontier (Charnes, Cooper, Lewin, Seiford, 1994). The DEA approach produces a "best practice" measure of efficiency. This is an advantage for public-sector performance measurement since an inefficient government can learn from peers who have similar output profiles but have different input levels and mixes.

DEA also has some disadvantages compared to other models. First, since functional forms are not required, the selection of inputs and outputs and the number inputs and outputs are *ad hoc* (Hammonds, 2002). Because of this drawback, input and output selection must be carefully selected reflecting some understanding of the production process. We address this limitation through using publicly available data classified by the units of government themselves. The government units should be in the best position to identify their production processes.

We also use recommended practice to limit the number of inputs and outputs in the model. Hammond (2002) and Boussofiane et, al (1991) recommend that the product of inputs and outputs in a DEA model should not exceed the total number of observations to preserve DEA's discriminatory power (this is analogous to the degrees of freedom in parametric methods). Given that this study evaluates state government efficiency in one year (2016), the sample size is 50. We include two inputs measures and two input price measures. Therefore, we can include a maximum of twelve output indicators (4 inputs * 12 outputs = 48). We limited the output measures further for some of the functions analyzed because early estimates showed signs of degeneracy - more than half of the sample was found to lie on the frontier, but at the same time, they were not peers to any inefficient unit.

Another limitation of DEA is that it may not be able to account for external variables (those that are fixed or not under control of the DMUs). For example, in evaluating school efficiency, student characteristics such as family income level and IQ, may be important control variables. Aggregate measures of these variables can be incorporated into a DEA model as fixed inputs, however, the discriminatory power to separate between efficient and inefficient schools will be significantly reduced (Waldo, 2007; Hammond, 2002). Given this tradeoff between discriminatory power and control of fixed factors such as external variables, we omit fixed inputs to maximize discriminatory power.

b. DEA and Public-Sector Efficiency

There have been numerous studies that use DEA to evaluate efficiency in the public sector. In the area of public safety, Drake and Simpler (2002) use both parametric and nonparametric methods to analyze the relative efficiency of 42 police units in England and Wales during 1992-1997. Their model included three inputs: the number of police and civilian staff, the value of capital investment, and transportation expenditure, three input prices: average labor cost, capital investment per capita and transportation expenditures per capita, and two outputs: crime rates and the number of traffic offenses. Drake and Sampler (2002) find that both DEA and parametric methods produce similar efficiency rankings, suggesting that both are viable methodologies to calculate relative efficiency for public services. The authors do note that DEA is better since it reveals the sources of inefficiency. As another example, Gorman and Ruggiero (2009) use DEA to evaluate the technical efficiency of prosecutor's offices in the United States. They use four outputs: misdemeanor cases closed, felony cases closed, felony jury verdicts, and population, and two inputs: prosecutorial staff and other staff. Regressing efficiency scores against various external factors, they find that as median income increases, technical efficiency increases.

Public Transportation Performance

In the transportation domain, Nolan, Ritchie, and Rowcroft (2001) examine the causes of inefficiency in 25 transit agencies providing public bus services in the U.S during 1989-1993. Using an input-fixed DEA model with inputs of the number of buses in the active fleet, maintenance employees, fuel gallons, route miles served and non-maintenance employees, and a single output of passenger vehicle miles. The passenger vehicle miles are used as output indicator instead of revenue vehicle miles because it is "consumption-based measure" in which external factors may also determine the level of this indicator. Their results suggest that state and local government subsidies on bus production and maintenance positively enhance efficiency while federal subsidies for operation exert a negative effect on productivity. The authors postulate that this is due to information asymmetry in the types of subsidization.

Public Health and Hospital Service Performance

DEA has been used extensively in public health and hospital service productivity evaluation. For example, Byrnes and Valdmanis (1994) use DEA to produce estimates of technical and allocative efficiency for 123 non-teaching public hospitals in California. They use three output measures (medical-surgical acute discharges, medical-surgical intensive case discharges, and maternity discharge), six input variables (registered nurse, management and administrative personnel, technical service personnel, aides and orderlies and licensees' practical nurses) and 6 input prices (wage rate of each personnel types and depreciation rate of staff beds). They find that the hospitals suffer from allocative inefficiency to a greater degree than technical inefficiency; on average, inefficient hospitals can cut about 39% of the cost per inpatient discharge compared to the benchmarks.

Elsewhere, Luasa, Dineen, and Zieba (2018) use an input-oriented model to evaluate the technical efficiency of 112 public and private Irish nursing homes. This study is unique in that they use a bootstrap procedure to calculate efficiency scores with 95% confidence intervals. The results suggest that private nursing homes are relatively less efficient than public ones and that the primary sources of inefficiency are diseconomies of scale. In another example, Valdmanis, Kumanarayake, and Lertiendumrong (2004) use DEA to understand whether the Thailand Ministry of Health's new policy requiring that public hospitals must serve clients regardless of ability to pay will result in inefficiency. Their results suggest that serving both non-poor (who pay the full cost of medical service) and poor clients (who pay a partial cost of service or none at all) does not reduce efficiency.

Overall Government Spending Performance

DEA has also been used to compare overall government efficiency in providing service functions by level of government (i.e., municipal, regional, or central governments). For example, Moore, Nolan, and Segal (2005) use DEA to evaluate the relative efficiency of providing 11 public services in the 46 largest cities in the U.S. over six years. Their model includes 26 inputs and 14 outputs. The results from their second-stage analysis suggest that fixed inputs, including average snowfall and using the mayor form of government (as opposed to employing a city manager/administrator), reduce municipality operational efficiency. Meanwhile, population and state and local tax revenue increase municipal operating efficiency.

The last example is from the international level, using DEA to examine central government operating efficiency in 22 OECD countries during 2000-2010 (Pina, Torres and Martin, 2019). The authors specify a DEA model with 15 outputs in seven service functions, including general administration, education, health, public infrastructure, distribution, stability, and economic performance. The authors specify six service inputs: public expenditure in general government, education, health, infrastructure, social services, and other economic development-related expenditure.

III. THEORY

DEA is a non-parametric technique that compares the efficiency of a decision-making unit (DMU) to other DMUs (Farrell 1957; Charnes, Cooper, Lewin & Seiford, 1978). In this study, the DMUs are state governments making decisions regarding the allocation of public resources within and across service areas (we will refer to them as functions) based on their policy concerns and management processes. The relative efficiency of a DMU is defined as the ratio of total weighted outputs to total weighted inputs (Pina, Torres & Martin, 2019). DEA uses mathematical linear programing to assign each DMU's multiple input and output weights that maximize its productivity compared to other DMUs. This study uses an input-oriented DEA model where output is held constant. Given the weights that minimize inputs, an efficient DMU is one that achieves the highest ratio of weighted outputs to weighted inputs relative to other DMUs; hence, it is impossible to find other DMUs in the samples outperforming it. Efficient DMUs are used as benchmarks to which less efficient DMUs are compared.

We use an input-oriented DEA because in government service provision, outputs are workloads determined by citizen demands; as a result, the primary factor that can be manipulated is input. Following Gorman and Ruggiero (2009) in assessing U.S. district court efficiency, the input-oriented linear programing model is:

$$TE_j^{VRS} = Min\ \theta_j$$

$$s.t.$$

$$\sum_{i=1}^{n} \lambda_i \ y_{ki} \geq Y_{kj} \quad \forall\ k=1\ldots\ldots,s$$

$$\sum_{i=1}^{n} \lambda_i \; x_{li} \geq \theta_j x_{lj} \quad \forall \; l = 1 \ldots\ldots, m$$
$$\sum_{i=1}^{n} \lambda_i = 1$$
$$\lambda_i \; \geq 0 \;\; \forall \; i = 1, \ldots \ldots . N. \qquad (1)$$

where Y and X represent vectors of s outputs and m inputs, respectively. For each DMU, j (j = 1, ...N), $Y_j \equiv (y_{lj}, \ldots, y_{sj})$ and $X_j \equiv (x_{lj}, \ldots, x_{mj})$ represent the vectors of j's outputs and inputs, respectively. This DEA linear program is based on Banker, Charnes, and Cooper (BCC) (1984) in which the DMUs' production scales of DMU samples can be different, i.e., variable returns to scale (VRS). In equation (1), the weighted inputs and outputs of each DMU are used to calculate their ratio of technical efficiency (TE_j^{VRS}). The most efficient DMUs and their profiles of weighted inputs and outputs are then used as benchmarks to which all other DMUs are compared. The TE^{VRS}ranges from 0 to 1 where 1 is the most technically efficient indicating that the DMU is in the group of the most efficient units.

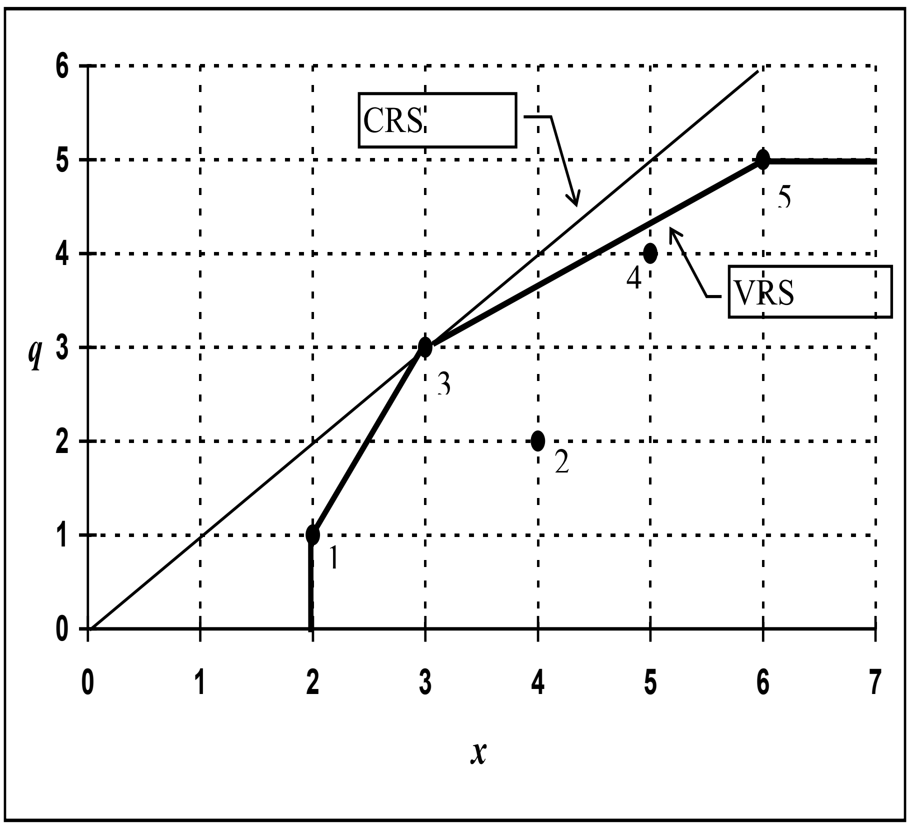
As explained by Gorman and Ruggiero (2009), removing the convexity constraint $\sum_{i=1}^{n} \lambda_i = 1$ in equation (1) results in DEA calculation that assumes a constant return to scale (CRS) technology. We refer to the measure of technical efficiency in this situation as $TE_j^{CRS} = Min\, \theta_j$ (Charnes, Cooper and Rhodes, 1984). In a sense, the TE_j^{CRS} represents a long-run production process where average total cost is fully adjusted given the level of outputs produced. Thus, a scale economy measure (SE_j) can be calculated by dividing TE_j^{CRS} with TE_j^{VRS} as shown in equation (2).

$$SE_j \; = \; TE_j^{CRS} / TE_j^{VRS} \; \leq 1 \qquad (2)$$

The scale efficiency measure suggests whether a state's production process is an optimal size compared to output produced. Scale efficiency measures the ability of a producer in varying its inputs (i.e., personnel and budgetary resource) given the volume of outputs produced. Decreasing Returns to Scale (DRS, when SE < 1) occurs when a state uses too many inputs compared to outputs produced. If a DRS producer wants to enhance efficiency, it will have to either (1) change production technology by investing in new service branches and facilities to gain capacity, or (2) cut back operational inputs, especially administrative costs. Increasing Returns to Scale (IRS, SE > 1) occurs when a state uses too few inputs compared to output volume. States with IRS who want to enhance efficiency must increase production size by increasing operational inputs and keep producing more outputs until an efficient level of production is achieved. IRS production processes mostly occur due to relatively large fixed costs from capital investment in building and facilities and so greater volumes reduce the marginal cost of production. Constant Returns to Scale (CRS, SE = 1) suggests that a state has reached maturity of its production process; all fixed inputs have been amortized over a large output. In CRS, cost rises in proportion to output, so a state can vary its cost directly by varying output.

Figure 1 below presents a summary of the main theoretical concepts discussed above. In the situation captured by the graph, two inputs, x and q, are used for a given level of output. The DEA "frontier," the dark line, indicates the minimum amount of inputs that are necessary to produce the output, assuming a VRS production process. Therefore, DMUs 1, 3, and 5, which lie on the line, are efficient. For these units the technical efficiency measures, TE_1^{VRS}, $TE_3^{VRS}, and\ TE_5^{VRS}$, will be equal to 1.00. DMUs 2 and 4 are inefficient; they could cut some inputs based on their benchmarks' (or peers) profile to become efficient. Which combination of inputs that could be cut can be identified by looking at the unit's "efficient peers." For DMU 2, its peers are DMUs 1 and 3 because they are closest to those units. To become efficient, DMU 2 could cut input x by 1.5 units while maintaining the same level of input q at two units. Alternatively, DMU 2 can follow either DMU 3 by using one unit less of input x and one unit more of input q. Finally, they could follow DMU 1 by cutting input x and q by two and one units, respectively. The figure also suggests that when we relax the VRS assumption (moving to the more lightly colored CRS assumption line – relaxing the assumption $\sum_{i=1}^{n} \lambda_i = 1$ in equation (1)), only DMU 3 is efficient; and its $TE_3^{CRS} = TE_3^{VRS} = SE_3 = 1.0$.

Figure 1. Illustration of DEA Method



Source: Coelli, Rao, O'Donnell, & Battese (2005).

As discussed above, DEA can be extended to calculate allocative efficiency and examine where a unit's mix of inputs and productivity given input prices. In order to calculate allocative efficiency, we need input price data in addition to input use and output volume data. We use a three-step process to calculation allocation efficiency: (1) calculate standard technical efficiency as described above, (2) calculate cost efficiency (CE_i), and (3) divide (1) by (2). Cost efficiency and allocative efficiency are shown in equations (3) and (4) below.

$$min_{\lambda,X\ i*}\quad W_j' X_j^*$$

$$s.t. -q_i \ + Q\lambda \ \geq 0$$

$$X_j^* - X\lambda \ \geq 0$$

$$\text{I}\ 1'\lambda = l$$

$$\text{CE}j = w_i' x_i^* / \ w_i' x_i \qquad (3)$$

$$AE_j = \ CE_j / TE_j \qquad (4)$$

where w_i is the vector of input prices faced by the j-th firm and x_i* is the cost-minimising vector of input quantities, given the input prices w_i and the output levels y_i. The input quantities (x_i*) are the decision variables in this linear programming step. Equation (3) calculates cost efficiency (*CE*) as the ratio of minimum cost to observed cost. Equation 4 calculates allocative efficiency as the ratio of cost efficiency (*CE*) to technical efficiency (*TE*).

IV. DATA

We built our DEA model specification for each of eight service functions of state government based on the function's missions and activities. The DEA models were refined several times based on model performance (judged by the number of frontlines). We do not use service goals and outcomes in this study, as we are trying to assess the efficiency of the government production process. Outcomes are the impacts of that process (Kettl, 1997).

Table 1 presents data on our input variables (total direct expenditures and total full-time equivalent employment (FTE)) for the eight service functions. We used operational spending data for all functions except public infrastructure and transportation. Public infrastructure expenditure includes total capital outlay for corrections, natural resources, and parks and recreation facilities. Also, we exclude capital outlay for public school and university facilities as data are not available across states. Finally, we use capital outlays for the infrastructure function instead of operational spending because often state governments allocate budgets to operation and capital project acquisition separately. They prioritize operational spending and allocate resources to infrastructure based on resource availability after they set operational spending levels (Bartle, 1996; Pagano, 2002; Srithongrung, 2010). Therefore, our results for this function will measure the capacity of state legislators and management personnel in the central budget office in allocating resources and executing project acquisition.

Likewise, for state transportation services, we include state capital outlays for highways and mass-transit systems. We use this definition, as performance output data for air and water transportation by state are not available. The performance results thus function as measures of the managerial process and budget allocation by central administration offices. Some states, such as Illinois, separate state highway spending decisions from decisions about other state infrastructure, and as such, this function is mutually exclusive from other infrastructure.

Table 1. Summary Statistics for Input Variables, FY 2016 (Expenditures in thousands of dollars)

Input	Mean	Std. Dev.	Min.	Max.
HIGHER EDUCATION				
Total state direct expenditure, operational	4,312,806	4,583,174	504,526	26,101,272
Total FTE	53,511	47,556	6,328	259,714
ELEMENTARY AND SECONDARY EDUCATION				
Total state direct expenditure, operational	1,169,332	1,149,245	97,119	6,248,463
Total FTE (state only)	1,621	5,684	56	36,019
PUBLIC WELFARE				
Total state direct expenditure, operational	664,764	13,911,381	824,802	79,810,075
Total FTE	4,910	4,099	415	24,027
HEALTH AND HOSPITALS				
Total state direct expenditure, operational	2,392,819	2,517,225	194,710	11,925,992
Total FTE	12,333	12,769	789	67,779
TRANSPORTATION				
Total state direct expenditure, operational	2,175,260	2,091,770	364,327	9,309,907
Total FTE	5,169	5,199	1,003	27,819
PUBLIC SAFETY				
Total state direct expenditure, operational	1,427,392	2,013,751	138,047	13,230,068
Total FTE	10,961	12,525	1,155	69,253
ENVIROMENT AND HOUSING				
Total state direct expenditure, operational	669,612	820,412	132,459	5,777,169
Total FTE	3,847	3,769	735	22,227
INFRASTRUCTURE				
Total state direct expenditure, operational	63,838	490,338	8,382	3,370,061
Total FTE (infrastructure only)	72	129	5	822

Note: Expenditure data from U.S. Census Bureau, Annual Survey of State and Local Government Finances (2019); Employment data from U.S. Census Bureau, Annual Survey of Public Employment and Payroll (2019).[2]

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[2] Personnel data were taken from the following categories in the Annual Survey of Public Employment and Payroll: Higher Education: 1482 - Higher Education Total; Elementary and Secondary Education: 1481 - Elementary and Secondary Total; Public Welfare: 1220 - Public Welfare; Health and Hospitals: 1240 – Health and 1260 – Hospitals; Transportation: 1160 - Highways, 1180 – Air Transportation, and 1200 - Water Transport and Terminals; Public Safety: 1100 – Police Protection Total and 1140 – Corrections; Fire safety personnel figures were not reported, therefore we do not include them; Environment and Housing: 1300 – Solid Waste Management, 1320 - Sewerage, 1340 – Parks and Recreation, 1360 – Housing and Community Development, and 1380 – Natural Resources; General Government Administration (used to calculated Infrastructure, see discussion in text): 1020 – Financial Administration, 1040 – Other Government Administration, 1060 – Judicial and Legal Administration, and 1580 – Other and Unallocable.

Table 1 shows that total state spending for higher education is $4.3 billion, ranking the largest spending category, followed by health and hospital services and transportation. Excluding transportation, state infrastructure is the smallest state spending category. Higher education also had the highest average employment, followed by health and hospital services and public safety. Since state personnel data for public infrastructure is not available, we use total FTE in general government administration weighed by the ratio of state infrastructure expenditure to total direct expenditure. Similarly, for elementary and secondary education, only eight states reported personnel working at the state level. Therefore, we use total FTE in general government administration weighted by the ratio of total school expenditure to total expenditure in the other 42 states.

Table 2 presents summary statistics for the two input price variables we use in this study. The regional price parity data capture price differences for similar baskets of goods and services purchased in different states. We use this measure as a proxy indicator for the aggregate price of supplies, goods, and services required to produce public services. For elementary and secondary education, in the states which do not report school personnel separately, we use the average wage for FTE personnel in general government. In states which report school personnel, we use the average wage of general government administration and school personnel.

Public infrastructure and school services are the functions with the highest average pay. The personnel in public infrastructure and school services are most expensive since they have a higher proportion of managerial/administrative positions. Higher education and environmental functions had the lowest average wage, with transportation, safety, health and hospital, and welfare functions in the middle.

Table 2. Summary Statistics for Input Prices, FY 2016 (Expenditures in thousands of dollars)

Input Price	Mean	Std. Dev.	Min.	Max.
Regional Price Parity (All Functions)	97.1	8.3	86.4	118.4
Average Monthly Wage per FTE				
Higher Education	3,378	525	2,427	4,916
Elementary and Secondary Education	4,365	1,126	1,838	6,318
Public Welfare	4,019	915	2,679	6,231
Health and Hospitals	4,395	850	2,840	7,615
Transportation	4,628	966	3,121	7,897
Public Safety	4,522	1,153	2,891	7,313
Environment and Housing	4,003	895	2,735	5,946
Infrastructure	5,046	754	3,679	6,508

Notes: Regional Price Parity data from U.S. Bureau of Economic Analysis (2019); Average Monthly Wage per FTE calculated from U.S. Census Bureau, Annual Survey of Public Employment and Payroll (2019).

We use 32 output variables in the eight functions in our model (Table 3). For higher education, degrees awarded, and total enrollment variables reflect higher education output and workloads, respectively. In the elementary and secondary education function, average daily attendance, total enrollment, and ACGR data measure education workload. We capture teaching effectiveness through the average math and reading score variables. We use total Medicaid enrollment, total recipients for Temporary Assistance to Need Families (TANF), and total enrollment for the Affordable Care Act (ACA) to measure output in the public welfare function. For environmental and housing service function, we used total housing occupancy units as a proxy indicator for housing service demands. According to the U.S. Census, operational outlays for this service function go to support park and recreation service and housing service including plumbing and solid waste management systems. Finally, for the public infrastructure service function, we note that while counts of jails and prison facilities may not be the best indicator of workload given that the size of the facilities may differ, standardized size data is not available in all states.

Table 3. Summary Statistics for Output Variables

Output Variable	Mean	Std. Dev.	Min.	Max.	Obs.
HIGHER EDUCATION					
Degrees Awarded, 4-Year Public University, 2016	40,016	44,629	2,860	207,235	49
Degrees Awarded, 2-Year Public Institution, 2016	23,146	30,728	115	185,656	49
Total Enrollment, 4-Year Public University, 2016	224,503	302,418	14,306	1,872,066	49
Total Enrollment, 2-Year Public Colleges, 2016	162,845	220,022	731	1,080,184	49
ELEMENTARY AND SECONDARY EDUCATION					
Average-daily attendance (ADA), public schools, 2015-2016	943,355	1,120,620	82,759	6,031,796	50
Total enrollment, public schools, 2015-2016	1,007,080	1,183,946	87,866	6,305,347	50
4th Grade Math Average Score, 2017	239.4	5.2	229.0	249.0	50
4th Grade Reading Average Score, 2017	221.2	5.8	207.0	236.0	50
8th Grade Math Average Score, 2017	282.2	6.8	267.0	297.0	50
8th Grade Reading Average Score, 2017	265.8	5.2	256.0	278.0	50
Public high school 4-year adjusted cohort graduation rate (ACGR), 2010-11 to 2015-16	84.0	4.6	71.0	91.3	50
PUBLIC WELFARE					
Medicaid Enrollment, 2016	17,847,798	23,945,060	763,338	149,892,683	50
TANF Recipients, 2016	52,804	136,271	1,036	955,029	50
Affordable Care Act (ACA) Enrollment, 2016	253,184	359,942	14,564	1,742,819	50
HEALTH AND HOSPITALS					
Proportion of Adults Reporting Any Mental Illness, 2016	0.19	0.02	0.16	0.24	50
Hospital Admission per 1,000 Population, State Owned Hospitals	14.62	13.41	1	64	42
% Public Water System (PWS) Site Visits by State	36	17	9	99	50
Air Quality Control (AQC) Facilities Evaluated by State, 2016	1,238	1,063	70	4203	50
TRANSPORTATION					
Lane Miles of Public Roads, State Owned, 2016	37,510	39,136	2,489	195,952	50
Annual Average Daily Travel (AADT)/Total Lane Mile (LANE), 2016	3,401	2,341	618	9,995	50
Average Passenger Trip Length (miles)	4.7	1.8	1.6	11.1	49
PUBLIC SAFETY					
Prisoners in State Correctional Facilities, 2016	26,324	31,405	1,735	163,703	50
Jail Population, 2016	15,521	16,982	51	82,220	47
Probation Population, 2016	74,035	90,222	3,861	410,964	50
Parole Population, 2016	14,989	24,937	21	112,351	49
ENVIRONMENT AND HOUSING					
State-Owned Park Visits, 2016	15,828,021	17,581,783	1,032,828	78,906,248	50
Total housing units (proxy for Solid Waste Management Users), 2016	2,707,781	2,813,396	270,625	14,061,375	50
INFRASTRUCTURE					
Levees (miles), 2017	592	1,449	1	9,560	50
State Parks (acres), 2016	371,951	787,873	9,790	4,281,380	50
State Trails (miles), 2016	796	1,164	6	6,276	48
State Prison Facilities, 2016	20	23	3	149	49
Jail Facilities, 2016	70	48	10	252	45

Notes: Higher Education data from National Center for Education Statistics, Integrated Postsecondary Education Data (IPEDS) Collection (2019); Elementary and Secondary Education Data from National Center for Education Statistics (2019); Medicaid data from Medicaid.gov; TANF recipient, ACA Enrollment, Mental Illness, and Hospital Admission data from Henry J. Kaiser Family Foundation (2019); Public Water System Site Visit and Air Quality Control Facilities data from U.S. Environmental Protection Agency, Enforcement and Compliance History Online (ECHO - 2019); Transportation data from U.S. Department of Transportation, Federal Highway Statistics (2019); Public Safety data from The Sentencing Project (2019). State Park Visit data from National Association of State Park Directors, Statistical Report of State Park Operations (2017); Housing data from U.S. Census Bureau (2019).

IV. EMPIRICAL RESULTS AND DISCUSSION

Using the DEA specification described in the theoretical section of the paper, we derived relative efficiency values for state public services by function. Table 4 presents summary statistics for the DEA results including input-oriented technical efficiency (TE^{VRS}), scale efficiency (SE), economic efficiency (EE), and allocative efficiency (AE). All efficiency values are reported by state in Tables A.1- A.8 of Appendix, along with each state's rank by function, the state's benchmarks (peers), and return to scale type.

Table 4. DEA Empirical Results

Service Function	Mean	Std. Dev.	Min	Max	Obs.	Frontier States
HIGHER EDUCATION						
TE INPUT, VRS	0.78	0.17	0.50	1	49	11
SE	0.89	0.14	0.40	1	49	6
EE	0.71	0.19	0.43	1	49	9
AE	0.90	0.09	0.70	1	49	9
ELEMENTARY AND SECONDARY EDUCATION						
TE INPUT, VRS	0.67	0.28	0.06	1	50	16
SE	0.80	0.22	0.16	1	50	2
EE	0.62	0.31	0.00	1	50	15
AE	0.88	0.21	0.04	1	50	15
PUBLIC WELFARE						
TE INPUT, VRS	0.79	0.15	0.50	1	50	7
SE	0.90	0.13	0.40	1	50	4
EE	0.29	0.26	0.08	1	50	3
AE	0.35	0.25	0.10	1	50	3
HEALTH AND HOSPITALS						
TE INPUT, VRS	0.45	0.33	0.06	1	42	8
SE	0.91	0.16	0.37	1	42	6
EE	0.41	0.33	0.06	1	42	7
AE	0.93	0.13	0.41	1	42	7
TRANSPORTATION						
TE INPUT, VRS	0.79	0.23	0.19	1	49	17
SE	0.87	0.18	0.24	1	49	8
EE	0.72	0.24	0.10	1	49	12
AE	0.90	0.13	0.54	1	49	13

PUBLIC SAFETY						
TE INPUT, VRS	0.75	0.22	0.28	1	46	9
SE	0.84	0.19	0.37	1	46	4
EE	0.72	0.24	0.28	1	46	10
AE	0.96	0.09	0.66	1	46	10
ENVIRONMENT AND HOUSING						
TE INPUT, VRS	0.72	0.22	0.31	1	50	11
SE	0.76	0.24	0.24	1	50	3
EE	0.62	0.25	0.24	1	50	6
AE	0.84	0.16	0.39	1	50	7
INFRASTRUCTURE						
TE INPUT, VRS	0.67	0.36	0.04	1	43	19
SE	0.77	0.24	0.16	1	43	9
EE	0.62	0.35	0.04	1	43	15
AE	0.91	0.10	0.63	1	43	15

Note: Variable returns to scale were assumed.

a. Technical Efficiency (TE^{VRS})

As described in the theoretical section, TE^{VRS} is defined as percent of input efficiently used to produce outputs compared to the governments on the frontier. A technical efficiency measure of one (1.0) suggests that a state achieves the largest possible ratio of output per input used; its productivity cannot be further maximized unless it changes its production process. As shown in Table 4, average TE^{VRS} ranges from 0.45 to 0.79 over the eight functions. This suggests that on average state governments can cut their input by about 21%-55% in certain functions. State governments perform best in welfare and transportation with an estimated 21% of excess input in each function. Higher education, safety, and environmental and housing functions are the next best performers, with excess inputs from 22% to 28%. On average, school and public infrastructure services have excess input at about 33% for both functions. Health and hospital function has the highest level of excess inputs at 55% of output.

The last column of Table 4 shows the number of frontier states indicated by the model as achieving the highest efficiency possible. For the higher education function, 11 states were shown to be frontiers (Table A.1 lists those states). Although the welfare service function achieves the largest average technical efficiency, it has the lowest number of states (seven) achieving maximum efficiency. The public infrastructure function has the largest number of frontier states (19).

Scale Efficiency

The scale efficiency value (SE) suggests whether a state's production process is an optimal size compared to the level of output produced. Scale efficiency measures the capacity of a producer to vary its inputs given the volume of outputs produced. As presented in Table 4, the average SE values ranges between 0.76 for environmental and housing to 0.91 for health and hospital service functions, respectively. This suggests that on average, diseconomies of scale may not be the main problem driving technical inefficiency. If it were, the average SE value would not be greater than for the other types of efficiency, EE and AE. However, we note that among all four types of efficiency, scale efficiency contains the smallest number of states achieving maximum efficiency, except for the public welfare function.

Table 5 presents results for the return to scale profile of the states by function. Public infrastructure and transportation are the functions with the largest numbers of states exhibiting scale efficiency. In most of the functions, nearly half or more than half of states exhibit increasing returns to scale, indicating that production size (and therefore operating budgets) should be expanded. Elementary and secondary education and public infrastructure are the functions with the most states exhibiting decreasing returns to scale. This suggests that many states should cut their budgets in this area or change their managerial and production processes, depending on the growth rate of service demands. Managerial causes for decreasing returns to scale include a relatively high degree of bureaucracy, multiple layers of personnel and middle management, and too much complexity in the production process (Steinemann, Apgar and Brown, 2005). Organizational restructuring may help in cutting inputs.

Table 5. Returns to Scale by Service Function

Service Function/Returns to Scale	CRS	IRS	DRS
Higher Education	6	40	3
Elementary and Secondary Education	2	12	36
Public Welfare	4	37	9
Health and Hospitals	6	21	15
Transportation	8	21	20
Public Safety	4	32	10
Environment and Housing	3	42	5
Infrastructure	9	12	22

We observe no geographic or size patterns in the data. For example, in the higher education function, six relatively large states that are geographically dispersed (Arizona, California, Florida, Georgia, Illinois and Michigan) achieved constant returns to scale while three other relatively large states (NY, NC and TX) show decreasing returns. For public welfare, decentralization of service provision also does not affect the results substantially. In elementary and secondary education, states can centralize or decentralize services through patterns of budget allocation and hiring. However, this institutional variable appears to not affect scale efficiency, as some might presume. Centralized states such as Alaska, Hawaii, Louisiana, Massachusetts, New Jersey, Rhode Island, and Texas report state-hired instructional staff, faculty and administrators while decentralized states report that they hire none of these personnel and shift responsibility to the local levels. Among these centralized states, none achieves constant returns to scale; four states (Alaska, Hawaii, Louisiana, and Rhode Island) have increasing returns while the rest show decreasing returns.

Economic Efficiency

Economic efficiency (EE) refers to least cost per output unit. EE is related to output, price, input volume, and total budget. For economic efficiency, a value of 1.00 suggests that a state produces public services at the least cost per unit, compared to other states. EE depends mainly on an optimal size for the production process and an efficient mix of inputs given their price.

As presented in Table 4, the average EE by function lies between 0.29 to 0.72. Public welfare is the least economically efficient function (0.29) while transportation and safety are the most economically efficient functions (0.72). We note that average EE is the smallest among all types of efficiency (TE^{VRS}, SE, EE, and AE) for all functions. This suggests that the main cause for technical inefficiency among state samples are economic inefficiency. Table 6 offers support for this statement. Among all outputs, average cost per service unit in 21 outputs (or 77%) in the efficient states (frontier units) is markedly less than that of the inefficient states. For example, in school function, the average cost per daily attendance in the efficient states is $1,322 compared to $1,828 in inefficient. The cost per enrollment in efficient states is $1,246 compared to $1,700 in the inefficient ones.

As seen in Table 6, some deviations from the above pattern occur in higher education, transportation and infrastructure function. At least one or all outputs in these three functions have average cost per output unit that is higher in the efficient states than in the inefficient states. There are some sensible explanations for this seeming deviation. First, it may be that the economic

Table 6. Average Cost Per Output by Efficient Group and Function

HIGHER EDUCATION	**4-year Degree**	**2-year Degree**	**4-year Enrollment**	**2-year Enrollment**	
Efficient States (EE = 1.0)	113,548	858,497	20,438	132,814	
Inefficient States (EE < 1.0)	119,834	286,350	22,275	39,073	
ELEMENTARY AND SECONDARY EDUCATION**	**ADA Students**	**Enrollment**			
Efficient (EE = 1.0)	1,322	1,246			
Inefficient (EE < 1.0)	1,828	1,700			
WELFARE	**Medicaid Enrollment**	**TANF Recipients**	**ACA Enrollment**		
Efficient (EE = 1.0)	505	241,831	33,854		
Inefficient (EE < 1.0)	766	374,801	66,249		
HEALTH AND HOSPITALS	**Hospital Admission**	**Mental Illness (%)**	**PWS**	**AQC**	
Efficient (EE = 1.0)	51,564	337,229	11,763,912	751,899	
Inefficient (EE < 1.0)	393,004	1,617,721	99,676,949	3,220,215	
TRANSPORTATION	**Highway Lane Miles**	**AADT/ Lane Mile**	**Mass-Transit Passenger Miles**		
Efficient (EE = 1.0)	139,202	1,093,257	571,763		
Inefficient (EE < 1.0)	66,129	719,304	429,055		
SAFETY	**Prisoners**	**Jailers**	**Probationers**	**Parolees**	
Efficient (EE = 1.0)	43,118	73,114	20,183	137,125	
Inefficient (EE < 1.0)	71,270	584,352	29,617	599,427	
ENVIRONMENT AND HOUSING	**State Park Visits**	**Housing Units**			
Efficient (EE = 1.0)	36	344			
Inefficient (EE < 1.0)	82	353			
INFRASTRUCTURE	**Levee Miles**	**State Park Acreage**	**Trail Miles**	**Prison Facility**	**Jail Inmates**
Efficient (EE = 1.0)	2,115,278	584	603,399	11,035,450	4,266,204
Inefficient (EE < 1.0)	2,460,232	1,638	2,328,452	14,044,140	4,017,194

Note: ** Cost per output for the following variables: grade 4^{th} and 8^{th} average test scores in math and reading and high school graduate rate (ACGR) was not calculated due to not having a clear interpretation of the units.

efficiency is not the main source of inefficiency. Second, the DEA model may treat certain outputs as less important in determining efficiency scores. Taking infrastructure as an example, among five average costs per unit one is greater in the efficient group than in the inefficient group. It is possible that the DEA model assigns a smaller weight for jail population than for the other outputs in this service function.

Higher education has some similarly incongruous results. Looking more closely at the data, in four-year institutions, the average cost per service unit is smaller in the efficient group than in the inefficient group. However, for two-year institutions, the pattern reverses. There are two plausible explanations for this. First, four-year higher education institutions are more economically efficient overall than two-year institutions. In this situation, DEA would assign more weight to the former than the later. The figures for degrees awarded in Table 3 supports this since the average degrees awarded by four-year institutions is greater than in two-year institutions (40,016 versus 23,146). Average enrollment is also greater in four-year institutions. Second, economic inefficiency may not be the main problem for this function. Instead, scale efficiency may be the main cause for technical inefficiency in this function. Table 5 suggests that most states show increasing returns to scale and so need to re-align their input and output sizes.

Allocative Efficiency

Allocative efficiency (AE) refers to utilization of an efficient mix of inputs given their prices. We use government budgetary resources and personnel are used as inputs to understand state productivity. Table 4 showed that the average AE values ranged from 0.35 to 0.91. Public welfare has the lowest average AE value while transportation has the highest. Except for welfare function, average AE value is the highest among all 4 types of efficiency (TE^{VRS}, SE, EE, and AE) for all functions. This implies that majority of states perform well when it comes to choosing the right mix of production inputs. Allocative efficiency is different than technical efficiency in that it incorporates price and the combination of inputs into efficiency calculation in addition to output and input volume. Allocative efficiency depends on wages for labor and the price of non-labor inputs. Table 7 presents results for input prices and the use of inputs by function.

As shown in Table 7, average state price parity in allocatively efficient states is higher than those in inefficient states for all functions except for safety and health and hospital functions. Also, in four functions – higher education, transportation, environment and housing, and infrastructure – average wage per FTE in efficient states is higher than that in the inefficient ones. Further, total outlays are higher in efficient states is higher except for health and hospitals. The combination of these measures in a sense capture the total cost of living in a state. It is likely that labor costs are much higher in states with higher costs of living. These results suggest that the cost of living is unlikely a key determinant of allocative efficiency in most functions but may be a determinant for safety and health and hospital functions. In the safety and elementary and secondary education functions, the number of FTE in efficiency group is larger than those in inefficiency group. This implies that for these two functions, which are naturally labor-intensive, allocative efficiency is achieved through lower labor costs and the use of a large staff.

Table 7. Average Input Price and Mix by Group and Function

	State Price Parity	Wage/FTE	Total Outlay	Total FTE
HIGHER EDUCATION				
Efficient States (AE = 1.0)	104	3,870	8,717,370	89,885
Inefficient States (AE < 1.0)	95	3,263	3,401,478	46,364
ELEMENTARY AND SECONDARY EDUCATION				
Efficient (AE = 1.0)	99	4,277	1,541,036	1,902
Inefficient (AE < 1.0)	96	4,403	1,010,031	1,500
WELFARE				
Efficient (AE = 1.0)	102	3,910	38,997,638	4,863
Inefficient (AE < 1.0)	97	4,026	9,891,898	4,913
HEALTH AND HOSPITALS				
Efficient (AE = 1.0)	94	4,263	673,496	4,825
Inefficient (AE < 1.0)	98	4,417	2,672,709	13,555
TRANSPORTATION				
Efficient (AE = 1.0)	101	5,228	2,821,543	6,272
Inefficient (AE < 1.0)	96	4,420	1,987,478	4,864
SAFETY				
Efficient (AE = 1.0)	94	4,233	2,889,844	20,926
Inefficient (AE < 1.0)	97	4,449	1,061,792	8,647
ENVIRONMENT AND HOUSING				
Efficient (AE = 1.0)	104	5,050	1,340,185	5,248
Inefficient (AE < 1.0)	96	3,832	560,449	3,619
INFRASTRUCTURE				
Efficient (AE = 1.0)	99	5,073	378,388	110
Inefficient (AE < 1.0)	95	5,034	175,488	59

Average direct expenditures in allocatively efficient states are larger than those in inefficient states in all service functions except one. In most functions, it seems that the size of outlays does not influence productivity. Finding an efficient input mix is the key to be allocatively efficient. The exception is health and hospital services where the average outlay in efficient states is smaller than those in the inefficient group. Given that health and hospital function's average allocative efficiency value (Table 4) ranks second highest (0.93) and that the efficient group has smaller labor size and outlays, it is likely that its allocative efficiency may be obtained from the use of capital assets such as public hospital infrastructure, rather than from labor and operational costs.

As discussed earlier, the welfare function ranks lowest in allocative efficiency. Data in Table 7 **suggests that the allocatively efficient group's average total outlay ($38.9 million) is significantly larger than that of the allocatively inefficient group ($9.8 million).** This suggests that states may be using the wrong input mix, resulting in exceptionally low allocative efficiency values. Given that labor cost is lowest among all functions, in-house labor, such as social workers and child protection agents, should be used instead of relying on supplies or contractual services. The results in Table 7 suggest that this is especially true for the states with relatively high costs of living. Finally, the difference in outlays between allocatively efficient and inefficient states reveals that, similarly to health and hospitals, total outlay is not the main key for allocative efficiency.

V. SUMMARY RESULTS

Table 8 provides summary information for the identified causes of efficiency achieved by states. We identified scale economies as the main source of efficiency for higher education and environment and housing functions. For higher education, most states in this function exhibit increasing returns to scale production profile in which fixed cost such as university campus facilities and high-rank administrative officials tend to be relatively large. The implication is that state university and colleges in the IRS states will need to keep producing and expanding investment so that marginal cost of higher education service will fall out as output expands. In other words, if demands for public higher education is steadily increasing, the IRS state universities should keep producing public service with more numbers of operating personnel (e.g., instructors, educational staff, and faculty). In the IRS states, as their service output grows, average fixed cost per unit (i.e., student seat) will decline. Thus, slowing down physical capital assets and limiting the size of high-rank management executive personnel is recommended for those IRS states to re-align their production size. For decreasing returns to scale states, operational costs must be cut, especially through reducing bureaucracy, perhaps through reducing management layers. Production profiles of the states exhibiting constant returns to scale (Arizona, California, Florida, Georgia, Illinois, and Maryland) can be used as examples in realigning production scales. Table A.1 lists benchmark states for each state without constant returns.

Table 8. Summary for Possible Main Causes for Technical Efficiency by Function

Service Function	SE	EE	AE
Higher Education	X (CRS)		
Elementary and Secondary		X (LL)	X (L)
Welfare		X (LL)	X (L)
Health and Hospitals		X (LL)	X (C)
Transportation	X	X	
Safety		X (LL)	X (L)
Environment and Housing	X (CRS)		
Infrastructure	X	X	

Notes: LL = “relatively low labor cost”; L = “in-house labor Intensive”; C = “capital-intensive”

In the environment and housing function 42 states exhibit increasing returns to scale (Table A.8). This function has a high fixed cost component for land and housing infrastructure. In order to improve productivity, states with increasing returns to scale need to hire more staff (e.g., park rangers and state housing development officers) to serve increasing demand. For states exhibiting decreasing returns to scale (California, Florida, New York, Pennsylvania, and Texas), their parks and other housing services may be too large and too complex. Since these states are relatively large geographically, one way to improve state recreational service productivity may be to divide relatively large-scale service units (i.e., parks or housing development offices) into multiple smaller units to break down bureaucratic rigidities and to be more accessible to local clients. Constant returns to scale states including Illinois, Ohio, and Oregon can be used as examples in rescaling production.

The main source of efficiency for elementary and secondary education, welfare, safety, and health and hospital services is allocative efficiency which results from economic efficiency (least cost output). About a third of states are allocatively efficient in elementary and secondary education (detailed in Appendix A.2), four states are efficient in the welfare function (Appendix A.3), ten states are efficient in the safety function (Appendix A.6), and seven states are efficient in health and hospital services (Appendix A.7). These benchmarks are varied in terms of size and location in the country. For the first three functions, average wage per FTE is lower while the number of in-house personnel is higher than those of the inefficient group. This profile suggests that inefficient states should reallocate inputs by using a greater number of in-house school personnel, taking advantage of lower wages in this function. Specialization and training may be important for elementary and secondary education, welfare, and safety functions. Schoolteachers, social workers, and correctional officers tend to be highly specialized yet have lower wages compared to those in their private-sector counterparts. In health and hospital services, the combination of results suggests that allocative efficiency may be achieved by using fewer in-house personnel and utilizing more physical capital assets.

Transportation and infrastructure functions have similar profiles; this is reasonable since both are capital-intensive. At the first glance, the sources of productivity are unclear given that statistical comparisons and average DEA results do not suggest any pattern. For transportation, statistical data for cost per service and input mix from efficient and inefficient groups do not immediately support an assertion that allocative and economic efficiency are the primary sources of productivity. One concern there is that there are a relatively large number of benchmark units (19 for each function, as detailed in Appendices A.4 and A.5). When this is the case, a concern is that the model may have low capacity in distinguishing decision-making unit productivity; as a result, the large number of frontiers are unique and cannot be used to measure relative efficiency (Hammond, 2002). This appears not to be the case for the transportation function. The second condition for a degenerate solution such as the one described by Hammond (2002) is that the frontier units are not benchmark peers for other units. In this study, all 19 frontier states are used as peers for inefficient states. This suggests our DEA model can distinguish efficiency.

Further inspection of the efficient states offers some clues regarding transportation and infrastructure efficiency. Nine of the 19 efficient states in transportation (Appendix A.4) have diseconomies of scale (seven with decreasing returns to scale and two with increasing returns). Six of the states are not economically efficient (Appendix A.5) while they are scale efficient. This pattern implies that the sources of inefficiency for transportation could be either diseconomy of scale or economic efficiency but are unlikely to be both. Future studies may need to verify this assumption by replicating this study with larger numbers of observations.

Infrastructure results exhibits similar patterns. Seven of the 19 benchmarks are frontiers for scale efficiency. Two states achieve only scale economy and not cost efficiency. The remaining eight states do not achieve scale economy but achieve cost efficiency. Only two frontier states achieve neither scale nor cost efficiency. This pattern of results suggests that scale economies may be the major reason for productivity in the infrastructure function. If states achieve scale economy, they also tend to achieve cost efficiency. The results also suggest that cost efficiency can be achieved even when states face diseconomies of scale; this is probably due to a state's efficient input mix given prices they face. The states in this group are relatively large states in terms of population.

VI. CONCLUSIONS

This study measures efficiency in state provision of eight service functions including higher education, elementary and secondary education, welfare, health and hospital, transportation, safety, environmental and housing, and infrastructure. We use data on inputs, input prices, and outputs which are collected by federal government data agencies. We then estimate a data envelopment model which not only produces estimates of the relative efficiency of each state in each function, but also allows us to identify likely reasons for efficiency and inefficiency. The results suggest that, on average, state governments can cut input usage by anywhere from 21% to 55% while producing a similar amount of output. Among service functions, health and hospital services have the largest inefficiency problem, while public welfare and transportation are the most efficient. On average, the welfare service function is the most economically and allocatively inefficient function, although it does has demonstrate optimal output compared to service demands.

In addition to technical efficiency, the study examines other types of efficiency, which can reveal the major causes of technical efficiency. Causes of service efficiency vary markedly by function. The main source of efficiency in higher education and environmental housing appears to be scale economies. The main source of efficiency in the other functions include both economic and allocative efficiency. Given the labor-intensiveness of the elementary and secondary education, welfare, and safety functions, requiring specialized training to deliver services while having a relatively low labor cost, efficiency can be achieved by using the optimal input mix where in-house labor is used more than contractors. For health and hospital services, both labor cost and labor inputs are relatively small in efficient states compared to those in inefficient states. In the capital-intensive transportation and infrastructure functions, a state that fails to achieve scale economies will also fail to achieve economic efficiency. This is not suspiring because in production functions with very high fixed costs, scale strongly affects average and marginal cost.

This study contributes to both the academic literature and practical governance. In academic terms, we can identify patterns of state efficiency and what drives that efficiency. For practitioners, we report the results by state and function along with benchmarks (peers) for each inefficient state. The results can act as a starting point for citizens, policy makers, and public administrators to determine if and what changes are needed in the production process. It is our hope to expand this study through incorporating more output data and using a panel data approach in order to understand the evolution of state productivity over time.

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APPENDIX

Table A.1: Higher Education Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	44	0.5425723	IRS	0.4555172	0.839551	FL,GA,IL,SD
ALASKA	1	1	IRS	1	1	FL
ARIZONA	1	1	CRS	1	1	FL,IL,MD
ARKANSAS	28	0.762904	IRS	0.6540471	0.857312	AZ,FL,GA,WY
CALIFORNIA	1	1	CRS	1	1	
COLORADO	40	0.5752252	IRS	0.4775396	0.830179	FL,GA,IL,SD
CONNECTICUT	49	0.4973373	IRS	0.4537975	0.912454	FL,IL,MD,WY
DELAWARE	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
FLORIDA	1	1	CRS	1	1	
GEORGIA	1	1	CRS	0.7009033	0.700903	GA,IL
HAWAII	32	0.6973532	IRS	0.5562376	0.797641	FL,IL,WY
IDAHO	15	0.9186752	IRS	0.6883475	0.749283	FL,IL,WY
ILLINOIS	1	1	CRS	1	1	
INDIANA	41	0.5697614	IRS	0.4290661	0.753063	FL,IL,WY
IOWA	20	0.8265869	IRS	0.6674448	0.807471	AZ,FL,GA,SD
KANSAS	16	0.9024634	IRS	0.7304957	0.809446	AZ,FL,GA,IL
KENTUCKY	27	0.7699364	IRS	0.7390653	0.959904	AZ,GA,SD,WY
LOUISIANA	12	0.9504183	IRS	0.9268007	0.97515	AZ,CA,FL,WY
MAINE	22	0.8103524	IRS	0.6353552	0.784048	FL,SD,WY
MARYLAND	1	1	CRS	1	1	FL
MASSACHUSETTS	47	0.5317841	IRS	0.4615885	0.868	FL,IL,MD,WY
MICHIGAN	46	0.5320289	IRS	0.4756358	0.894004	FL,IL,WY
MINNESOTA	34	0.6601095	IRS	0.6573418	0.995807	AZ,CA,FL,MD
MISSISSIPPI	13	0.9408181	IRS	0.917602	0.975323	AZ,GA,SD,WY
MISSOURI	24	0.7924182	IRS	0.5855052	0.738884	FL,IL,SD,WY
MONTANA	29	0.7569525	IRS	0.6708094	0.886197	FL,SD,WY
NEBRASKA	25	0.785776	IRS	0.7640535	0.972355	FL,IL,MD,WY
NEVADA	17	0.8980557	IRS	0.8664639	0.964822	AK,FL,SD,WY
NEW HAMSHIRE	31	0.7386636	IRS	0.6306936	0.853831	FL,SD,WY
NEW JERSEY	19	0.8415029	IRS	0.7793764	0.926172	FL,IL,MD,WY
NEW MEXICO	21	0.8107897	IRS	0.7487106	0.923434	AZ,GA,IL,SD
NEW YORK	1	1	DRS	1	1	AZ,CA,FL
NORTH CAROLINA	23	0.8019936	DRS	0.801586	0.999492	AZ,CA,FL
NORTH DAKOTA	36	0.6540877	IRS	0.60237	0.920932	CO,SD,WY
OHIO	35	0.6580485	IRS	0.5068266	0.770196	FL,IL,WY
OKLAHOMA	42	0.5594697	IRS	0.5093959	0.910498	AZ,FL,SD,WY
OREGON	26	0.7756196	IRS	0.7098049	0.915146	FL,IL,MD,WY
PENNSYLVANIA	48	0.5162085	IRS	0.4826049	0.934903	FL,IL,MD,WY
RHODE ISLAND	18	0.8653956	IRS	0.7081192	0.818261	FL,SD,WY
SOUTH CAROLINA	38	0.5945143	IRS	0.5796307	0.974965	AZ,CA,FL,MD
SOUTH DAKOTA	1	1	IRS	0.9089922	0.908992	FL,GA
TENNESSEE	30	0.7534982	IRS	0.6114828	0.811525	AZ,FL,GA,IL
TEXAS	1	1	DRS	1	1	CA
UTAH	45	0.5320787	IRS	0.5320064	0.999864	AK,CA,FL,WY
VERMONT	14	0.9388992	IRS	0.9364366	0.997377	AK,FL,WY
VIRGINIA	39	0.5849252	IRS	0.5332639	0.911679	AZ,FL,IL,WY
WASHINGTON	43	0.5464383	IRS	0.4764272	0.871877	AZ,FL,GA,WY
WEST VIRGINIA	37	0.5993862	IRS	0.5311604	0.886174	AZ,GA,SD,WY
WISCONSIN	33	0.670056	IRS	0.5247954	0.783211	AZ,FL,GA,IL
WYOMING	1	1	IRS	1	1	AZ,IL,MD

Table A.2: Elementary and Secondary Education Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	43	0.3619356	IRS	0.2987485	0.825419	ND,TX
ALASKA	49	0.2225862	IRS	0.0168015	0.075483	ND,TX
ARIZONA	20	0.73807	IRS	0.723536	0.980308	ND,TX
ARKANSAS	40	0.4228836	IRS	0.3841599	0.908429	ND,TX
CALIFORNIA	1	1	DRS	1	1	
COLORADO	24	0.6581831	DRS	0.5954235	0.904647	NH,ND,TX
CONNECTICUT	36	0.4889603	DRS	0.4540541	0.928611	MA,NH,TX
DELAWARE	47	0.2311157	IRS	0.1935769	0.837576	ND,TX
FLORIDA	1	1	DRS	1	1	CA,MA
GEORGIA	41	0.409324	DRS	0.3828832	0.935404	ID,MT,TX
HAWAII	50	0.0622119	IRS	0.0023251	0.037374	ND,TX
IDAHO	1	1	DRS	1	1	MT,TX
ILLINOIS	30	0.5668295	DRS	0.5660965	0.998707	ID,MT,NH,TX
INDIANA	1	1	DRS	1	1	NH,TX,WY
IOWA	1	1	DRS	1	1	NH,ND,TX
KANSAS	1	1	DRS	0.8179566	0.817957	NH,ND,TX
KENTUCKY	46	0.2429606	DRS	0.2210501	0.909819	IA,NH,ND,TX
LOUISIANA	48	0.2287508	IRS	0.175842	0.768706	ND,TX
MAINE	26	0.6379878	DRS	0.5620655	0.880997	MT,NH,ND,TX
MARYLAND	29	0.5922129	DRS	0.4518897	0.763053	KS,NH,ND,TX
MASSACHUSETTS	1	1	DRS	1	1	NE,NH,TX,VA
MICHIGAN	31	0.5549602	DRS	0.5473063	0.986208	MT,ND,TX
MINNESOTA	1	1	DRS	1	1	NH,TX
MISSISSIPPI	33	0.5081489	IRS	0.4838318	0.952146	ND,TX
MISSOURI	23	0.6827697	DRS	0.551493	0.807729	IA,NH,ND,TX
MONTANA	1	1	DRS	1	1	NH,ND,TX
NEBRASKA	1	1	DRS	1	1	IA,NH,ND,TX
NEVADA	35	0.4909006	IRS	0.3860535	0.786419	ND,TX
NEW HAMSHIRE	1	1	DRS	1	1	ND,TX
NEW JERSEY	1	1	DRS	1	1	
NEW MEXICO	34	0.5018572	IRS	0.4507535	0.898171	ND,TX
NEW YORK	28	0.5946528	DRS	0.4381095	0.736748	NH,ND,TX
NORTH CAROLINA	42	0.3954057	DRS	0.3091168	0.781771	KS,NH,ND,TX
NORTH DAKOTA	1	1	CRS	1	1	
OHIO	22	0.6935452	DRS	0.6460043	0.931452	NH,TX,VA
OKLAHOMA	32	0.517865	IRS	0.4065736	0.785096	ND,TX
OREGON	27	0.6284901	DRS	0.6195222	0.985731	MT,ND,TX
PENNSYLVANIA	38	0.4421053	DRS	0.4249996	0.961309	CA,NH,TX,VA
RHODE ISLAND	44	0.343022	DRS	0.1088111	0.317213	NH,ND,TX
SOUTH CAROLINA	45	0.2659186	IRS	0.2591043	0.974374	ND,TX
SOUTH DAKOTA	18	0.8718394	DRS	0.8643127	0.991367	MT,NH,ND
TENNESSEE	37	0.4794653	DRS	0.3934644	0.820632	IA,ND,TX
TEXAS	1	1	CRS	1	1	ND
UTAH	21	0.7008781	DRS	0.6573198	0.937852	NH,ND,TX
VERMONT	17	0.9854415	DRS	0.8829324	0.895976	MT,NH,ND
VIRGINIA	1	1	DRS	1	1	MA,NH,TX
WASHINGTON	39	0.4339142	DRS	0.4002056	0.922315	ID,NH,TX
WEST VIRGINIA	25	0.63924	DRS	0.5094197	0.796915	IA,ND
WISCONSIN	19	0.7413236	DRS	0.6721867	0.906739	IA,NH,ND,TX
WYOMING	1	1	DRS	1	1	NH,ND

Table A.3: Welfare Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	20	0.857472	IRS	0.16868	0.196718	CO,LA,NC,SD
ALASKA	42	0.625103	IRS	0.239879	0.383744	CA,CO,SD,WY
ARIZONA	28	0.775785	IRS	0.157773	0.203372	LA,NC
ARKANSAS	27	0.776844	IRS	0.151056	0.194449	LA,NC,WY
CALIFORNIA	1	1	CRS	1	1	
COLORADO	1	1	CRS	0.305906	0.305906	CA,NC
CONNECTICUT	35	0.694477	IRS	0.110662	0.159345	CO,LA,NC,SD
DELAWARE	34	0.695148	IRS	0.316264	0.454959	CA,CO,SD,WY
FLORIDA	1	1	CRS	1	1	
GEORGIA	13	0.925755	IRS	0.17507	0.18911	FL,NC,WY
HAWAII	1	1	IRS	1	1	CA,NC,WY
IDAHO	15	0.899883	IRS	0.288397	0.320483	FL,NC,WY
ILLINOIS	17	0.885517	DRS	0.14629	0.165202	CA,NC
INDIANA	46	0.589133	IRS	0.138382	0.234891	LA,NC,SD,WY
IOWA	44	0.598312	IRS	0.196741	0.328826	CA,CO,SD,WY
KANSAS	40	0.63243	IRS	0.182994	0.289351	CA,CO,NC,SD
KENTUCKY	37	0.688933	IRS	0.109845	0.159442	CA,CO,SD
LOUISIANA	1	1	IRS	0.161693	0.161693	NC
MAINE	45	0.591405	IRS	0.187091	0.316349	CA,FL,NC,SD,WY
MARYLAND	47	0.583493	IRS	0.112087	0.192096	CA,CO,NC,SD
MASSACHUSETTS	49	0.537242	DRS	0.124424	0.231597	CA,CO,NC
MICHIGAN	21	0.84854	DRS	0.101112	0.11916	CA,NC
MINNESOTA	50	0.500132	IRS	0.245921	0.491713	CA,CO,NC,WY
MISSISSIPPI	33	0.697955	IRS	0.134423	0.192595	CO,LA,NC,SD
MISSOURI	31	0.715838	IRS	0.118891	0.166086	CA,FL,NC,SD
MONTANA	11	0.95297	IRS	0.26263	0.275591	CA,FL,NC,SD,WY
NEBRASKA	24	0.795681	IRS	0.199499	0.250727	CA,FL,SD
NEVADA	9	0.977146	IRS	0.224763	0.23002	CA,CO,NC,SD
NEW HAMSHIRE	38	0.650872	IRS	0.245656	0.377426	LA,NC,SD,WY
NEW JERSEY	48	0.58339	DRS	0.103798	0.177923	CA,CO,NC
NEW MEXICO	12	0.93538	IRS	0.351721	0.376019	CA,CO,NC,WY
NEW YORK	32	0.701963	DRS	0.481196	0.685501	CA,NC
NORTH CAROLINA	1	1	CRS	1	1	CA
NORTH DAKOTA	19	0.865609	IRS	0.735881	0.850132	HI,NC,WY
OHIO	25	0.78436	DRS	0.46364	0.591107	CA,NC
OKLAHOMA	41	0.625393	IRS	0.07526	0.120341	CO,LA,NC,SD
OREGON	43	0.615688	IRS	0.083737	0.136005	CA,CO,NC,SD
PENNSYLVANIA	39	0.642581	DRS	0.108017	0.168099	CA,CO,NC
RHODE ISLAND	26	0.78004	IRS	0.341265	0.437497	CA,CO,SD,WY
SOUTH CAROLINA	10	0.968452	IRS	0.148446	0.153282	CO,LA,NC,SD
SOUTH DAKOTA	1	1	IRS	0.251179	0.251179	CA,FL
TENNESSEE	16	0.88881	IRS	0.128094	0.144119	CA,CO,NC,SD
TEXAS	30	0.741857	DRS	0.154901	0.208802	CA,FL,NC
UTAH	14	0.903341	IRS	0.258994	0.286707	FL,SD,WY
VERMONT	18	0.872263	IRS	0.276655	0.317169	LA,NC,SD,WY
VIRGINIA	29	0.768826	IRS	0.304457	0.396003	CA,FL,SD,WY
WASHINGTON	22	0.844756	DRS	0.087722	0.103842	CA,CO,NC
WEST VIRGINIA	23	0.796508	IRS	0.150723	0.18923	CO,LA,SD
WISCONSIN	36	0.692892	IRS	0.338219	0.488126	CA,CO,NC,SD,WY
WYOMING	1	1	IRS	0.803379	0.803379	FL,NC

Table A.4: Transportation Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	42	0.516704	IRS	0.440134	0.85181	MO,NM,RI,UT,WI
ALASKA	45	0.480158	IRS	0.479894	0.99	ND,UT,VT
ARIZONA	33	0.682044	DRS	0.680389	0.99	HI,MI,RI,UT,WI
ARKANSAS	32	0.698737	IRS	0.541216	0.77456	MO,NM,RI,SD
CALIFORNIA	1	1	DRS	1	1	MA,NJ,TX
COLORADO	37	0.606523	IRS	0.531521	0.87634	MO,NM,RI,UT,WI
CONNECTICUT	23	0.884658	DRS	0.730653	0.82592	HI,MA,NJ,NC,RI
DELAWARE	28	0.795927	IRS	0.508799	0.63925	ME,NM,RI
FLORIDA	25	0.852586	DRS	0.833509	0.97763	MA,NJ,TX,VA
GEORGIA	34	0.675614	DRS	0.674654	0.99	MA,NC,UT,WI
HAWAII	1	1	DRS	1	1	RI,UT
IDAHO	22	0.984144	IRS	0.871495	0.88554	NM,RI,SD,UT,VT
ILLINOIS	46	0.447938	DRS	0.440398	0.98317	MA,NC,UT,WI
INDIANA	36	0.619198	DRS	0.618581	0.99	MI,NC,RI,UT,WI
IOWA	38	0.588943	IRS	0.576249	0.97845	RI,SC,SD,WI
KANSAS	35	0.628	IRS	0.523147	0.83304	MO,NM,RI,SD,WI
KENTUCKY	30	0.772384	DRS	0.771658	0.99	NC,UT,WI
LOUISIANA	40	0.572073	IRS	0.455858	0.79685	MO,RI,SC,SD,WI
MAINE	1	1	CRS	0.737614	0.73761	
MARYLAND	26	0.81239	DRS	0.792734	0.9758	HI,MA,NJ,NC,UT
MASSACHUSETTS	1	1	DRS	1	1	HI,RI,WI
MICHIGAN	1	1	DRS	0.996915	0.99	NC,RI,UT,WI
MINNESOTA	48	0.326931	IRS	0.231113	0.70692	MO,NM,RI,SD,WI
MISSISSIPPI	31	0.700595	IRS	0.478819	0.68345	MO,NM,RI,SD
MISSOURI	1	1	CRS	0.883626	0.88363	NC,UT
MONTANA	21	0.991518	IRS	0.654049	0.65964	NH,NM,VT
NEBRASKA	29	0.783646	IRS	0.67343	0.85935	MO,NM,RI,SD,WI
NEVADA	24	0.874549	IRS	0.764158	0.87377	NM,RI,SD,UT,VT
NEW HAMSHIRE	1	1	IRS	0.661838	0.66184	MO,NM,RI
NEW JERSEY	1	1	DRS	1	1	
NEW MEXICO	1	1	CRS	0.872343	0.87234	ME,RI
NEW YORK	49	0.189714	DRS	0.103145	0.54369	MO,NJ,NC,RI
NORTH CAROLINA	1	1	CRS	1	1	
NORTH DAKOTA	1	1	IRS	1	1	UT,WI
OHIO	41	0.519301	DRS	0.51926	0.99	MA,MI,NC,UT,WI
OKLAHOMA	39	0.587193	IRS	0.551751	0.93964	NM,SC,SD,WI
OREGON	44	0.497934	IRS	0.383567	0.77032	NM,RI,SD,UT,WI
PENNSYLVANIA	47	0.333851	DRS	0.331646	0.99339	NC,UT,WI
RHODE ISLAND	1	1	CRS	1	1	
SOUTH CAROLINA	1	1	CRS	0.982901	0.9829	MO,NM,UT
SOUTH DAKOTA	1	1	IRS	1	1	SC,WI
TENNESSEE	27	0.800421	DRS	0.76184	0.9518	NC,RI,SC,UT,WI
TEXAS	1	1	DRS	1	1	MA,NC,VA
UTAH	1	1	CRS	1	1	RI
VERMONT	1	1	IRS	1	1	RI,SD,UT,WI
VIRGINIA	1	1	DRS	1	1	MA,NC,UT
WASHINGTON	43	0.513386	DRS	0.363776	0.70858	HI,NJ,NC,RI,UT
WEST VIRGINIA	20	0.99357	IRS	0.734589	0.73934	MO,NH
WISCONSIN	1	1	CRS	1	1	HI,MI,RI,UT
WYOMING	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.

Table A.5: Infrastructure Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	25	0.658579	DRS	0.518872	0.787865	GA,TN
ALASKA	1	1	DRS	1	1	CO,TX
ARIZONA	1	1	IRS	1	1	AR,IL
ARKANSAS	1	1	CRS	1	1	CO,IL,ND
CALIFORNIA	1	1	DRS	1	1	
COLORADO	1	1	CRS	1	1	FL,IL,NV,OK
CONNECTICUT	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
DELAWARE	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
FLORIDA	1	1	DRS	1	1	
GEORGIA	1	1	DRS	1	1	IL,TX
HAWAII	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
IDAHO	21	0.853659	IRS	0.689008	0.807124	AR,NV,ND,SC
ILLINOIS	1	1	CRS	1	1	
INDIANA	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
IOWA	39	0.15913	DRS	0.130731	0.821534	IL,MI,OK,TN
KANSAS	29	0.388814	DRS	0.24434	0.628425	IL,OK,TN
KENTUCKY	35	0.252264	DRS	0.188753	0.748237	AR,MI,OK
LOUISIANA	20	0.944396	DRS	0.814717	0.862686	CA,MO
MAINE	22	0.837424	IRS	0.751276	0.897127	CO,NV,ND,SC
MARYLAND	37	0.212537	IRS	0.161276	0.758816	AR,CO,NE,NV,ND,SC
MASSACHUSETTS	40	0.154556	DRS	0.147141	0.952028	CO,FL,IL,NH,SC
MICHIGAN	1	1	CRS	1	1	CO,IL,NH,ND,SC
MINNESOTA	30	0.381548	DRS	0.310781	0.814526	CO,IL,MI,ND,OK,TN
MISSISSIPPI	24	0.698655	DRS	0.613559	0.878201	AR,IL,MI,OK
MISSOURI	1	1	DRS	1	1	IL,ND,TX
MONTANA	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
NEBRASKA	1	1	CRS	0.826579	0.826579	AR,CO,ND
NEVADA	1	1	CRS	0.705904	0.705904	AR,CO
NEW HAMSHIRE	1	1	CRS	1	1	CO,FL,IL,SC
NEW JERSEY	43	0.03907	IRS	0.036954	0.945851	CO,NV,ND,SC
NEW MEXICO	27	0.532516	IRS	0.447449	0.840254	AR,CO,ND
NEW YORK	1	1	DRS	1	1	AK,FL,TX
NORTH CAROLINA	33	0.281483	DRS	0.281403	0.999715	FL,GA,IL,NH
NORTH DAKOTA	1	1	CRS	1	1	
OHIO	32	0.328022	DRS	0.327576	0.998639	GA,MI,NH,TX
OKLAHOMA	1	1	DRS	0.775486	0.775486	IL,MI,NH,ND,SC
OREGON	41	0.122846	IRS	0.111773	0.90987	AZ,AR,CO,ND,SC
PENNSYLVANIA	34	0.269657	DRS	0.268319	0.995039	FL,GA,IL,NH
RHODE ISLAND	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
SOUTH CAROLINA	1	1	CRS	1	1	IL,NH
SOUTH DAKOTA	23	0.757905	IRS	0.628437	0.829176	AR,CO,NV,ND
TENNESSEE	1	1	DRS	0.942045	0.942045	CO,IL,ND,OK
TEXAS	1	1	DRS	1	1	CA,FL,IL
UTAH	38	0.202366	IRS	0.189681	0.937313	CO,ND,SC
VERMONT	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
VIRGINIA	36	0.218936	DRS	0.207213	0.946454	FL,IL,NH,OK,SC
WASHINGTON	42	0.119944	IRS	0.11947	0.996047	AZ,AR,IL,ND,SC
WEST VIRGINIA	31	0.373329	IRS	0.276198	0.739825	CO,NV,ND
WISCONSIN	28	0.42441	DRS	0.398926	0.939954	FL,GA,MI,NH,OK
WYOMING	26	0.608406	IRS	0.520324	0.855226	CO,NV,ND

Table A.6: Safety Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	1	1	DRS	1	1	GA,LA,MS
ALASKA	41	0.449428	IRS	0.427967	0.952247	MS,ND,SD
ARIZONA	17	0.855683	DRS	0.854409	0.99	GA,LA,TX
ARKANSAS	11	0.986791	IRS	0.831036	0.84216	LA,ND
CALIFORNIA	1	1	DRS	1	1	TX
COLORADO	33	0.613858	IRS	0.611922	0.99	GA,LA,MS,SD
CONNECTICUT	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
DELAWARE	40	0.479007	IRS	0.433677	0.905366	GA,MS,ND,SD
FLORIDA	1	1	DRS	1	1	
GEORGIA	1	1	CRS	1	1	
HAWAII	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
IDAHO	16	0.856407	IRS	0.856393	0.99	GA,LA,MS,SD
ILLINOIS	25	0.727026	DRS	0.726781	0.99	GA,LA,TX
INDIANA	15	0.887723	IRS	0.884968	0.99	GA,MS,SD
IOWA	28	0.706284	IRS	0.693219	0.981501	GA,LA,MS,ND,SD
KANSAS	29	0.672844	IRS	0.518411	0.770477	GA,LA,ND
KENTUCKY	14	0.902553	IRS	0.898	0.994956	GA,LA,MS,SD
LOUISIANA	1	1	CRS	1	1	
MAINE	26	0.717724	IRS	0.71727	0.99	LA,SD
MARYLAND	45	0.377221	IRS	0.375276	0.994844	GA,LA,MS,SD
MASSACHUSETTS	46	0.278712	IRS	0.278186	0.99	GA,MS,SD
MICHIGAN	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MINNESOTA	13	0.983171	IRS	0.974567	0.991249	GA,SD
MISSISSIPPI	1	1	CRS	1	1	GA,LA
MISSOURI	27	0.70816	IRS	0.464805	0.656357	GA,LA,ND
MONTANA	22	0.80667	IRS	0.801765	0.993919	LA,MS,ND,SD
NEBRASKA	42	0.44833	IRS	0.437756	0.976414	GA,MS,ND,SD
NEVADA	19	0.843005	IRS	0.64714	0.767658	LA,ND
NEW HAMSHIRE	23	0.7717	IRS	0.736747	0.954706	LA,ND,SD
NEW JERSEY	32	0.629821	IRS	0.625866	0.993719	GA,PA,SD
NEW MEXICO	34	0.613494	IRS	0.611276	0.99	LA,SD
NEW YORK	44	0.386854	DRS	0.386268	0.99	GA,LA,PA,TX
NORTH CAROLINA	43	0.396848	IRS	0.356064	0.897229	GA,LA,ND
NORTH DAKOTA	1	1	IRS	1	1	GA,MS,SD
OHIO	12	0.985919	DRS	0.982925	0.99	GA,LA,TX
OKLAHOMA	21	0.811679	DRS	0.811128	0.99	AL,MS
OREGON	18	0.84521	IRS	0.843082	0.99	LA,PA,SD
PENNSYLVANIA	1	1	CRS	1	1	GA,LA,TX
RHODE ISLAND	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
SOUTH CAROLINA	31	0.667431	IRS	0.441106	0.660902	GA,LA,ND
SOUTH DAKOTA	1	1	IRS	1	1	GA,LA,MS
TENNESSEE	20	0.832117	IRS	0.83047	0.99802	GA,LA,MS
TEXAS	1	1	DRS	1	1	
UTAH	35	0.546489	IRS	0.541504	0.990878	LA,ND,SD
VERMONT	30	0.668711	IRS	0.668665	0.99	ND,SD
VIRGINIA	39	0.491872	DRS	0.491843	0.99	GA,LA,TX
WASHINGTON	37	0.533906	IRS	0.529735	0.992188	GA,LA,MS,SD
WEST VIRGINIA	38	0.525427	IRS	0.382837	0.728621	LA,ND
WISCONSIN	36	0.534133	IRS	0.533842	0.99	GA,LA,PA,SD
WYOMING	24	0.756706	IRS	0.75183	0.993556	LA,ND,SD

Table A.7: Health and Hospitals Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	1	1	DRS	1	1	
ALASKA	1	1	CRS	1	1	
ARIZONA	16	0.497715	IRS	0.457764	0.919732	AK,ME,WY
ARKANSAS	21	0.323418	DRS	0.248672	0.768885	AK,ID,OK,WY
CALIFORNIA	42	0.058766	IRS	0.0587	0.998875	AK,OK,WY
COLORADO	12	0.571356	IRS	0.569806	0.997287	AK,OK
CONNECTICUT	41	0.093317	IRS	0.092778	0.994225	AK,ME,SD
DELAWARE	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
FLORIDA	36	0.134313	DRS	0.133233	0.991955	AK,ME,OK,WY
GEORGIA	22	0.318317	IRS	0.316854	0.995402	AK,OK
HAWAII	28	0.187921	IRS	0.165585	0.881142	ID,SD,WV,WY
IDAHO	1	1	CRS	1	1	
ILLINOIS	26	0.204296	DRS	0.202861	0.99298	AK,ME,OK
INDIANA	9	0.918232	DRS	0.912344	0.993587	AK,ID,OK,WY
IOWA	18	0.473041	IRS	0.396791	0.838809	AK,OK,WY
KANSAS	23	0.273474	IRS	0.273175	0.998907	AK,OK,WY
KENTUCKY	24	0.244524	DRS	0.242935	0.9935	AK,ID,OK,WV,WY,
LOUISIANA	11	0.70319	DRS	0.310261	0.44122	OK,WV,WY
MAINE	1	1	CRS	1	1	AK,WV
MARYLAND	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
MASSACHUSETTS	29	0.185413	DRS	0.18519	0.998798	AK,ID,OK
MICHIGAN	37	0.128657	IRS	0.128041	0.995213	AK,OK
MINNESOTA	19	0.41622	IRS	0.172691	0.414903	AK,OK,WV,WY
MISSISSIPPI	15	0.514519	DRS	0.451368	0.877262	AL,OK,WY
MISSOURI	35	0.138715	DRS	0.136708	0.985535	AK,ME,OK,WV,WY
MONTANA	10	0.771033	IRS	0.62428	0.809668	AK,ID,SD,WV
NEBRASKA	17	0.496712	IRS	0.466606	0.939389	ID,SD,WV,WY
NEVADA	14	0.516234	IRS	0.453787	0.879034	ID,SD,WV,WY
NEW HAMSHIRE	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
NEW JERSEY	33	0.1657	IRS	0.165184	0.996882	AK,OK
NEW MEXICO	34	0.152276	IRS	0.129665	0.851511	AK,OK,WY
NEW YORK	38	0.125727	IRS	0.122382	0.973389	AK,OK,WY
NORTH CAROLINA	25	0.230451	DRS	0.192264	0.834291	OK,WV,WY
NORTH DAKOTA	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
OHIO	30	0.183625	IRS	0.181327	0.987485	AK,OK
OKLAHOMA	1	1	CRS	1	1	
OREGON	31	0.179219	DRS	0.17657	0.985222	AK,ID
PENNSYLVANIA	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
RHODE ISLAND	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
SOUTH CAROLINA	20	0.355134	DRS	0.351149	0.988781	OK,WV,WY
SOUTH DAKOTA	1	1	IRS	0.98947	0.98947	AK,ME,WV
TENNESSEE	13	0.57134	IRS	0.436083	0.763263	AK,OK,WV,WY
TEXAS	39	0.118439	IRS	0.117497	0.992049	AK,OK
UTAH	32	0.17203	DRS	0.171272	0.995596	AK,ID,WV
VERMONT	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
VIRGINIA	27	0.188606	IRS	0.185972	0.986035	AK,OK
WASHINGTON	40	0.109197	DRS	0.1082	0.990866	AK,ID,OK,WY
WEST VIRGINIA	1	1	CRS	1	1	ID,WY
WISCONSIN	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
WYOMING	1	1	CRS	1	1	

Table A.8: Environment and Housing Performance Results by State

STATE	TE RANK	TE MEASURE	RETURNS TO SCALE	EE MEASURE	AE MEASURE	PEER STATES
ALABAMA	15	0.930568	IRS	0.587246	0.631061	IL,NV
ALASKA	48	0.367402	IRS	0.327463	0.891294	NV,RI,VT
ARIZONA	1	1	IRS	0.987198	0.987198	IL,OH
ARKANSAS	43	0.48905	IRS	0.348089	0.711765	IL,NV,OR
CALIFORNIA	1	1	DRS	1	1	
COLORADO	26	0.675072	IRS	0.633892	0.938999	AZ,CT,NV,OH
CONNECTICUT	1	1	IRS	1	1	OH
DELAWARE	17	0.923132	IRS	0.815137	0.883012	NV,RI,VT
FLORIDA	16	0.927812	DRS	0.905053	0.97547	CA,NY,TX
GEORGIA	46	0.447558	IRS	0.288983	0.645688	IL,NV
HAWAII	32	0.615414	IRS	0.580933	0.943971	NV,VT
IDAHO	45	0.453554	IRS	0.333527	0.735363	NV,OR,RI
ILLINOIS	1	1	CRS	0.853419	0.853419	
INDIANA	23	0.713286	IRS	0.711519	0.997524	AZ,CT,OH
IOWA	13	0.988493	IRS	0.692767	0.700832	IL,NV,OR
KANSAS	20	0.797617	IRS	0.690517	0.865724	CT,NV,OH,RI
KENTUCKY	47	0.378016	IRS	0.343567	0.908868	AZ,CT,NV,OH
LOUISIANA	50	0.305608	IRS	0.252548	0.826378	AZ,IL,NV
MAINE	30	0.629439	IRS	0.594446	0.944407	CT,NV,RI,VT
MARYLAND	35	0.593822	IRS	0.592866	0.998391	CT,OH
MASSACHUSETTS	25	0.682778	IRS	0.669936	0.981193	CT,OH,OR
MICHIGAN	21	0.731304	IRS	0.729303	0.997265	CT,OH
MINNESOTA	49	0.34534	IRS	0.323402	0.936472	AZ,CT,NV,OH
MISSISSIPPI	40	0.517279	IRS	0.243602	0.47093	IL,NV
MISSOURI	28	0.636071	IRS	0.540871	0.850332	IL,NV,OH,OR
MONTANA	37	0.582088	IRS	0.436043	0.749102	NV,VT
NEBRASKA	1	1	IRS	0.393263	0.393263	IL
NEVADA	1	1	IRS	0.853314	0.853314	AZ,IL
NEW HAMSHIRE	14	0.979332	IRS	0.9487	0.968721	CT,NV,VT
NEW JERSEY	29	0.631483	IRS	0.631249	0.99963	AZ,CT,OH
NEW MEXICO	31	0.622683	IRS	0.506762	0.813836	NV,OR,RI
NEW YORK	1	1	DRS	1	1	
NORTH CAROLINA	41	0.514959	IRS	0.457431	0.888288	AZ,IL,OH
NORTH DAKOTA	19	0.832667	IRS	0.456155	0.547824	NV
OHIO	1	1	CRS	1	1	
OKLAHOMA	38	0.567226	IRS	0.363112	0.640155	IL,NE,NV
OREGON	1	1	CRS	1	1	
PENNSYLVANIA	39	0.546327	DRS	0.345416	0.632251	IL,NY,TX
RHODE ISLAND	1	1	IRS	1	1	CT,OR
SOUTH CAROLINA	42	0.512586	IRS	0.428505	0.835968	AZ,IL,NV
SOUTH DAKOTA	18	0.890787	IRS	0.555967	0.62413	IL,NV,OR
TENNESSEE	24	0.690652	IRS	0.489426	0.708643	IL,NV,OR
TEXAS	1	1	DRS	0.944652	0.944652	NY
UTAH	36	0.585318	IRS	0.517253	0.883713	CT,NV,RI,VT
VERMONT	1	1	IRS	1	1	CT,NV
VIRGINIA	34	0.608641	IRS	0.510086	0.838073	AZ,IL,NV
WASHINGTON	44	0.487977	IRS	0.373277	0.764948	IL,NV,OR
WEST VIRGINIA	27	0.653671	IRS	0.347023	0.530883	IL,NE,NV
WISCONSIN	33	0.609008	IRS	0.515772	0.846905	IL,NV,OH,OR
WYOMING	22	0.72616	IRS	0.642023	0.884134	NV,RI,VT