EFFICIENCY-BASED BUDGET (EBB) ALLOCATION: MUNICIPAL GOVERNMENTS' EXPERIENCE

ARWI SRITHONGRUNG-KRIZ, RESEARCH FELLOW,
INSTITUTE FOR ILLINOIS PUBLIC FINANCE, UNIVERSITY OF ILLINOIS SPRINGFIELD

This study develops and proposes a model for budget decision-making based on program service function efficiency and suggests that such efficiency-based budgeting yields tangible benefits in terms of personal income growth. The performance-based budget concept used in this study is based on Reinventing Government *principles that advocate governments finance their public service programs according to the program service demands, efficiency, and effectiveness. The study samples include 14 Florida cities' budget priorities and service performance results during the period of 2008-2016. The empirical results indicate positive impacts of a performance-based budget on local personal income growth. Implications and recommendations are discussed.*

INTRODUCTION

In the wake of the 2020 pandemic, national unemployment rates have been rising (U.S. Bureau of Labor Statistics, 2020), and state and local governments are seeing revenue shortfalls (McNichol and Leachman, 2020). This has created tremendous uncertainty for the fiscal position of those governments. In such an atmosphere, long-term financial planning may not be practical given forecasting difficulties. Subnational governments are at once compelled to cut their budgets due to balanced budget requirements and political infeasibility of raising tax rates. Meanwhile, they remain responsible for delivering essential services and encouraging local economic development to expand their property tax base.

This study has two purposes. First, it develops a model for budget decision-making based on program service function efficiency. Second, it suggests that benefits of performance-based budgets can be realized through increasing economic growth, all else equal. Nearly 30 years ago, Osborne and Gaebler (1992) called for reinventing government by utilizing private-sector production concepts to make governments more results-oriented and focused on public program beneficiaries as customers. According to these concepts (Osborne and Gaebler, 1992), in order to "purchase" program services from government

agencies, central budget offices should consider which programs are needed in the following fiscal year, program sizes correspondent with public demand, and whether rightsizing or eliminating duplicative or ineffective programs is needed. Answering these questions helps the governments make the right decision in "buying" effective and efficient programs and create a competitive environment where public agencies use the most efficient production processes through technology usage and innovation in the production process.

In this paper, we introduce the concept of efficiency-based budgeting (EBB). EBB focuses on ranking spending priority by public service functions and creating program budgets responsive to public demand (i.e., effectiveness and efficiency). EBB focuses on both macro-level budgeting processes debated by key budget actors in the executive and legislative branches and micro-level budgeting decisions made by budget analysts, program officers, and legislative officials. The broad concept of EBB is that after functional budget sizes (spending ceilings) are determined at the macro level, budget analysts will further analyze program funding levels. These micro-level decisions will then be mutually determined between budget analysts and the program managers and approved by legislative officers. The ceiling set at the macro level will be an instrument for these tasks:

1. Controlling total budget size.
2. Guiding budget cutbacks at the macro-level through providing functional limits.
3. Forcing budget analysts and program managers to reduce programs' budget sizes based on program demands.

For example, if there is evidence that a service function is more efficient in aligning service demands with budget levels than those of its peers and that service function faces increasing demands in the next year, it will receive a budget increase. If inefficiency is found compared to those of the peers and if service demands are likely to fall in the next year, budgets for programs housed in that service function may be reallocated to other programs in the same service function or other service functions.

CONCEPTUAL FRAMEWORK

As implied by its name, EBB's main instruments to make informed budget

decisions are measurements of program efficiency. The performance measurement literature contains two distinctive approaches to measuring program efficiency. The first is a simple measurement of cost per service output, and the second is a statistical technique called data envelopment analysis (DEA). Cost per service output (Wang, 2006; Mikesell, 2017; Mikesell and Mullins, 2011) is calculated by dividing total budget expenditures by total population. For example, in a city's police patrol service function, total program cost (including personnel, supplies, and capital cost) is divided by population (Wang, 2006). Per capita cost for patrol service is then compared to adjacent or comparable jurisdictions to determine if the city's patrol service program is efficient.

This method is simple but has several shortcomings. First, the per capita budget cost does not communicate why the city's program is inefficient. A city's per capita cost may be higher than those of other cities for several reasons, e.g., different crime rates, different input costs (including both personnel and non-personnel), different mandates, or variations in management quality. Second, the per capita program cost method does not link output with program inputs; it measures operational activity but not necessarily any output accomplishment. The per capita cost ratio cannot connect outcomes with inputs — program output does not appear in the calculation. If we seek to implement *Reinventing Government* principles, governments must demonstrate program impacts; thus, per capita cost is not useful. Finally, the per capita cost ratio method cannot measure efficiency when a public program has multiple outputs. Most programs produce several outputs. For example, schools' program outputs include not only the number of school graduates but also gains in student achievement measured by math and reading test scores.

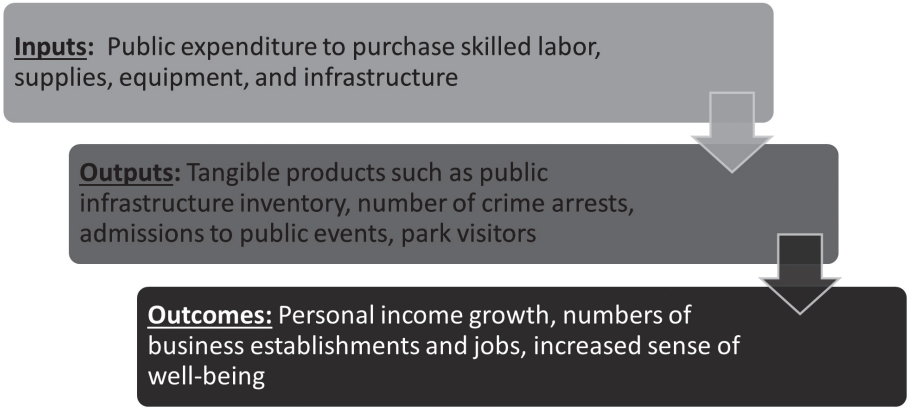
DEA has been proposed to overcome these shortcomings. It was developed to measure public service program productivity or efficiency (Charnes *et al*., 1994). DEA is a statistical technique that relates a government's service program inputs with its multiple outputs through assigning weights to the various inputs and outputs according to a jurisdiction's production profile (Pina *et al*., 2019). Then it statistically derives a computed productivity value for the function being analyzed (Pina *et al*., 2019). Finally, it identifies the best-performing jurisdictions in each function and calculates a measure of a jurisdiction's performance rate compared to the best performers, called peers (Pina *et al*., 2019). The method can even incorporate service demand measures and "confounding" environmental variables that might impact relative efficiency

levels (Sherman and Zhu, 2013). Through incorporating input and output efficiency, consisting of multiple inputs and outputs, and through combining other information, DEA improves markedly on the simple but inherently flawed method of calculating per capita cost (Sherman and Zhu, 2013). To date, DEA has been used in over 3,000 peer-reviewed studies to evaluate relative public performance efficiency (Srithongrung-Kriz, 2019).

Any attempt to measure or improve the efficiency of government units inevitably involves identifying the linkage among program inputs, outputs, and outcomes based on a logical model. Figure 1 presents a broad conceptual framework for the linkage among public service program inputs, outputs, and outcomes. In the language of performance budgeting, municipal service production inputs consist of government spending (operational and capital) used to purchase public official skills and expertise, equipment, land, and public infrastructure. Performance outputs can be measured as tangible products of government activities (e.g., numbers of fires extinguished and investigated, arrests, and public infrastructure inventory levels).

FIGURE 1

THE LINKAGE AMONG INPUTS, OUTPUTS, AND OUTCOMES OF PUBLIC PROGRAMS



These outputs, however, are not the outcomes of public spending. For outcomes, public productivity (outputs) must interact with external factors such as the local economic base, local economic condition, local workforce quality, and geographic location. Outcomes are intangible things like a better economy, greater security, and other things that are not directly visible. However, we can measure them indirectly with measures of economic growth or reported

measures of safety, security, well-being, and other latencies. In this paper, we demonstrate how EBB (determining budget allocations using measures of efficiency measured through data envelopment analysis) is related to socially-desirable economic outcomes.

DEA relates inputs not only to outputs but to measures of demand for public services. Measures of "cost efficiency" are produced but also measures of "scale efficiency" — whether the budget size is too large or too small or just right — compared to the level of demand for a service (on this point, see Daraio and Simar, 2007). This concept, frequently called effectiveness or responsiveness, allows managers and elected officials to see how budget allocations may be made to better provide the types of public services that citizens demand.

ANALYSIS APPROACH AND RESULTS

We wish to demonstrate the use of EBB and relate it to economic outcomes. Therefore, we gathered data from the Comprehensive Annual Financial Reports (CAFR) of 14 Florida cities over the period 2008-2016. The total number of observations is 126 (14 cities times nine years). These cities include Boca Raton, Daytona Beach, Deerfield Beach, Deltona, Lakeland, Miami Beach, North Miami Beach, Palm Bay, Pensacola, Plantation, Sunrise, Tamarac, Tampa, and Weston. We collected spending, employment, and output data across five functions, economic variables to measure outcomes, and other variables to "control" for moderating or amplifying influences of the local environment. Table 1 lists the variables we used in our analysis.

We performed three steps to examine the relationships between efficiency-based budget allocations and economic outcomes. First, we calculated spending efficiency values by public service function across all 14 cities over the nine-year period for which we have data. Figure 2 presents the basic idea of measuring spending efficiency through DEA.[1] Inputs in the form of labor and budgetary resources are combined using the managerial process to produce outputs. The better public managers use public budgetary resources, the greater the spending efficiency. We can measure this through looking at relative ratios of outputs per unit of input. The DEA process allows us to simultaneously look at the ratios and calculate an overall efficiency measure by function. As shown in Table 1, efficiency values were calculated for five municipal service functions, including general government, capital management, public safety, recreation, and transportation.

TABLE 1

VARIABLES USED IN THE ANALYSIS[3]

INPUTS:
- Full-time equivalent employment, by function
- Per capita operational and capital spending, by function

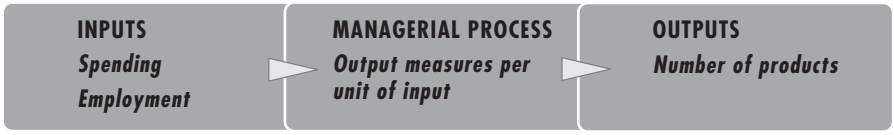
OUTPUTS:
- Per capita fee and per capita permit revenue (general government function)
- Per capita number of patrol units, fire stations, and miles of local roads, acres of parks (capital management function)
- Per capita number of total fire and emergency calls and arrests (public safety function)
- Per capita number of park admission tickets and recreation center admission tickets (recreation function)
- Per capita miles of roads resurfaced, and roads maintained (transportation function)

OUTCOMES: ECONOMIC VARIABLES
- Personal income (inflation-adjusted)
- Business establishments
- Employment

ENVIRONMENTAL VARIABLES:
- Total population
- Tax revenues (inflation-adjusted)
- Intergovernmental revenues (inflation-adjusted)

FIGURE 2

LINKAGE AMONG INPUTS, OUTPUTS, AND MEASURES OF EFFICIENCY



Second, we linked the efficiency measures with the local governments' budget allocations. We did this by ranking the annual government spending efficiency scores by service function, city, and year. Then, we did the same to annual government budget spending by function, city, and year. We then performed a correlation analysis of the two measures. This tells us the extent to which cities are making budget decisions in accordance with the relative efficiency of government spending. Table 2 presents the results of this analysis. Correlation measures range from zero to one. The closer the value is to one, the stronger the relationship.

TABLE 2

RELATIONSHIP BETWEEN CITY EFFICIENCY MEASURES AND BUDGET PRIORITY RANKINGS

CITY	2008	2009	2010	2011	2012	2013	2014	2015	2016
Boca Raton	0.4	0.2	0.6	0.1	0.6	0.8	0.5	0.6	0.2
Daytona Beach	0.2	0.7	0.6	0.6	0.9	0.9	0.2	0.4	0.5
Deerfield Beach	0.5	0.4	0.3	0.2	0.4	0.6	0.2	0.1	0.3
Deltona	0.6	0.9	0.7	0.7	0.9	0.3	0.1	0.6	0.3
Lakeland	0.1	0.3	0.1	0.0	0.0	0.2	0.3	0.6	0.1
Miami Beach	0.4	0.1	0.6	0.3	1.0	0.1	0.7	0.5	0.1
North Miami Beach	0.7	0.9	0.1	0.1	0.5	0.3	0.2	0.6	0.9
Palm Bay	0.5	0.8	0.8	0.1	0.5	0.6	0.7	0.3	0.0
Pensacola	0.6	0.5	0.2	0.1	0.3	0.3	0.1	0.1	0.6
Plantation	0.4	0.6	0.9	0.5	0.5	0.4	0.7	0.8	0.3
Sunrise	0.1	0.1	0.1	0.3	0.2	0.4	0.0	0.4	0.5
Tamarac	0.1	0.1	0.0	0.0	0.1	0.7	0.5	0.2	0.5
Tampa	0.1	0.6	0.2	0.3	0.8	0.7	1.0	0.7	0.3
Weston	0.8	0.3	0.4	0.1	0.6	0.1	0.3	0.5	0.1

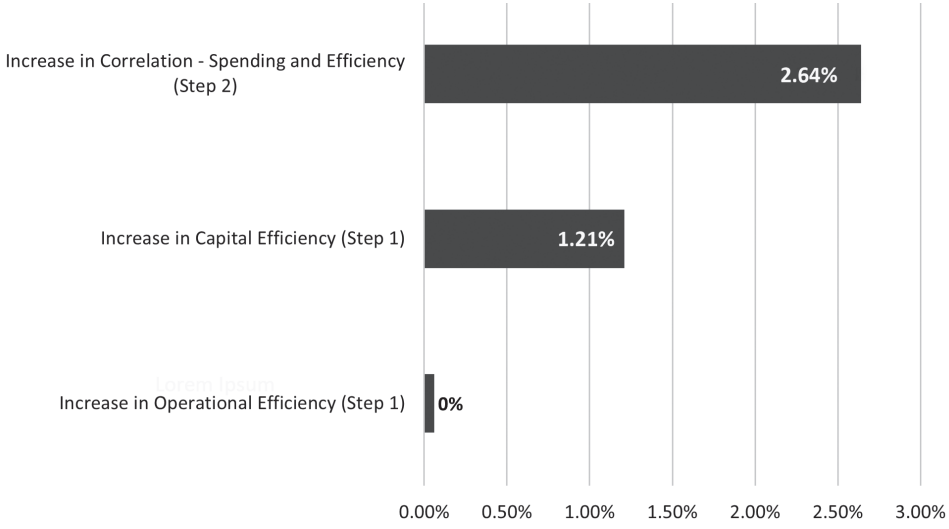
As shown in the table, budget allocation practices are varied widely, both within and across municipalities. For example, North Miami Beach had shown a very strong relationship between efficiency and budget decisions in 2008 and 2009, then the relationship weakened but became stronger again in 2015 and 2016. Overall, the cities of Boca Raton, Daytona Beach, Deltona, Palm

Bay, and Plantation make budget decisions that consistently have the strongest relationships with efficiency measures.

The third step in our analysis is to relate our efficiency measures and outcomes of greater economic growth. To do this, we used a statistical technique called panel data regression. This allows us to search for relationships between measures of efficiency calculated in the first step of our analysis, the correlations from the second step of the analysis, and economic growth, which we measure as the growth in personal income adjusted for inflation. It also allows us to control for environmental variables like increases in population that might affect the relationship.[2] Figure 3 shows the results for the variables of interest. Full results are presented in Appendix A.2.

FIGURE 3

EFFECT OF EFFICIENCY AND SPENDING VARIABLES ON ECONOMIC GROWTH



The results suggest that for each increase of 0.1 unit in the correlation index, a municipality will experience a 2.64% increase in personal income over a two-year period. This is a strong effect. Increases in the efficiency of capital spending themselves cause a 1.21% increase in economic growth. Increases in the efficiency of operational spending are estimated to have no significant effect on growth (meaning that we cannot infer based on the results that the relationship will hold in the larger population beyond the sample cities).

CONCLUSION AND IMPLEMENTATION

This study introduces the concept of efficiency-based budgeting (EBB), which facilitates cities making budget-allocation decisions based on the relative efficiency of public programs. In applying the EBB concept at the macro level, performance measurement results such as measurements of program efficiency can be used to set budget ceilings on service functions. Then at the micro-level, budget analysts can apply efficiency concepts to prioritize spending on certain programs. Our study suggests that this use of EBB will have tangible benefits in increasing community economic growth.

There are several practical recommendations that come from this analysis. First, during periods of budget reductions, local governments should consider using EBB to establish budget priorities and applying ceilings to public service functions. The ceilings should be determined based on performance measurement results, including efficiency measurements. This is an essential use of EBB: determining how to reallocate budgetary resources from one service function to another, especially when performance results suggest differences in relative demand for the services delivered among functions. Budget reallocations at the micro-level could be implemented like those demonstrated in this paper although data outputs the program level may be sparse.

Second, local governments should sustain and expand collection of performance data. Our study suggests a strong benefit to society when local governments make budget decisions informed by good performance information and proper evaluation techniques. It is always possible that politics could ultimately shape spending levels, but that should be contained at the marginal level while the foundation of resource allocation is determined using EBB and other "good government" concepts. Modern information technology allows for the systematic gathering, processing, and dissemination of performance information.

Last, performance measurement should be used to understand the alignment of public service demands, budgetary inputs, and service outputs rather than to punish governments as a whole. Budget cuts in a service program or function should be offset by budget increases in functions where demands are more pressing. The DEA technique used in this study can particularly yield benefits to governments in that the results are realized over time; a local government can compare its performance and assess different management styles across time to gain insights about the practices that work best in its particular context.

In this way, DEA acts as a benchmarking technique in which, when used over time, an analyst can find a "most efficient" period to act as a self-benchmark.

Although EBB can be useful for governments as discussed above, it has some challenges. First, like many other measures, efficiency scores provide only an overview of where change in the production process might occur to improve efficiency. Administrators should use them to identify potential areas of inefficiency, then meet with program managers and line staff to explore operational data, perhaps engaging consultants to help with identifying potential efficiency gains. Second, the public budgeting literature identifies a potential disconnect between the goals of public managers, citizens, and their elected representatives. For this reason, measures such as efficiency scores may become a source of negotiating power for the group that possesses them. For this reason, there should be an independent group such as internal auditors or external watchdogs that calculate and publish the results of efficiency studies. Third, EBB is a tool that can be used to help improve overall efficiency, including both effectiveness (i.e., capacity of a government to respond to public service demands) and economic efficiency. However, some bureaucrats and the public may view EBB as a tool to cut budgets or punish certain public programs. Education should incorporate EBB processes because the goal is to develop a budget process that creates the greatest overall municipal government efficiency and effectiveness.

EBB, like other budgeting approaches, also has limitations on top of those challenges. First, in a pluralistic society, EBB may not be able to be used as a sole instrument to allocate budget since a democratic society may require some programs that are not efficient and effective but are needed for some groups in the society (i.e., equity). For this reason, other criteria, such as equity and fairness, may be added into EBB.

Second, EBB is extremely useful for establishing functional spending ceilings at the macro-budgeting level; however, at the micro-level, it needs many more details in terms of costs ranging from a single input's volume and price. Also, to increase a program's efficiency, the public manager must have insights for the best use of input mix in the production process (i.e., to use relatively small number of labor and relatively large number of machines) and technical knowledge for the best way to produce public service (i.e., to use in-house service versus to contract out). The public manager's insights are, thus, the key to make EBB useful in productivity improvement at the micro-level. Unfortunately, obtaining public managers' insights to be used as information

in reinventing government production takes too much time and resources, and there may be a lack of top management support and commitment.

Finally, for this study the amount of data on outputs were somewhat limited. For a broader analysis, communities should have a good performance measurement system in place (this is something that should be done even without using EBB). This also speaks to the need to involve line managers in EBB analysis to expose data not collected in other ways.

Arwi Srithongrung-Kriz is a research fellow in the Institute for Illinois Public Finance, University of Illinois Springfield. Her research interests include fiscal policy and economic growth, capital budgeting, and public efficiency measurement.

ENDNOTES

[1] For a more in-depth discussion of the DEA technique, see the two Srithongrung-Kriz papers (2019) listed in the References.

[2] Outliers were removed from the dataset using Cook's d statistics. We tested for multicollinearity among variables using a VIF test (see Ott and Longnecker, 2001, for these analyses). Heteroskedasticity and autocorrelation are frequent problems in panel data. We used the Prais-Winsten quasi-differencing method with panel corrected standard errors (PCSEs) to address these threats. Endogeneity is another concern; we addressed this problem by specifying the regression model containing lead and lagged variables. This technique is commonly used in the economic growth literature to address endogeneity. After the regression analysis, we conducted simple correlation analyses to confirm that endogeneity was controlled. For details on these techniques, see Stock and Watson (2011). All analyses are available upon request.

[3] Source of data are the cities' CAFRs. Output variables are consistent across time periods and city samples. Per capita fees are an indicator of businesses' and residents' demands to perform activities within the jurisdiction, paying fees in exchange for government permission to engage in the activities in the jurisdiction. Per capita permits are a measure of the number of new resident and commercial buildings in a jurisdiction. If a local government performs well in terms of managing the entire city so that it is attractive to new residents and businesses, then these two indicators should increase. Combined, the two variables are a general indicator suggesting how attractive the government has made the city for new residents and businesses. Capital management inputs include budgets for both new projects and maintenance projects. Capital management outputs are "usable assets" that could result from new project acquisition or routine maintenance. Patrol units include all equipment, including police vehicles, that allow patrol units to function effectively.

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APPENDIX: RESULTS OF STATISTICAL MODELS

TABLE A.1

DESCRIPTIVE STATISTICS FOR VARIABLES IN THE REGRESSION MODEL

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
Total personal income (adjusted for inflation)	7,141,781	12,100,000	84,579	51,900,000
Total population	95,552	70,449	35,721	353,840
Tax revenue (adjusted for inflation)	75,400,000	75,000,000	17,000,000	285,000,000
Intergovernmental revenue (adjusted for inflation)	27,088,067	31,969,998	4,363,234	151,884,611
Total number of new business establishments	5,617	5,745	111	24,155
Efficiency index for capital spending	1.16	0.57	0.24	3.87
Efficiency index for operational spending	1.05	0.21	0.63	1.72
Correlation of budget priority ranking and efficiency ranking by service function	0.407	0.268	0.000	1.000
Employment	69,346	22,986	53,419	83,476

TABLE A.2

RESULTS OF THE REGRESSION ANALYSIS OF ECONOMIC GROWTH ON EFFICIENCY MEASURES AND BUDGET ALLOCATION CORRELATIONS (14 CITIES, 9 YEARS); DEPENDENT VARIABLE IS LOG OF REAL PERSONAL INCOME

VARIABLE	COEFFICIENT	STANDARD ERROR (PCSE)	Z VALUE	P>|Z|
Constant	18.363	0.887	20.69	0.000
Log of total employment (t-1)	0.035	0.004	7.37	0.000
Log of total number of new business establishments (t-1)	0.393	0.034	11.52	0.000
Log of total population (t-1)	2.526	0.208	12.09	0.000
Log of total tax ($ real, 2013 based year, t-1)	-2.591	0.086	-30.01	0.000
Log of total intergovernmental revenue ($ real, 2013 based year, t-1)	0.579	0.086	6.74	0.000
Efficiency index for capital spending (t-2)	0.121	0.035	3.48	0.001
Efficiency index for operational spending (t-2)	-0.018	0.069	-0.25	0.801
Value for correlation between budget priority and efficiency ranks (Spearman's Rho, t-2)	0.264	0.072	3.66	0.000
Time fixed effect	Included through time demean method			
Entity fixed effect	Included through entity demean method			
Number of observations	119			
Panels: Correlated (unbalanced)				
Autocorrelation: panel specific AR (1)				
Sigma computed by case wise selection				
Estimated covariance	105			
Estimated autocorrelation	14			
Estimated coefficients	9			
Number of groups	14			
Wald chi2 (7)	8544.62			
Prob > chi2	0.000			

Note: Due to panel heteroskedasticity and autocorrelation, Prais-Winsten regression, correlated panels corrected standard errors (PCSEs) is used to test hypotheses. Panel autocorrelation was corrected by autocorrelation of residuals; standard error is for panel-level heteroskedastic and correlation across panels. Lag periods were chosen based on unit roots and trend results. Test results on panel heteroskedasticity and autocorrelation are available upon request.