Marketing Faculty Publications   Department of Marketing

2022

Improving Arts Management/Marketing Efficiency: Optimizing Utilization of Scarce Resources to Produce Artistic Outputs

Theresa A. Kirchner
Old Dominion University, tkirchne@odu.edu

Linda L. Golden
University of Texas at Austin

Patrick L. Brockett
University of Texas at Austin

Improving arts management/ marketing efficiency: optimizing utilization of scarce resources to produce artistic outputs

Theresa A. Kirchner
Department of Marketing, Strome College of Business, Old Dominion University, Norfolk, Virginia, USA
Linda L. Golden
Department of Marketing, McCombs School of Business, The University of Texas at Austin, Austin, Texas, USA, and
Patrick L. Brockett
Center for Risk Management and Insurance, Information, Risk and Operations Management, The University of Texas at Austin, Austin, Texas, USA

Abstract

Purpose – This longitudinal research examines US symphony orchestra sector organizations to determine individual efficiencies in allocating resources (donations, governmental/private funding, etc.) for desirable outputs (concerts, educational programs, community outreach). It provides researchers and managers with a tool for identifying, assessing and mitigating organizational inefficiencies.

Design/methodology/approach – This study assesses relative efficiencies in performing arts organizations using Data Envelopment Analysis (DEA), a widely-used nonparametric data-intensive benchmarking technique that determines an optimal "production frontier" of best-practice organizations among their peers and assesses their abilities to turn multivariate inputs into multivariate desired outputs.

Findings – This analysis highlights efficiency differences in a wide range of orchestras in converting available resources into performance-related outputs. It provides individual arts organizations with useful results for developing practical benchmarks to achieve organizational efficiency improvement.

Research limitations/implications – This study provides constructive benchmarking guidance for improving efficiencies of relatively-inefficient organizations. Future analysis can expand the scope to utilize a two-stage DEA model to provide more specific guidance to arts organizations.

Practical implications – This pragmatic analysis enables arts/culture institutions to assess their organizational efficiencies and identify opportunities to optimize resources in producing social outputs for their target markets.

Social implications – Efficiency improvements enable performing arts organizations to provide additional artistic/social services, with fewer resources, to larger audiences.

Arts and the Market
Vol. 12 No. 3, 2022
pp. 181-196
Emerald Publishing Limited
2056-4945
DOI 10.1108/AAM-07-2021-0029

Originality/value – This research demonstrates the abilities of DEA analysis to assess both a sector and its individual organizations to determine efficiencies, identify sources of inefficiencies and assess longitudinal efficiency trends.

Introduction

Even in strong economic climates, not-for-profit arts organizations often struggle to survive (Byrnes, 2014; Gregor, 2012). Like other nonprofits that exist to benefit society (versus profits and return on investment), arts organizations typically have scarce resources and risk failure when they function inefficiently. Financial health of symphony orchestra organizations was examined by Kirchner *et al.* (2007), who applied Granger Causality Analysis to determine financial distress risk paths. Cultural economics literature also discusses factors involved in this fiscal vulnerability, such as organizational administration, fundraising, investment and price inefficiencies (Jacobs and Marudas, 2009; Flanagan, 2012; O'Reilly, 2011).

Arts production itself also contributes to financial dilemmas facing performing arts organizations. A program of Haydn string quartets, performed by four musicians for two hours when played in the 1700s, still requires the same number of people and time today. Baumol and Bowen (1966) described this production cost inflexibility as a "cost disease". They suggested that technological innovations and increasing automation that yield cost efficiencies in other industries cannot easily be applied to arts production (Lin and Lin, 2018). Financial vulnerability affecting arts organizations is further compounded by inflation increases in the arts sector, which historically rise about 2% higher per year than the Consumer Price Index (Baumol, 1995). Performing arts managers must identify and develop alternative cost reduction strategies without sacrificing vital artistic aspects of performances. Finding and eliminating various forms of inefficiencies is one option.

Operational expense constraints increasingly motivate performing arts organizations to search for increased efficiency (Jacobs and Marudas, 2007). However, the percentage of US orchestras' budgets coming from performance revenue decreased from 60% in 1940, to 41% in 2005–06 (Gregor, 2012). Newer generations of potential audiences are changing their views of leisure activity and decreasing leisure time consumption (Flanagan, 2012). Orchestra audiences fell 10.5% between 2010–2014 (Voss *et al.*, 2016). Orchestras increasingly depend on endowments, grants, donations and invested funds, so productive investment strategies and investment inefficiency reduction must be optimized. "Some orchestras earn returns on investment as much as 10% points lower than returns earned by other orchestras incurring the same level of risk" (Gregor, 2012). Finding and reducing/eliminating inefficiencies is important, since potentials for productivity improvements are constrained by demographic preference shift and the "cost disease."

Inefficiency elimination has side benefits. The more technically efficient a not-for-profit becomes, the more monetary donations it can raise (Callen, 1994). Volunteer labor (sometimes utilized as a way to combat "cost disease") seems complementary to money donations, since volunteer support is also affected by inefficiency. People tend to be less interested in donating to (or volunteering with) organizations viewed as inefficiently using their resources (Callen, 1994).

Throsby's research (1977) was the first quantitatively to examine efficiency in the performing arts sector, using a parametric Cobb–Douglas production function. Luksetich and Hughes (1997, 2003) used nonparametric Data Envelopment Analysis (DEA) to examine orchestra sector efficiency, assessing efficiency in development/fundraising in 78 U S. orchestras. They focused on fundraising efficiency, rather than efficiency of service provision, which is the focus of this research.

Our methodological approach employs DEA, which was invented by Charnes, Cooper and Rhodes in 1978 and has been applied successfully in numerous management/marketing contexts. DEA is a well-accepted methodology for assessing relative efficiencies of organizations. A bibliography of DEA articles from 1978–2016 (Emrouznejad and Yang, 2018) lists 10,300 DEA-related journal articles. Table 1 lists research that leverages DEA to evaluate efficiency in the not-for-profit performing arts sector.

Examining a collection of organizations, all trying to use similar input variables to produce a similar set of output variables, DEA identifies organizations that are relatively most efficient in this "production" process. An "efficient" organization exhibits "best practice" performance, meaning that no other entity can use its same inputs to produce more outputs (Pareto optimal production). In our application, organizations use multiple input resources to create multiple artistic outputs. Unlike classical Cobb–Douglas production functions, DEA does not require a prespecified parametric mathematical form relating outputs to inputs, so DEA can uncover otherwise unseen relationships. Additionally, DEA assesses every organization for efficiency. If inefficient, DEA output provides a list of efficient peer organizations for benchmarking and specifies sources of inefficiency (i.e. where an inefficient organization fell short and needs improvement to decrease inefficiency and which resources (inputs) are overutilized and/or which outputs are under-produced and by how much). Managerially, these identified sources of inefficiency can be viewed as furnishing Key Performance Indicator (KPI) variables, which can be monitored to track performance toward a strategic efficiency goal. Since DEA supplies both KPIs and the amount by which each KPI must change to obtain full efficiency, it provides a metric for determining if an orchestra is on track to achieve its objectives.

Fully efficient organizations provide "best practice" benchmarks for inefficient organizations. DEA supplies concrete information on sources of inefficiencies, calculating how much an inefficient organization would produce if operating efficiently and providing a practical managerial tool for improving performance of inefficient organizations.

These managerial implications motivated our use of DEA as a performance efficiency measurement technique to identify and assess relative sources of efficiencies/inefficiencies in performing arts organizations and provide strategic guidance for mitigating inefficiencies.

Efficiency of fund-raising activities in symphony orchestras	1997, 2003	Luksetich and Hughes	*Nonprofit and Voluntary Sector Quarterly*
Cost functions for symphony orchestras	1985	Lange *et al*	*International Journal of Nonprofit and Voluntary Sector Marketing*
Measuring best practices in Canadian symphony orchestras	2004	Bhatt *et al*	*Administrative Sciences Association of Canada*
Monitoring managerial efficiency in the performing arts (musical theatres)	2006	Marco-Serrano	*Annals of Operations Research*
Corporatization and economic efficiency in Australian symphony orchestras	2012	Boyle and Throsby	*Economic Papers*
Efficiency of musical societies in the Valencian community	2013	Rausell-Köster *et al*	*Journal of Quantitative Methods for Economics and Business Administration*
Strategic management of youth orchestras	2014	Hong	*Journal of Arts Management Law and Society*
Dynamic efficiency evaluation of German public multidisciplinary theatres	2016	Kleine and Hoffmann	*Data Envelopment Analysis and its Applications*
Measuring technical efficiency and marginal costs in the performing arts	2019	Fernández-Blanco *et al*	*Journal of Cultural Economics*

Table 1.
Performing arts research using data envelopment analysis (DEA)

DEA offers benchmark guidance opportunities for peer organizations that use multiple input resources to produce multiple desired artistic/social/organizational/economic outputs.

Research scope/considerations

This research evaluates efficiency (and prescriptions for remedying inefficiency) of performing arts organizations, using orchestra sector data. One difficulty in assessing "efficiency", in an environment where "gain" is partially or primarily a non-financial social good, is lack of a simple univariate "bottom line" measure of successful performance (e.g. "Financial Profit" or "Return on Investment" metrics used in for-profit organizations). Orchestras exist primarily to make music and the value that they create is primarily cultural/artistic, not financial (McClintock, 2017). This makes it more difficult to assign a numerical baseline metric against which entities can be compared side-by-side and rank-ordered and to identify "best performers" so that benchmarking and performance improvement opportunities can be pursued. Prior focus on efficiency in performing arts related to spending ratios, like the ratio of fundraising expenses and/or management expenses to all expenses or revenue (Cashwell *et al.*, 2019; Marudas and Jacobs, 2007). Despite the non-fiscal nature of performing arts outputs, Turbide and Laurin's (2009) survey of arts organizations indicated that managers/marketers still tend to evaluate their organizations primarily in traditional financial terms, rather than using equally pertinent core artistic measures or societal contributions. Kaplan and Norton (2001) stress that measurement/assessment of the extent to which a not-for-profit organization delivers on its mission should use multiple non-financial and financial indicators. Since output for performing arts organizations should not be measured only in dollars, an efficiency assessment metric that is capable of incorporating multiple variables with different numeraires that transcend financial metrics is required (Berman, 2003). As Williams-Burnett and Skinner (2017) noted, arts organizations may view both "art for arts sake" and economic results as critically important when evaluating and goal-setting. This analysis therefore incorporates both financial and non-financial performance-based metrics.

Data

This longitudinal study provides a practical example of the balanced assessment of financial/artistic efficiency described above, applying DEA to the orchestra sector, a relatively homogeneous group of performing arts organizations. Our study uses the most recent set of 10 consecutive years of League of American Orchestras (LAO) data (2003–2012). The sample frame includes all LAO member orchestras (393) that completed the member survey in at least one of those ten years, with an average of 162 participants per year. The LAO provided that data from the last years that the organization used its own robust system to collect data from member orchestras. (That reporting mechanism was replaced by a different performing arts organization reporting system in 2013–14.) This timespan also contains data from years ranging from before, to after, the 2008 financial crisis, allowing for assessment of efficiency changes over that timeframe.

LAO supplied this data for our analysis with the explicit condition that we not provide/attribute information identifiable to individual orchestras. Accordingly, letters/numbers are used to represent orchestras, rather than names.

Methodology for assessing efficiency in performing arts organizations

Mathematically, performing arts organizations can be viewed as individual "production units", since they utilize similar collections of private/public funds, income, expenses and human capital as inputs and provide/produce desirable outputs (e.g. musical performances).

This formalization (transforming inputs into outputs) allows utilization of econometric models of production and comparison of relative efficiencies of individual arts organizations.

Ranking organizations in terms of efficiency is relatively straightforward when a single input is used to produce a single output, as portrayed in Figure 1. The ratio of output produced to input used is a metric of efficiency akin to an ROI ratio in finance. Another example is the SEER rating system used to evaluate refrigerator/air conditioner efficiency. The efficiency ratio is a ratio of output (cooling degrees) to input (electrical current used). A higher SEER rating indicates a higher relative efficiency.

Figure 1 illustrates the single input/single output situation and relative efficiency of production. Organizations L1 – L4 are deemed "efficient", since they best use their input to produce more output than could any other organization utilizing the same inputs. Connecting dots L1 – L4, the four organizations form an efficiency "envelope" for all organizations. Organizations inside this envelope, like L5, are inefficient (i.e. other organizations can produce more output using the same input). There are two ways to see the inferiority of the "inside the envelope" inefficient units: (1) L5 is inferior since a combination of L2 and L3 could use the same 5 units of input as L5, but produce more output than L5 (vertical arrow) and (2) the same 3 units of output produced by L5 could have been produced using a combination of L1 and L2, but with less input than the 5 units L5 required (horizontal arrow).

The single-input single-output ratio measure of efficiency portrayed in Figure 1 can be generalized to more common situations involving multiple inputs producing multiple outputs. Charnes *et al.* (1978, 1981) developed a multidimensional DEA conceptualization of efficiency for the purpose of determining relative efficiencies of peer organizations that consume multiple input resources to produce multiple outputs and use variables which need not be measured with the same numeraire.

When multiple inputs/outputs occur, as with orchestras, a first impulse may be to generalize single input/single output models by using a weighted sum of input values and a weighted sum of output values. Efficiency would be evaluated using a ratio of (weighted) output to (weighted) input, presenting the issue of how the weights are chosen. Multi-Criteria Decision Making (MCDM) analysis addresses the weight-choice problem by adopting a single common set of weights for all evaluated organizations, with weights chosen by a single decision maker (Opricovic and Tzeng, 2003). Orchestras, however, have different goals, available resources, management teams and clientele. One uniform set of weights does not
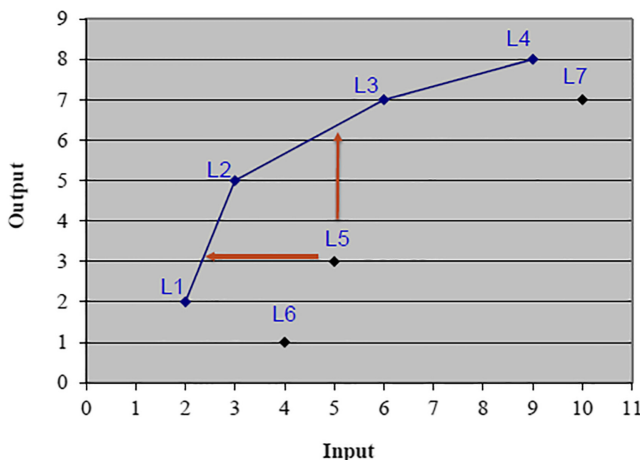
reflect organizational differences in goals, resources or stakeholder values. One common weight choice might make an orchestra look relatively efficient, while another could make the same organization look relatively poor.

In DEA (unlike MCDC) weights are not pre-selected and not assumed to be equally applicable across organizations. Each organization can determine its own weighting scheme, optimally selected to make it "as efficient as possible". In other words, each organization chooses weights to maximize its own apparent efficiency ratio, with the weights reflecting differences in production strategies, individual input access and output importance, as judged by the orchestra itself. For example, some orchestras may put greater weight on producing Pops concerts and community outreach programs, while others may put little/no weight on those. If a DEA-evaluated organization can be outperformed (i.e. other organizations can produce more weighted output for a given weighted input), even while using its personally-selected weighting scheme, then it is termed inefficient, or dominated. If it is not dominated, it is efficient.

Implementing DEA and determining efficiency

While theoretic and mathematical in nature, DEA analysis is quite easy to accomplish computationally. (The formal mathematical treatment of implementing DEA analysis is discussed in Appendix.) DEA computer programs identify the set of fully-efficient organizations in the dataset and produce an efficiency frontier created as a piecewise linear surface produced by connecting efficient producers' input-output relationship points. This "efficiency frontier" in the multidimensional setting is analogous to the piecewise linear curve in Figure 1.

Choosing target benchmark organizations is a difficult problem when managers/marketers subjectively select their own potentially-biased benchmarks (Brockett *et al.,* 2001; Lewellen *et al.,* 1996). DEA's exemplar organizations are objectively-determined. For inefficient orchestras, DEA provides a list of fully efficient organizations that are managerially relevant for benchmarking. DEA also addresses another crucial benchmarking component: identifying which variables to benchmark against for improvement. It provides managerial guidance to inefficient orchestras by delineating over-utilized inputs and/or under-produced outputs relative to their efficient benchmark targets (cf., Brockett *et al.*, 2001).

A discussion of the concept/goals of DEA and related software is provided in Cooper *et al.* (2007). Information about off-the-shelf DEA computer programs and freeware is provided in Table 2. This analysis used commercially-available DEA SolverPro™, which is easily accessible for interested managers/researchers.

The DEA SolverPro™ program allows the user to choose between several DEA models that focus on different aspects of efficiency and differing assumptions. This research employed the most widely used DEA model, the BCC model (Banker *et al.*, 1984). It allows for the possibility of variable returns to scale (RTS) in production (increasing, decreasing, or constant RTS) and its output provides RTS information for each organization.

We selected an "input-oriented" DEA model focusing on minimizing resources (inputs) needed to produce orchestral output. This is analogous to the horizontal arrow in Figure 1. (An 'output oriented' DEA model fixes inputs and maximizes outputs, analogous to Figure 1s vertical arrow.) We chose the input orientation because of the fiscal vulnerability of the orchestra sector, to conserve resources while producing committed levels of outputs (performances scheduled in advance have little flexibility).

An organization responsible for transforming inputs into outputs is termed a Decision-Making Unit (DMU). For *n* entities (DMUs), DEA provides a ratio measure of each DMU's efficiency, calculated using its optimal individually-chosen weighted sum of outputs over its weighted sum of inputs.

Software name	Web link	Notes
Freeware		
Open Source DEA (OSDEA)	http://www.opensourcedea.org/ index.php?title=Open_Source_DEA *(accessed 06/27/2022)*	Downloadable for use on all platforms (e.g. Windows 7–10, Linus and Mac). Source code can be used in your own programs
EMS: Efficiency Measurement Analysis (DEA)	http://www.holger-scheel.de/ems/ *(accessed 06/27/2022)*	Free download for academic users
DEAS (Data Envelopment Analysis Using Stata)	http://sourceforge.net/projects/deas/ *(accessed 06/27/2022)*	Option for those familiar with the Stata programing language
Package rDEA	https://www.uv.es/deaRshiny/deaR. html *(accessed 06/27/2022)*	Robust DEA package written in R language
Commercially Available Software Used in This Study		
DEA SolverPro™	http://www.saitech-inc.com/ products/prod-dsp.asp *(accessed 06/ 27/2022)*	Operates as a Microsoft$^{©}$ Excel add-on, allowing flexible structure, choice of models and input or output orientation. Large datasets are permitted

Table 2.
Data envelopment analysis (DEA) software options

The first DEA step is to determine, for each DMU, its "best" weights for forming a weighted input sum and a weighted output sum. The weights are not pre-specified, since some orchestras emphasize certain inputs or outputs more than other orchestras. Orchestras have differing priorities, resources and/or clientele and the weights reflect these differences. DEA weighting permits individual orchestras to emphasize their own situations.

DEA weights are chosen by the orchestra (DMU_0) to give itself its highest possible efficiency. Weights represent the relative importance that a DMU_0 places on inputs/outputs. A constraint is placed on the allowable set of weight choices a DMU can select. It cannot select weights in such a manner that it, or another DMU, thereby becomes more than 100% efficient by using those weights. For any DMU (e.g. DMU_0), the DEA program simultaneously examines all other DMUs using DMU_0's weighting scheme and compares this efficiency ratio across DMUs. If the efficiency ratio is less than one after DMU_0 optimizes its weights (subject to the constraint that no DMU can be more than 100% efficient using DMU_0's weights), then DMU_0 is inefficient. Otherwise, it is efficient. Inefficiency indicates that some other group of DMUs (orchestras) could use DMU_0's given inputs and weighting scheme to produce larger outputs than DMU_0 and therefore, DMU_0 is dominated (inefficient). DEA explicitly identifies this other group of DMUs for inefficient orchestras.

Table 3 lists the financial and non-financial (social contribution) input/output variables used here. While the LAO data contained many variables, we focused on the specific items listed in Table 3 that constituted either an input or an output for an orchestra. Not all variables are measured in dollars and some outputs measure social contribution (e.g. educational and community outreach attendance). Efficiency is the weighted output sum divided by weighted input sum.

Results

The BCC input-oriented DEA was run for each year using data from orchestras reporting that year. 266 (266/393 = 58.5%) orchestras were fully efficient in at least one reporting year and 21.6% (85/393) were efficient in each of the reporting years. The annual efficiency score of all 393 orchestra reports was 0.778. The average annual percent of efficient orchestras was 40.5%.

Outputs y_{kj} / Inputs x_{ki}	Regular Concert Attendance		Pops Concerts Attendance		Educational Outreach Attendance		Community Outreach Attendance	
	Aver. Correl.	p-value	Aver. Correl.	p-value	Aver. Correl.	p-value	Aver. Correl.	p-value
Government Support – **National** – **State** – **Local**	0.465	<0.0005	0.356	<0.0005	0.338	<0.0005	0.122	NS
Private Support – **Business** – **Individual** – **Foundation**	0.858	<0.0005	0.457	<0.0005	0.434	<0.0005	0.35	<0.0005
Unrestricted Operating Revenue	0.914	<0.0005	0.548	<0.0005	0.417	<0.0005	0.425	<0.0005
Total Operating Expenses – **Marketing** – **Development** – **General / Administrative** – **Education and Community**	0.920	<0.0005	0.55	<0.0005	0.422	<0.0005	0.42	<0.0005
Number of Musicians	0.368	<0.0005	0.22	<0.001	0.258	<0.0005	0.121	NS
Number of Volunteers	0.533	<0.0005	0.442	<0.0005	0.421	<0.0005	0.231	<0.001
Z-Score Difference In Correlations for Government vs. Private Support*	$Z = -11.02$	0.0000	$Z = -4.057$	0.0000	$Z = -3.815$	0.0000	$Z = -3.151$	<0.001

Note(s): *Z-Scores are calculated based on Fisher's transformation for correlations to approximate standard normal distribution Z. A negative Z-Score indicates Private Funding is more correlated with output

Table 3.
Average annual correlations of input variables with output variables

The onset of the 2008 financial crisis affected both survey participation and orchestra efficiency. Pre-crisis (2003–2007), the per-year average number of orchestras reporting was 182. Post-crisis (2009–2012), the average fell to 137. This decreased participation rate may be attributable to fiscally-constrained orchestras' redirection of resources toward more critical tasks than survey completion. This was a productive decision in terms of efficiency, since the average annual percent of 100% efficient orchestras increased from 31.75% of orchestras pre-crisis to 52.04% post-crisis. According to Indiana University's Center on Philanthropy (Chronicle of Philanthropy, 2009), for every stock market decline of 100 points (as during the financial crisis), charitable giving declines by $1.85 billion. During the crisis, returns on donations and endowments also fell markedly, leaving orchestras less funding to accomplish commitments. Constraints, like the "cost disease", meant that orchestras "tightened their belts" in other areas to survive. This decreased level of other inputs providing already-

scheduled outputs resulted in increased efficiency, on average. Once efficiencies had been recognized and achieved, solutions could be identified, encouraged and continued. Supporting this "learning from efficiency achievement" hypothesis, 146 of 266 orchestras (55%) that achieved full efficiency at some point in the decade never subsequently reported a score below 100%. In addition, the average annual efficiency scores for orchestras post-crisis increased from their pre-crisis average score of 74.2% to a post-crisis efficiency score of 81.1%.

DEA also provides correlations, which identify which inputs are significantly related to producing which outputs. Overall correlations between input and outcome variables were positive and highly significant (see Table 3). Only the correlations between community outreach concert attendance and (1) level of governmental support and (2) number of musicians, were insignificant. Larger correlations indicate which input variables should be critically examined to control/modify resources when an output is underproduced.

Relationships between levels of governmental/private support and the four output/ development activities are important, since these funding sources provide backstops. Table 3 shows that private support significantly dominates government support in terms of correlation with most variables and, because of US tax policy, it is a much more significant output-producing funding mechanism for concert attendance. While many countries provide substantial governmental subsidies to performing arts, the US provides governmental support primarily through tax subsidies. That indirect funding accrues due to foregone governmental tax revenues (e.g. individuals/corporations deducting donations from taxable income), which now accounts for 96% of the US federal government's support to orchestras (Gregor, 2012). Tax-incentivized donations are categorized as private donations, while the related government "funding" generally is not recognized as orchestra support.

Comparison of efficiency levels of individual orchestras (a focus of DEA) shows intriguing differences. The BCC DEA model used in this study allows that different orchestras might, due to differing demographic or economic circumstances, have different economies of scale and that was the case. Some orchestras may benefit from expansion and others by reduction. For each individual orchestra, this "returns to scale" (RTS) information has managerial implications. If DEA reveals an increasing RTS, management could scale up operations to take advantage of it. If RTS is decreasing, management could consider scaling back related aspects of operations. A constant RTS implies that management need not worry about scale effects.

Table 4 provides the ten orchestras that were efficient in eight or more years of the 10-year study. Names are masked for confidentiality, although other pertinent non-identifying aspects of efficient orchestras are included. The age of an organization (computed using the orchestra's founding year) is positively related to donations (c.f., Jacobs and Marudas, 2009). Most of the 10 most-efficient orchestras were formed 100+ years ago (during the 1800s or early-1900s).

Table 4 also confirms that size is important, e.g. in fundraising. Larger orchestras have expanded options for production (e.g. streaming performances, touring, CD sales, free publicity, etc.) not available to smaller orchestras. We used Budget Size (the LAO proxy for orchestra size) and related budget categories (Voss *et al.,* 2016): A (>$20m); B ($5–20m); C ($2–5m); D ($300,00–2m) and E (<$300,000). These groups contained 21, 21, 24, 31 and 10 orchestras respectively in 2014.

Another measure related to the size of the orchestra's draw area is its Metropolitan Statistical Area (MSA) geographical region ranking, defined by the US Office of Management and Budget. MSAs generally have relatively high population density, an identifiable core city (or set of geographically-close cities) and significant economic interconnections. Of 384 MSAs in the US in 2010, each of the top 50 had at least one orchestra. The population of an orchestra's MSA provides a proxy for its potential stakeholder base. To avoid identification

Characteristics of frequently efficient orchestras	Ten-year average efficiency	Efficient in all years except
Orchestra 1 (Decreasing RTS) Budget Group A Founded: 1880–1890 Metro Size Class: 1	1	Always Efficient
Orchestra 2 (Decreasing RTS) Budget Group A) Founding: 1840–1850 Metro Size Class: 1	1	Always Efficient
Orchestra 3 (Decreasing RTS) Budget Group A Founded: 1900–1910 Metro Size Class: 1	1	Always Efficient
Orchestra 4 (Constant RTS) Budget Group A Founded: 1890–1900 Metro Size Class 1	0.992	Efficient Except 2006 (efficiency 0.92)
Orchestra 5 (Decreasing RTS) Budget Group B Founded: 1940–1950 Metro Size Class: 1	0.995	Efficient Except 2008 (efficiency 0.95)
Orchestra 6 (Decreasing RTS) Budget Group A Founded: 1950–1960 Metro Size Class: 1	0.994	Efficient Except 2004 (efficiency 0.94)
Orchestra 7 (Decreasing RTS) Budget Group D Founded: 2000–2010 Metro Size Class: 4	1	Always Efficient but not reporting 2003, 2004
Orchestra 8 (Decreasing RTS) Budget Group C Founded: 1930–1940 Metro Size Class: 4	1	Always Efficient but not reporting 2011, 2012
Orchestra 9 (Decreasing RTS) Budget Group B Founded: 1920–1930 Metro Size Class: 1	0.957	Efficient Except in 2010 (efficiency 0.8) and in 2012 (efficiency 0.77)
Orchestra 10 (Decreasing RTS) Budget Group A Founded: 1910–1920 Metro Size Class: 1	0.961	Efficient Except in 2011 (efficiency 0.9) and in 2012 (efficiency 0.71)

Table 4.
Characteristics of 10
orchestras efficient in
at least 8 of 10 Years

of specific orchestras, we consolidated MSAs into MSA Groups of 20 and identified the MSA Group, rather than the specific MSA rank, in our analysis.

Two medium-sized (Budget Groups C and D and MSA Group 4) orchestras in Table 4 completed the survey in only eight of ten years but were fully efficient in each reporting year. The rest of the efficient orchestras were delineated as large and as useful benchmark referents for inefficient orchestras.

90% of Table 4's orchestras exhibited decreasing RTS (one had constant RTS), so increasing scale is not a managerially positive strategy for these orchestras. Among the efficient orchestras, only 32.7% had decreasing RTS, while 63.5% of inefficient orchestras had decreasing RTS. In 2012, few efficient or inefficient orchestras exhibited increasing RTS. 2010 data shows that orchestras in the two largest budget categories had much more tendency toward decreasing RTS (0% had increasing RTS and 51% had decreasing RTS),

while the opposite is true for orchestras in the smaller two orchestral categories (27% had increasing RTS and 7% had decreasing RTS). This provides managerial insight/direction for increasing performance based on orchestra size RTS likelihood. Larger orchestras should plan for decreasing RTS and smaller orchestras for increasing RTS.

Two consistently-efficient orchestras have significantly small budgets – one in Budget Group C and another in Budget Group D. The most marked outlier in Table 4 reported for only 8 years, but was not founded until early in 2000–2010 and began reporting in 2005. Despite its young age, relatively small budget and relatively low stakeholder base (measured by its MSA Group), it achieved full efficiency for each of 8 reporting years. It was the successor to a previous orchestra, founded in the 1920–1930 era, which declared bankruptcy, so clearly it was able to learn from inefficiencies and improve performance.

DEA provides guidance for inefficient orchestras. An example orchestra is located in a large US southern central city, with an MSA Group category of 4. This orchestra, identified as Orchestra X, was inefficient in 2012, with an efficiency score of 0.720. This indicates that there is a group of other orchestras which, in combination, could utilize no more input than Orchestra X, while producing more output than Orchestra X. DEA identifies these orchestras and they can be used for benchmarking purposes. Table 5 presents DEA output for this inefficient orchestra. Examining the causes of inefficiency for Orchestra X indicates that it uses too many resources to produce its level of outputs. If it were to become efficient, it could reduce its levels of Government Support, Private Support, Operating Revenue and Operating Expenses by 28% each. It could, potentially, operate as well with 33% fewer musicians and 55% fewer volunteers. These numbers are obtained by comparison to the specified benchmark that orchestras would use to create the same level of artistic output. Even using these reduced inputs, the designated combination of other orchestras identified for benchmarking by DEA analysis could produce an additional regular concert attendance of 374 people (a 3% increase).

Not all inefficient orchestras over-utilize their inputs as Orchestra X did. Some over-use just a subset of inputs. A variety of inefficiency-causing deficiencies are exhibited by inefficient orchestras in the data, indicating that no "one size fits all" approach to rectifying inefficiency is possible. Each individual inefficient orchestra must analyze its own slack variables (which identify over-used inputs or under-produced outputs) to see (by comparison

Inputs possibly over-utilized or outputs possibly under-produced	Original variable value	Projected variable value if operating efficiently	Change if operating efficiently	Percent change if operating efficiently
Total government support	$106,766	$76,910	−$29,856	−28.0
Total private support	$2,524,349	$1,818,440	−$705,909	−28.0
Unrestricted operating revenue	$4,747,071	$3,419,600	−$1,327,471	−28.0
Total operating expenses	$4,727,820	$3,405,733	−$1,322,087	−28.0
Number of musicians	84	56	−28	−33.4
Number of volunteers	260	116	−144	−55.3
Total regular concert attendance	12,563	12,937	374	3.0
Total pops concert attendance	19,105	19,105	0	0.0
Educational outreach attendance	6,500	6,500	0	0.0
Community outreach attendance	300	300	0	0.0

Table 5.
Inefficient Orchestra X (decreasing RTS and efficiency 0.720): Projected resources saved and/or output increased if operating efficiently. Percent Change if Operating Efficiently Indicate Inputs Over-Utilized (−) or Outputs Under-Produced (+)

with its own DEA-identified designated nodal benchmark set of efficient orchestras) how to perform better and more efficiently.

Managers want specific guidance for advancing toward efficiency. Using Orchestra X as an example, the first step is determining sources of inefficiency (which DEA provides in Table 5). These become Key Performance Indicator (KPI) variables for tracking performance toward an efficiency goal. Next, a plan can be created to move toward efficiency, concentrating on one slack variable at a time. Goals are relatively easy to define after examining DEA results (reduce over-used inputs and increase under-produced outputs). Steps for achieving them can be formulated in consultation with DEA-specified benchmark orchestras, since DEA has already singled them out as efficient orchestras (cf., Scheff and Kotler, 1996; Rickards, 2003). While benchmarking against competitors in the same industry is generally difficult, because competitors can be reluctant to share best practice approaches/ solutions fearing lost business, this is not the case in the orchestra sector. Orchestras generally perform in distinct geographic areas, so they face little or no market competition threat by sharing solutions and managerial guidance involving their approaches to managing over-utilized input variables.

Managerial implications and opportunities for future research

This research assesses each orchestra to determine its operating efficiency. For inefficient orchestras, DEA provides detailed guidance about sources of inefficiency, which are used as KPIs for reducing or eliminating inefficiency. This provides a path to improved efficiency performance. Tracking temporal trends in efficiency is also possible, enabling organizations to see if improvements are being made (cf., Brockett *et al.*, 1999). The interesting finding that the 2008 financial crisis improved post-crisis average efficiency could be examined for robustness by doing a similar analysis using post-COVID-19 health/financial crisis data.

Some variables may be pertinent as input or outputs in efficiency analysis, but may not be under managerial control (e.g. community average education, wealth, etc.) and are therefore non discretionary, but may affect the efficiency ratio. DEA techniques can handle non-discretionary variables (Cooper *et al.*, 2007). A two-stage DEA model (Berber *et al.*, 2011) can disaggregate efficiencies of fundraising and marketing from efficiencies of resource usage for orchestral outputs, since, for example, raising funds and producing orchestral performances require different skill sets. Its application could provide more specific and targeted guidance for managers/marketers and boards of directors.

Performing arts associations may consider providing web-based DEA software and support to their managers and member organizations. Individual performing arts organizations can also conduct analysis of their own organizations using DEA freeware/ commercial software. LAO also has the capability to supply each member orchestra that participates in its annual survey with data for its peer organizations. If an orchestra is inefficient, it can look at its specific DEA-identified efficient benchmark orchestras, consult with these benchmark orchestras to discuss options for improvement and managerially address specific problematic input/output variables.

Future research could also focus on application of DEA to other types of performing arts and cultural organizations (museums, galleries, cultural centers, fairs and festivals, historic sites, arts/cultural commissions/councils, etc.)

References

Banker, R.D., Charnes, A. and Cooper, W.W. (1984), "Some models for estimating technical and scale inefficiencies in Data Envelopment Analysis", *Management Science*, Vol. 30 No. 9, pp. 1078-1092.

Baumol, W.J. (1995), "Case for subsidizing arts", *Challenge*, Vol. 38 No. 5, pp. 50-56.

Baumol, W.J. and Bowen, W.G. (1966), *Performing Arts, Economic Dilemma: A Study of Problems Common to Theater, Opera, Music and Dance*, M.I.T. Press, Cambridge, MA.

Berber, P., Brockett, P.L., Cooper, W.W., Golden, L.L. and Parker, B.R. (2011), "Efficiency in fundraising and distributions to cause-related social profit enterprises", *Socio-Economic Planning Sciences*, Vol. 4 No. 1, pp. 1-9.

Berman, M.A. (2003), "Effective giving: measuring what matters", *Linkages, Newsletter of Rockefeller Philanthropy Advisors, Winter*, Madison Ave., New York, NY.

Bhatt, S.K., Duggan, B. and Rheault, M. (2004), "Measuring best practices in Canadian orchestras using Data Envelopment Analysis", *Administrative Sciences Association of Canada Conference ASAC 2004*, Quebec, Canada.

Brockett, P.L., Golany, B. and Li, S. (1999), "Analysis of intertemporal efficiency trends using rank statistics with an application evaluating macro economic performance of OECD nations", *Journal of Productivity Analysis*, Vol. 11 No. 2, pp. 167-180.

Brockett, P.L., Gerberman, J., Golden, L.L. and Sarin, S. (2001), "Identification of target firms and functional areas for strategic benchmarking", *Engineering Economist*, Vol. 46 No. 4, pp. 274-299.

Boyle, S. and Throsby, D. (2012), "Corporatisation, economic efficiency and Australian symphony orchestras", *Economic Papers*, Vol. 31 No. 1, pp. 36-49.

Byrnes, W.J. (2014), *Management and Arts*, Focal Press, Boston, MA.

Callen, J.L. (1994), "Money donations, volunteering and organizational efficiency", *Journal of Productivity Analysis*, Vol. 5 No. 2, pp. 215-228.

Cashwell, K., Copley, P. and Dugan, M. (2019), "Using ratio analysis to manage not-for-profit organizations", *The CPA Journal*, Vol. 89 No. 5, pp. 52-57.

Charnes, A., Cooper, W.W. and Rhodes, E. (1978), "Measuring efficiency of decision-making units", *European Journal of Operational Research*, Vol. 2 No. 6, pp. 429-444.

Charnes, A., Cooper, W.W. and Rhodes, E. (1981), "Evaluating program and managerial efficiency: an application of data envelopment analysis to program follow through", *Management Science*, Vol. 27 No. 6, pp. 668-697.

Chronicle of Philanthropy (2009), "Obama's tax plan could cause giving by wealthy to drop by several billion dollars annually", Chronicle of Philanthropy News Updates (February 27, 2009), available at: http://philanthropy.com/news/updates/7285/obamas-tax-plan-could-cause-giving-by-the-wealthy-to-drop-by-several-billion-dollars-annually (accessed 27 March 2022).

Cooper, W.W., Seiford, L.M. and Tone, K. (2007), *Data Envelopment Analysis: A Comprehensive Text with Models, Applications and References and DEA Solver Software*, 2nd ed., Kluwer Academic Publishers, Norwell, MA.

Emrouznejad, A. and Yang, G. (2018), "A survey and analysis of the first 40 years of scholarly literature in DEA: 1978–2016", *Socio-Economic Planning Sciences*, Vol. 61 C, pp. 4-8.

Fernández-Blanco, V., Rodríguez-Álvarez, A. and Wiśniewska, A. (2019), "Measuring technical efficiency and marginal costs in the performing arts: the case of the municipal theatres of Warsaw", *Journal of Cultural Economics*, Vol. 43 No. 1, pp. 97-119.

Flanagan, R.J. (2012), *The Perilous Life of Symphony Orchestras: Artistic Triumphs and Economic Challenges*, Yale University Press, New Haven, CT; London.

Gregor, A. (2012), "No Easy Remedy for Symphony Orchestra 'cost Disease'", *Insights by Stanford Business*, Stanford Graduate School of Business February 08, 2012, available at: https://www.gsb.stanford.edu/insights/no-easy-remedy-symphony-orchestra-cost-disease (accessed 27 March 2022).

Hong, J. (2014), "Data Envelopment Analysis in strategic management of youth orchestras", *Journal of Arts Management Law and Society*, Vol. 44 No. 3, pp. 181-201.

Jacobs, F. and Marudas, N. (2007), "Impact of fundraising inefficiency on donations to nonprofit organizations", *Proceedings of 2007 American Society of Business and Behavioral Sciences Conference*, pp. 818-825.

Jacobs, F. and Marudas, N. (2009), "Combined effect of donation price and administrative inefficiency on donations to US nonprofits organizations", *Financial Accountability and Management*, Vol. 25 No. 1, pp. 33-53.

Kaplan, R.S. and Norton, D.P. (2001), "Transforming the balanced scorecard from performance measurement to strategic management: part I", *Accounting Horizons*, Vol. 15 No. 1, pp. 87-104.

Kirchner, T.A., Markowski, E.P. and Ford, J.B. (2007), "Relationships among levels of government support, marketing activities and financial health of nonprofit performing arts organizations", *International Journal of Nonprofit and Voluntary Sector Marketing*, Vol. 12 No. 2, pp. 95-116.

Kleine, A. and Hoffmann, S. (2016), "Dynamic efficiency evaluation of German public multidisciplinary theatres by RC-DEA model", *Data Envelopment Analysis and Its Applications*, Vol. 33, p. 202.

Kleiner, B.M. (1994), "Benchmarking for continuous performance improvement: tactics for success", *Total Quality Environmental Management*, Vol. 3 No. 3, pp. 283-295.

Lange, M., Bullard, J., Luksetich, W., Jacobs, W. and Jacobs, P. (1985), "Cost functions for symphony orchestras", *Journal of Economic Literature*, Vol. 9 No. 2, pp. 71-85.

Lewellen, W.G., Park, T. and Ro, B.T. (1996), "Self-serving behavior in managers' discretionary information disclosure decisions", *Journal of Accounting and Economics*, Vol. 21 No. 2, pp. 227-251.

Lin, L. and Lin, Y. (2018), "The Cost Disease in consumption and spectatorship management: a cross-country study of value creation mechanism in performing arts", *International Journal of Arts Management*, Vol. 21 No. 1, pp. 17-27.

Luksetich, W.A. (2003), "Orchestras", in Towse, R. (Ed.), *A Handbook of Cultural Economics*, Edward Elgar Publishing, Cheltenham, pp. 35-54.

Luksetich, W.A. and Hughes, P.N. (1997), "Efficiency of fund-raising activities: an application of data envelopment analysis", *Nonprofit and Voluntary Sector Quarterly*, Vol. 26 No. 1, pp. 73-84.

Marco-Serrano, F. (2006), "Monitoring managerial efficiency in performing arts: a regional theatres network perspective", *Annals of Operations Research*, Vol. 145 No. 1, pp. 167-181.

Marudas, N. and Jacobs, F. (2007), "The extent of excessive or insufficient fundraising among US arts organizations and effect of organizational efficiency on donations to US arts organizations", *International Journal of Nonprofit and Voluntary Sector Marketing*, Vol. 12 No. 3, pp. 267-273.

McClintock, A. (2017), "Why no symphony orchestra in the world makes money", *ABC Radio National*, Posted Mon 3 Apr 2017 at 9:22 pm, available at: https://www.abc.net.au/news/2017-04-04/why-no-symphony-orchestra-in-the-world-makes-money/8413746 (accessed 26 March 2022).

O'Reilly, D. (2011), "Mapping the arts marketing literature", *Arts Marketing: An International Journal*, Vol. 1 No. 1, pp. 26-38.

Opricovic, S. and Tzeng, G.H. (2003), "Comparing DEA and MCDM method", *Multi-Objective Programming and Goal Programming. Advances in Soft Computing*, Springer, Berlin, Heidelberg, Vol. 21, available at: https://doi.org/10.1007/978-3-540-36510-5_32 (accessed 26 March 2022).

Rickards, R.C. (2003), "Setting benchmarks and evaluating balanced scorecards with data envelopment analysis", *Benchmarking: An International Journal*, Vol. 10 No. 3, pp. 226-245.

Rausell-Köster, P., Coll-Serrano, V., Abeledo Sanchis, R. and Marco-Serrano, F. (2013), "The efficiency of musical societies in Valencian community", *Journal of Quantitative Methods for Economics and Business Administration*, Vol. 15 No. 1, pp. 117-132.

Scheff, J. and Kotler, P. (1996), "How arts can prosper through strategic collaborations", *Harvard Business Review*, Vol. 74 No. 1, pp. 52-62.

Throsby, D. (1977), "Production and cost relationships in supply of performing arts services", in Tucker, T. (Ed.), *Economics of Australian Service Sector*, Croom Helm, London, pp. 414-432.

Turbide, J. and Laurin, C. (2009), "Performance measurement in arts sector: the case of performing arts", *International Journal of Arts Management*, Vol. 11 No. 2, pp. 56-70.

Twu, R.D. (2007), "A study of factors influencing reported fundraising efficiency of symphony orchestras", PhD Dissertation, Indiana University: ProQuest Dissertations Publishing.

Voss, Z.G., Voss, G.B., Yair, K. and Lega, K. (2016), "Orchestra facts: 2006-2014 A study of orchestra finances and operations", *Commissioned by League of American Orchestras*, available at: https://www.arts.gov/sites/default/files/Research-Art-Works-League.pdf (accessed 26 March 2022).

Williams-Burnett, N.J. and Skinner, H. (2017), "Critical reflections on performing arts impact evaluations", *Arts and the Market*, Vol. 7 No. 1, pp. 32-50.

Further reading

Allio, R.P. and Allio, M.K. (1994), "Benchmarking: a management tool for performance improvement - Part I", *Water Engineering and Management*, Vol. 141 No. 5, pp. 16-21.

Appendix

The BCC Ratio Measure of Efficiency

This Appendix presents the mathematical formulation of the BCC ratio DEA measure of efficiency used in this paper. It shows how DEA optimally determines individualized "virtual weights" for inputs and outputs of each organization (DMU) in order to be able to form the largest possible ratio efficiency measure for that particular organization. Cooper *et al.* (2007) offers additional details, proofs and further discussion.

BCC Ratio Efficiency Form

Let (x_{ki}, y_{kr}) denote value of input i and output r of DMU #k for $i = 1,\ldots m$ and $r = 1,\ldots s$. The efficiency, E_k, of kth organization (DMU$_k$) is determined by comparison of their (weighted) input utilization and output performance relative to all other DMUs. set of weights $\{u_0, \{u_r\}, \{v_i\}\}$ are individually determined by DMU$_k$ so as to maximize their apparent efficiency:

$$E_k = \text{Max}\{u_0, \{u_r\}, \{v_i\}\} \frac{\sum_{r=1}^{s} u_r y_{kr} - u_0}{\sum_{i=1}^{m} v_i x_{ki}} \tag{1}$$

Subject to n constraints

$$\frac{\sum_{r=1}^{s} u_r y_{pr} - u_0}{\sum_{i=1}^{m} v_i x_{pi}} \leq 1, \text{for p} = 1, 2, \ldots, n$$

here $u_r \geq 0$ for $r = 1, 2, \ldots, s$ and $v_i \geq 0$ for $i = 1, 2, \ldots, m$ and u_0 is unconstrained in sign.

The $\{u_r\}$ and $\{v_i\}$ are called virtual multipliers and the ratio in (1) can be viewed as a "weighted indexed output" over a "weighted indexed input", generalizing the usual ratio measure of efficiency with one output over one input.

The additional parameter, u_0, augmenting numerator in (1) allows determination of whether evaluated DMU_k exhibits decreasing RTS (when $u_0 < 0$), increasing RTS (when $u_0 > 0$), or constant RTS (when $u_0 = 0$).

In addition, the constraint set contains all DMU_p for p = 1, 2, n and the evaluated DMU_k is one of these DMUs, so it follows that $E_k \leq 1$. If $E_k < 1$ then some other DMU (or linear combination of DMUs) achieve that maximum in the constraint set before DMU_k does, indicating that DMU_k is dominated and inefficient.

About the authors

Theresa A. Kirchner is an Adjunct Associate Professor of Marketing with the Strome College of Business, Old Dominion University. Her background includes extensive for-profit corporate executive experience and pro bono work with non-profit boards of directors. Her research interests include strategic management/marketing of arts organizations, best practices and governance of not-for-profit organizations and organizational business continuity. Theresa A. Kirchner is the corresponding author and can be contacted at: tkirchne@odu.edu

Linda L. Golden holds the Joseph H. Blades Memorial Centennial Professorship in the University of Texas–Austin with appointments in the departments of Marketing and of Business, Government and Society. She has published in attribution theory, comparative advertising, retail image and patronage behavior, methodological scaling issues, social marketing, risk management and efficiency analysis of business and economic processes.

Patrick L. Brockett holds the Gus Wortham Chair in Risk Management, University of Texas–Austin McCombs School of Business, with joint appointments in Finance, Mathematics and Information, Risk and Operations Management. He is a Fellow of the Institute of Mathematical Statistics, the American Statistical Association, the Royal Statistical Society, the American Association for the Advancement of Science and the Institute for Risk Management.