A New Measure of Distributive
Justice by Data Envelopment Analysis

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Abstract: Traditionally, distributive justice has been measured with multiple question items to which respondents indicate the degree to which their working situation corresponds with those described in the question items. This article proposes an alternative method to measure distributive justice, using the data envelopment analysis (DEA) approach. We apply an efficiency measure calculated in DEA for the inputs/outcomes ratio to judge distributive justice in the organization. Using the data collected from accounting workers who live in the Tokyo metropolitan area, the results of correlation analysis show that this new measure of distributive justice has significant positive correlations with all three satisfaction variables in a male sample, and with one satisfaction variable in a female sample, providing some justification for using this new variable as a measure of distributive justice.

Keywords: data envelopment analysis; organizational justice; distributive justice; satisfaction

JEL Classification: M19

1 Introduction

Organizational justice has received a huge amount of attention from researchers in organizational behavior (OB). Organizational justice, that is, how fair an employee judges the behavior of the organization to be (Greenberg, 1987), is considered to include multiple aspects of fairness in organizational systems. Typically, distributive justice, procedural justice, and interactive justice have been considered dimensions of organizational justice (Brockner & Wisenfeld, 1996; Bies, 1987). Further, in the literature of OB, these dimensions of organizational justice have been examined as antecedents of workers' attitudes and behaviors (Greenberg, 1990).

Among these three dimensions of organizational justice, the concept of distributive justice is rather simple. It is based on the idea that "employees determine their perception of fairness in the workplace by comparing the equity of the ratio of their

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inputs to their outcomes in comparison to those of their co-workers" (Fields, 2002, p. 163). Although the ratio of inputs to outcomes is the basic concept of distributive justice, researchers have to consider how they can actually collect data about distributive justice from workers (respondents) when they plan to conduct empirical studies using the data. Usually, researchers collect the data by asking workers to answer multiple questions regarding the degree to which these workers perceive an organization's fairness in a situation where the organization is expected to take care of its workers in a fair manner. However, through these questions, researchers actually have no way to tell whether or how workers evaluate the equity of the ratio of their inputs to their outcomes in comparison with those of their co-workers.

In contrast to past researchers' approach, this article proposes a new idea: utilizing data envelopment analysis (DEA) to measure distributive justice. First, this article explains the basic idea of DEA. Second, it calculates a distributive justice variable through DEA and examines the relationship between this variable and satisfaction variables, using data collected from Japanese working persons. Results show the possibility and limitations of using this variable to measure distributive justice.

2. The DEA Approach and Its Effectiveness as a Measurement of Justice

DEA was created as one of the applications of the linear programming (LP) method and has been used as a method of comparing production efficiency between decision-making units (DMUs) (Cooper, Seiford, & Tone, 2007; Hirao, 2012; Shinmura, 2012). In DEA, DMUs are considered entities that have independent managerial authority, at least to some degree, and function similarly to each other. Typical DMUs are shops selling similar products, schools teaching students of similar generations, and teams in a sports league. However, in respect of the definition of DMUs as entities for which specific inputs and outputs can be identified, individual persons can also be considered DMUs. As a matter of fact, in research in organizational behavior, it is important to compare production efficiency of individual workers and identify what an inferior worker should do to approach the performance of a superior person. Some past studies have used DEA to compare efficiency of individual persons, such as Major League Baseball (MLB) pitchers (Chen & Johnson, 2010), supervisors of basketball teams (Fizel & D'Itri, 1999), managers of football teams (González-Gómez, Picazo-Tadeo, & García-Rubio, 2011), and politicians (Wei, 2007, 2008).

Further, application of DEA to analysis of individual behaviors can go beyond such simple comparison of performances of individual persons. In the classical equity theory of motivation (Adams, 1965), workers feel satisfaction when they perceive that the organization deals with them and other comparable workers on a fair basis.

Concretely described, workers psychologically calculate a ratio (i.e., outcomes/inputs) between rewards they receive from an organization, as outcomes, and their contributions to the organization, as inputs, and compare their own ratio with those of other available and comparable others. If their own ratio is perceived as lower than others' ratios, they are frustrated with the situation and try to remedy it by using various strategies, including biasing perceptions. If they perceive they cannot remedy it, they may even get out of the situation (quit the job). Organizational justice research took the basic framework of this equity theory and treated the perceived fairness based on this outcomes/inputs ratio as distributive justice.

The outcomes/inputs ratios of a person and others are originally based on individuals' psychological calculations; hence, it is considerably difficult for any researcher to elicit and examine them empirically. As a matter of fact, past researchers have used multiple items to measure respondents' perceptions of how fairly rewards are distributed by their organization. For example, Sweeney and McFarlin (1997) proposed 11 distributive justice items, and Niehoff and Moorman (1993) developed 5 distributive justice items. Other researchers have also created and proposed original items regarding distributive justice (Joy & Witt, 1992; Parker, Baltes, & Christiansen, 1997; Welbourne, Balkin, & Gomez-Mejia, 1995).

In contrast to these traditional methods, here we consider the possibility of using the idea of the efficiency ratio in the DEA approach to measure the degree of distributive justice. If inputs of the efficiency ratio are regarded as contributions of an individual worker to the organization and outcomes are rewards from the organization to him or her, this efficiency ratio in DEA can represent the measure of that worker's distributive justice. In the DEA approach, comparative efficiency values of individual entities are calculated, with the maximum efficiency converted to 1. When the calculated value for an individual is 1, it means, from the standpoint of a distributive justice argument, that the person is considered fairly treated in the organization. There might be more than one worker whose value is 1, and these workers constitute the efficiency frontier of fairly treated workers. When this value is below 1, it means the worker is positioned somewhere inferior to the efficiency frontier and is unfairly dealt with in the organization, even if he or she adopts the most optimistic viewpoint.

It might be controversial whether other DMUs in the DEA approach can be regarded as "comparable others" in the equity theory. However, a "gestalt" comprising others around an individual worker is often emphasized as comparative others rather than specific others in equity theory (Summers & DeNisi, 1990), and so this method is considered one of the meaningful approaches to organizational justice research. Further, it might also be suggested that not only distributive justice, but also procedural and interactive justice, should be considered in organizational justice theory. Even so, this method is considered important in

research on organizational justice because the past method of measuring distributive justice is not consistent with the original concept of equity ratio, as discussed above, and this method can be used complimentarily with the traditional method to collect data regarding organizational justice.

3. Hypothesis

One of the most difficult problems with applying the idea of equity theory to empirical study is how to determine the output (outcomes) and the input (contributions) of the basic ratios for self and comparable others. Outcomes are considered to be composed of intrinsic rewards and extrinsic rewards. For example, a sense of attainment and self-growth is typical of the former, and wage is considered one of the latter. In this study, both a sense of self-growth and wage are included as outcomes. On the other hand, we considered factors like labor hours and perceived ability as workers' contributions. It is needless to explain that how long workers spend at their job is included in their contribution. Further, perceived ability should be included in their contribution because workers tend to think they make a huge contribution to the organization if they evaluate their own ability very highly. Workers are unlikely to feel unfairness if they perceive that co-workers who have higher ability than they do get more money. Therefore, we can calculate the index of efficiency of each worker as below. Here, input and outcome weights are respectively denoted by v_1, v_2 and u_1, u_2.

$$\theta = \frac{u_1\, a\; sense\; of\; self\; growth + u_2\, wage}{v_1\, labor\; hours + v_2\, perceived\; self\; ability}$$

We assume all workers at least implicitly perceive their own θ and evaluate how fairly they are treated in the organization by comparing this θ to others' ratio. We further assume that "others' ratio" is not a specific person's value, but a sort of gestalt composed of ratios of workers with the same job category. DEA can provide an effective tool to compare the levels of efficiency of DMUs (workers). If a worker's efficiency is high (i.e., it is evaluated at or close to 1 in DEA), it means the worker's treatment is in his or her favor, so he or she is considered more satisfied with the current situation. In contrast, if a worker perceives his or her θ as lower than the gestalt, she or he feels unfairly dealt with in the organization and is dissatisfied with the current working situation. To summarize this point, we can propose the following basic hypothesis.

Hypothesis: The inputs/outcomes ratio of a worker calculated through DEA, a ratio that represents distributive justice to that worker, will positively influence the worker's satisfaction with a current work situation.

4. Research Method

4.1. Sample

This study utilized data from "Working Person Survey, 2010" by Recruit Works Institute (RWI). RWI has conducted a similar survey every two years since 2000. RWI deposited the data at the Center for Social Research and Data Archives (SSJDA), Institute of Social Science, University of Tokyo, to give researchers permission to use the data. The survey was conducted among workers (full-fledged, contracted, part-time, etc.) who lived within a 50-kilometer radius of the Tokyo metropolitan areas (Tokyo, Kanagawa, Chiba and Saitama Prefectures) and were 18 to 59 years old. Although previous versions of the survey were conducted by a placement method, this time all the respondents answered the questionnaires through the Internet. The total sample size is 9,931 (5,753 male workers; 4,178 female workers).

We assumed workers tend to regard other workers who have the same job as they do and live in an area similar to theirs as comparable to them. Therefore, these data are very useful for specifying the gestalt of workers because the survey was conducted in a specific urban area in Tokyo and the sample of the survey is divided into more than two hundred job categories.

In this study, we used only the data for workers in accounting jobs. We chose this job category because, in comparison with sales and production, we believe accounting work has to be based on standard accounting principles and practices, and the job contents are not so different among various organizations. Further, we divided the data by gender because, based on current Japanese culture and work environment, it is rare that workers compare their situation with that of opposite-gender workers even if they are in the same job category. Final sample size was 318 (133 male, 185 female).

4.2. Measures

As already described, we chose labor hours and perception of one's ability as the input values. Data about average labor hours per week were used as the former. As the latter, an original questionnaire had 12 items and asked respondents to indicate the degree to which they considered they had each of the abilities necessary for their work. Based on the result of exploratory factor analysis of responses to these 12 items, we regarded perceived ability as classified into three sub-categories, and we used an average of responses to the items constituting each sub-category as the variable for that sub-category. These sub-categories are human relations ability (6 items, $\alpha = 0.838$), problem analysis ability (7 items, $\alpha = 0.880$), and current job performance ability (2 items, $\alpha = 0.910$).

As outcomes received from the organization, wage and a sense of one's growth were used. The former is associated with extrinsic rewards, and annual income (10,000 Japanese yen as a unit) was used as the variable. The latter is related to intrinsic rewards, and we measured it with a five-point-scale item ranging from "realize self-growth" (5) to "do not realize self-growth" (1).

As satisfaction measures, three Likert-type five-point-scale items were considered. These items were for assessing respondents' satisfaction with the workplace, the organization, and the job, respectively. Although internal reliability was very high ($\alpha = 0.894$), we treated them separately because investigating various relationships between our measure of justice and different areas of satisfaction was necessary to explore effectively the possibility of the measure.

4.3. Analytical Process

There are multiple models regarding return to scale in DEA models. Although the most basic model is the Charnes-Cooper-Rhodes (CCR) model, which assumes constant returns to scale, the Banker-Charnes-Cooper (BCC) model was adopted in this study because it is not realistic to assume that wages and sense of growth would be doubled if skill or labor hours were doubled in a Japanese work environment.

5. Result

Table 1 and Table 2 show results of correlation analysis using data of the male sample. Table 1 displays correlations of initial variables that compose inputs and outcomes for the ratio representing distributive justice, and Table 2 exhibits correlations between our distributive justice variable and satisfaction variables. According to Table 1, correlations between any two ability variables are comparatively highly positive, but correlations of them with labor hours per week are close to zero. Further, a correlation between annual income and a sense of self-growth is also insignificant. This means that the two input variables represent different aspects of workers' contribution to the organization from each other and that the two output variables are also different. These insignificant correlations mean there are multiple aspects of inputs and outcomes, and that can be just as well for confirmation of the effectiveness of application of DEA to research in organizational justice.

Table 1. Inter-correlations of input or outcome variables (male workers, accounting job)

variables	means	Std. Dev.	1	2	3	4	5
1. human relations ability	3.623	.662					
2. problem solving ability	3.727	.670	.617**				
3. current job execution ability	3.724	.892	.471**	.695**			
4. labor hours per week	44.910	9.455	.001	.000	−.008		
5. annual income	589.993	244.185	.302**	.359**	.268**	.094	
6. a sense of self-growth	3.194	.969	.218*	.181*	.128	−.074	.150

N = 134, ** : p < .01, * : p < .05

Table 2 shows correlations of our distributive justice variable with each of three areas of satisfaction, using the data of male accounting workers. As shown in this table, all three correlations are significantly positive, meaning that the traditional idea of a positive effect of distributive justice on satisfaction is also confirmed through this new variable. This result is supportive of our hypothesis.

Table 2. Inter-correlations regarding distributive justice and satisfaction (male workers, accounting job)

variables	means	Std. Dev.	1	2	3
1. workplace satisfaction	3.261	.941			
2. organization satisfaction	3.537	.881	.718**		
3. job satisfaction	3.366	.914	.832**	.725**	
4. distributive justice	.820	.111	.195*	.288**	.241**

N = 134, ** : p < .01, * : p < .05

In contrast, Table 3 and Table 4 show results of correlation analysis using a female sample. As is the case with a male sample, correlations between any two input variables and between the two output variables are still insignificant. However, one difference of the correlations in Table 3 from those in Table 1 is the relationship between annual income and perceived ability. In the case of a male sample, the correlations of annual income with human relations ability and problem solving ability were significant. In contrast, in a female sample, only a correlation between annual income and current job execution ability is significant.

Table 3. Inter-correlations of inputs or outcome variables (female workers, accounting job)

variables	means	Std. Dev.	1	2	3	4	5
1. human relations ability	3.626	.557					
2. problem solving ability	3.568	.585	.508**				
3. current job execution ability	3.549	.759	.350**	.536**			
4. labor hours per week	35.087	10.803	.002	.006	−.119		
5. annual income	315.557	157.978	.007	.106	.165*	.466**	
6. a sense of self-growth	3.216	.954	.155*	.248**	.196**	.042	.041

N = 185, ** : p < .01, * : p < .05

Table 4. Inter-correlations regarding distributive justice and satisfaction (female workers, accounting job)

variables	means	Std. Dev.	1	2	3
1. workplace satisfaction	3.314	.902			
2. organization satisfaction	3.654	.794	.653**		
3. job satisfaction	3.443	.833	.704**	.562**	
4. distributive justice	.802	.126	.140	.274**	.115

N = 185, ** : p < .01, * : p < .05

Table 4 displays correlations between our distributive justice variable and satisfaction in a female sample. Although distributive justice has a significant positive correlation with only one of three areas of satisfaction, this significant correlation accords with our hypothesis.

6. Discussion and Conclusion

This article proposed a new variable to measure distributive justice, adopting the method of the DEA approach. Past study on organizational justice showed workers are more satisfied with their work environment if they perceive a high level of organizational justice, and our study revealed that our distributive justice variable also has positive correlations with many of the satisfaction variables, as expected. This result implies our new variable is reasonably effective in representing distributive justice.

One advantage of this method is consistency with the basic idea of an inputs/outcomes ratio in equity theory. As discussed, past studies adopted multiple question items, asking the degree to which respondents agree with sentences regarding how fairly they are dealt with in the organization. However, even if workers answer these question items adequately, their answers do not necessarily indicate that they have calculated such a ratio of their perceived contribution and outcomes from the organization. In contrast, a DEA approach directly calculates the ratio of input and output, and it can be said that this value is what the equity theory actually assumes.

On the other hand, there are some disadvantages in this method. First of all, neglect of workers' perceptual aspect might be a serious disadvantage associated with this method. Researchers examining the effect of organizational justice on attitudes and behaviors of workers actually focus, not on the actual, or institutional, aspects of organizational justice, but on workers' perception of organizational justice. Therefore, traditional organizational justice theory admits that each worker, who has a different perspective from others, considers a different set of people as "comparative others" even if workers are placed in objectively the same work environment in the organization. In contrast, this method assumes that each worker's perception is influenced, or determined to some degree, by a rather comprehensive situation that is composed of the sum of all workers' situations and that can be aggregated by compiling all the responses of workers. The degree to which each worker is fairly dealt with is measured with a gap between that worker's responses and those of others as a whole.

Further, even if the assumption of this method is valid, difficulty in specifying concrete contributions to and outcomes from the organization is also a problem. However, this is a problem, not with this method, but with the framework of the equity theory or organizational justice theory. In fact, the idea of the equity theory is essentially abstractive, and what workers really consider as inputs and outcomes is not deeply considered. Researchers focusing on distributive justice also leave the judgment of concrete inputs and outcomes to workers, who answer abstractive question items about how fairly rewards are distributed.

Despite some limitations, we believe the method using the DEA approach can give clues to help researchers reconsider measures of organizational justice again. We expect and encourage future study to use and improve this new method to further advance organizational justice theory.

7. References

Adams, J. S. (1965). Inequity in Social Exchange. In Berkowitz, L. (ed.). *Advances in Experimental Social Psychology*, 2, pp. 267–299. New York: Academic Press.

Bies, R. J. (1987). The Predicament of Injustice: The Management of Moral Outrage, in Cummings, L. L., & Staw, B. M., eds.. *Research in Organizational Behavior*, 9, pp. 289–319. Greenwich. CT: JAI Press.

Brockner, J., & Wisenfeld, B. M. (1996). An Integrative Framework for Explaining Reactions to Decisions: Interactive Effects of Outcomes and Procedures. *Psychological Bulletin*. 120. pp. 189–208. doi: 10.1037/0033-2909.120.2.189.

Chen, W. C., & Johnson, A. (2010). The Dynamics of Performance Space of Major League Baseball Pitchers 1871–2006. *Annals of Operations Research*, 181(1), pp. 287–302. doi: 10.1007/s10479-010-0743-9.

Cooper, W. W., Seiford, L. M., & Tone, K. (2007). *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software*. New York: Springer.

Fields, D. L. (2002). *Taking the measure of work: A guide to validated scales for Organizational Research and Diagnosis*. Thousand Oaks.CA: Sage Publishing.

Fizel, J. L., & D'Itri, M. P. (1999). Firing and Hiring of Managers: Does Efficiency Matter? *Journal of Management*, 25(4), pp. 567–585. doi: 10.1177/014920639902500405.

González-Gómez, F., Picazo-Tadeo, A. J., & García-Rubio, M. A. (2011). The Impact of a Mid-Season Change of Manager on Sporting Performance. *Sport, Business and Management: An International Journal*, 1 (1), pp. 28–42. doi: 10.1108/20426781111107153.

Greenberg, J. (1987). A Taxonomy of Organizational Justice Theories. *Academy of Management Review*, 12(1), pp. 9–22. Stable URL: http://www.jstor.org/stable/257990.

Greenberg, J. (1990). Organizational Justice: Yesterday, Today, and Tomorrow. *Journal of Management*. 16(2), pp. 399–432. doi: 10.1177/014920639001600208.

Hirao, Y. (2012). Efficiency of the Top 50 Business Schools in the United States. *Applied Economics Letters*, 19(1), pp. 73–78. doi: 10.1080/13504851.2011.568380.

Joy, V. L., & Witt, L. A. (1992). Delay of Gratification as A Moderator of the Procedural Justice-Distributive Justice Relationship. *Group & Organization Management*. 17(3). pp. 297–308. doi: 10.1177/1059601192173008.

Niehoff, B. P., & Moorman, R. H. (1993). Justice as a Mediator of the Relationship between Methods of Monitoring and Organizational Citizenship Behavior. *Academy of Management Journal*, 36(3), 527–556. Stable URL: http://www.jstor.org/stable/256591.

Parker, C. P., Baltes, B. B., & Christiansen, N. D. (1997). Support for Affirmative Action, Justice Perceptions, and Work Attitudes: A study of Gender and Racial-Ethnic Group Differences. *Journal of Applied Psychology*, 82(3), pp. 376–389. doi: 10.1037/0021-9010.82.3.376.

Shinmura, S. (2012). Efficiency Method in a Company (1): How to extend the usage of DEA (in Japanese). *The Journal of the Faculty of Economics. Seikei University*, 43(1), pp. 51–82.

Summers, T. P., & DeNisi, A. S. (1990). In Search of Adams' Other: Reexamination of Referents Used in the evaluation of Pay. *Human Relations*, 43(6), 497–511. doi: 10.1177/001872679004300601.

Sweeney, P. D., & McFarlin, D. B. (1997). Process and Outcome: Gender Differences in the Assessment of Justice. *Journal of Organizational Behavior*, 18(1), pp. 83–98, doi: 10.1002/(SICI)1099-1379(199701)18:1<83::AID-JOB779>3.0.CO; 2-3.

Wei, W. (2007). Study on Evaluating Relative Progress Effectiveness of Leader Behavior Performance. *Proceedings of 2007 International Conference on Management Science & Engineering (14th)*. Harbin. China, pp. 1578–1583.

Wei, W. (2008). Study on The Dynamic Evaluation Way of Behavior Performance of Government Leader. *Proceedings of the 7th World Congress on Intelligent Control and Automation*. Chongqing, China, pp. 3828–3833.

Welbourne, T. M., Balkin, D. B., & Gomez-Mejia, L. R. (1995). Gainsharing and Mutual Monitoring: A Combined Agency-Organizational Justice Interpretation. *Academy of Management Journal,* 38(3), pp. 881–899.