Probabilistic Preferences Composition in the Classification of Apparel Retail Stores

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ABSTRACT

This paper employs the probabilistic composition of preferences to classify stores by their operational efficiency. Probabilistic composition of preferences is a multicriteria analysis methodology based on the transformation of assessments by multiple attributes into probabilities of choice. The numerical initial measurements provide estimates for location parameters of probability distributions that are compared to measure the preferences. The probabilities of choice according to each attribute separately are aggregated according to probabilistic composition rules. A classification of two sets of stores into five classes is performed.

Keywords: Data Envelopment Analysis, Efficiency, Multiple Criteria, Probabilistic Preferences Composition, Retail Market, Sorting

INTRODUCTION

Composition of probabilistic preferences (CPP) is a multicriteria analysis methodology based on the association of numerical measurements to probability distributions in a way similar to the transformation of crisp numbers into membership intervals in the Theory of Fuzzy Sets (Zadeh, 1965). This association allows for the replacement of the vector of evaluations of a set of comparable options by a vector of probabilities of choice of each of these options. Probabilistic composition rules (Sant’Anna & Sant’Anna, 2001) can then be used to combine these probabilities of choice according to specific attributes to generate overall preferences for the options.

In fact, the evaluation of the preferences according to each attribute in terms of probabilities of choice allows for using the Theorem of Total Probability to combine these preferences by a weighted average as in classical multiattribute theory (Keeney & Raiffa 1976). The probability of choice according to each attribute can be seen as the probability of preference conditional on that attribute being the only one taken into account. If these probabilities of each of the different attributes being chosen can be determined, they can be used as weights for the conditional probabilities.

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Identification of such marginal probabilities is not easy, especially when, as is frequent in a production setup, there is some correlation between the attributes involved. In a production process, disturbances affecting the inputs reflect on the outputs. Larger revenue is associated with a higher number of sales and more sales happen if there are more sellers, who probably sell more if there is more space to display the products in the stores.

The decision-maker may employ, instead of the combination of conditional probabilities, rules based on the computation of probabilities of joint preference that represent other points of view. For instance Data Envelopment Analysis (DEA) algorithms (Charnes, Cooper & Rhodes, 1978) may combine the vectors of probabilities of maximizing desirable attributes and of minimizing undesirable ones.

A comparison of the rankings derived from probabilistic composition with those derived from direct application of DEA highlights the difference between diverse legitimate views. The stores presenting the highest productivities are not necessarily those attaining the largest production. By this reason, for the evaluation of productivity, a comparison to stores of the same size is more informative. A sorting procedure based on the probabilistic composition proposed by Sant’Anna, Costa & Pereira (2014) to divide the stores in groups of stores of similar size is here employed.

On the other hand, the transformation into probabilities of preference that reduces the dependence on scales of measurement is more reliable if the set of alternatives taken in the comparison is larger. To assess the effect of comparison to a larger set in the initial stage, after evaluating a first network, stores of a second network with different features were added to the analysis. The stores were then evaluated by probabilities of preference calculated within the set of stores of the two networks together and within the group of stores of one network alone. It was found high agreement between the scores.

The second network serves a different market, deriving its revenue from the sale of more expensive articles to consumers of a higher social class. This brings, for that network, numbers of sales and employees specialized in the sale function much smaller than those observed in the first. Nevertheless it was perfectly effective the application of the probabilistic approach to the sorting of the stores of the second network in the classes determined by the representative profiles of the first.

PROBABILISTIC PREFERENCES COMPOSITION

The preference for an option is essentially the probability of choosing such option. However, often only attributes of the options are known, or only a ranking of the options on the basis of each of such attributes can be objectively established (Sant’Anna, 2007). The technique of probabilistic composition of preferences extracts from the vector of evaluations of the options according to each attribute a vector of probabilities of choice and combines these particular probabilities of choice into a probability of final choice.

To derive from the vector of measurements of attributes, or of ranks according to them, a vector of probabilities of preference, Sant’Anna & Sant’Anna (2001) propose forms to treat these measurements or ranks as centers of intervals of values with different probabilities of occurrence that mirror the membership functions of Fuzzy Sets Theory (Zadeh, 1965).

Even if the attribute is accurately measured, the preference derived from it is inaccurate. The effective value of the attribute depends on the use or the benefit that the decision maker intends to extract from it. Thus, in the process of formation of preferences on the basis of a given attribute, the decision maker effectively establishes a membership interval around each value. The value of each attribute marks only the center of a probability distribution.
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