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Efficiency in the generation of social welfare in Mexico: A proposal in the presence of bad outputs ☆

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ABSTRACT

One of the main goals of any country is to secure the general welfare of society, entailing positive levels of education, health and income, coupled with low levels of social inequality. The following paper studies the efficient use of economic and social resources to generate social welfare in the presence of bad outputs in the states of Mexico during 2010. A two-level data envelopment analysis model was used to determine how efficient the 32 states of the Mexican Republic were, considering as model variables the socioeconomic indicators of the three dimensions of human development (education, health and income), and the data on poverty or inequity in the country. The analysis of the results reveals that only 5 of the 32 units studied were efficient in generating welfare and in reducing poverty, while the rest need to increase their welfare levels and especially reduce inequity in education and income using the economic and social resources they possess.

1. Introduction

Social welfare is the satisfaction of basic and secondary needs experienced by individuals in a community [38]. The concept of development should be understood as the process of creating the necessary conditions for increasing opportunities for active participation of a range of actors (civil society, private sector and public sector), in the efficient management of natural, technological and human resources. This process aims to achieve greater autonomy in growth capacity and modify relationships between social groups, thereby leading to economic improvement and a higher level of welfare in the population [88]. Consequently, development seeks to establish a mechanism to solve and attend to problems that concern the welfare of society [116,97].

Three main approaches have been used to measure social welfare: a purely economic approach; an approach based on utility functions; and measurement using social indicators [89]. The approach of social indicators using synthetic indicators to obtain an overall welfare perspective has motivated the creation of various indexes (see, for example, [81]), among which the Human Development Index (HDI) stands out. The HDI was first published in 1990 by the United Nations Development Program (UNDP) and encapsulates the postulates of Amartya Sen [101]. It is a mechanism to measure the level of development of a country, state or region, by determining its level of social welfare, and takes into account the conditions of health, education and personal income (see [59] for its measurement properties). Each of these dimensions is weighted in the same way in the index [116,29,46,82,85,93]. Owing to its simplicity and the ease of access to the statistical information required, it has become the most widely used mechanism for measuring human development, social welfare, and the success or failure of nations' policies [116,68].

The HDI was devised to measure social welfare and human development by considering the different aspects of human life [32].[1] However, since its publication, this index has come under close scrutiny in the literature. Some of the criticisms made concern the theoretical composition of the index: its view of human development is limited since it does not include other variables that affect individuals' welfare such as the environment, participation, social inclusion and equity in any of its three dimensions. Other criticisms are related to technical properties of the HDI, such as how the dimension indexes are derived from raw data; the additive form of aggregation to calculate the indexes by dimension; and equally

[1] Human development is the process by which human choices and their welfare are extended [46]. Basic human development opportunities are: enjoying a long and healthy life; being literate and possessing knowledge; having the necessary resources to achieve a decent standard of living; and participating in community life. If these basic opportunities are lacking many others can also be denied [116,68].

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weighting the three dimensions by aggregating the HDI [106,111,32,33,37,44,49,75,76,80,93].

Despite the criticism, there is a consensus that the HDI goes beyond the simplistic view of GDP *per capita* as a measure of development, capturing several aspects of the human condition [108,30,45]. In this line, Dasgupta and Weale [28] also considered that the HDI sub-indexes provided information on a disaggregated level. There is also a consensus that the concept of human development is very broad and that no index or set of indicators can fully represent it. However, the HDI is a composite index that comes fairly close to the complexity of the concept, taking general aspects of social welfare and including in its last measurements new variables to approach the concept in a better way [108,30,45].

Amartya Sen [101] understands poverty as an absolute phenomenon that is expressed in relative terms, referring to material and economic resources. In this way, poverty directly affects social welfare by influencing the satisfaction of an individual's needs in a society [38]. In addition, poverty is associated with living conditions that make individuals vulnerable; it prevents their basic needs from being met, and precludes their full social integration [114,20,4,62]. The concept of poverty goes beyond the economic dimension, which refers to the people's ability to purchase goods and services with their disposable income. Poverty is also associated with the inability to enjoy various essential aspects, many of which are provided by the State (such as access to education, health or public safety), or that are considered fundamental as economic, social, cultural and human rights. Therefore, the concept of poverty is multidimensional (economic, social, cultural and legal) in nature [113,20,66]. Consequently, from a multidimensional perspective, poverty can be understood as a series of deficiencies in multiple domains or dimensions. The number and type of dimensions to consider are directly related to the concept of what the minimum or acceptable condition is, to ensure a decent standard of living for each and every member of society. In this way, the concept of poverty is directly linked to social welfare, and therefore to human development, since there can be no welfare and development in a society if there is no initiative to combat poverty or inequality of income, education and health [113,118,18,25,4,5,60,64,71,87].

While there are several papers in the literature that discuss and attempt to improve the HDI (for example, [29,75,80–85,111,91,76,37,106–108,44–46,49,96,59,22,10,67,1,65,40,93,48,12,42], among others) only a few studies have evaluated the HDI using Data Envelopment Analysis (DEA). Some of these are [105,110,112,122,125,13,14,16,17,27,32–34,36,47,49,61,69,7,72,73,91,92,94,96]. In particular, few studies have attempted to overcome criticisms of the HDI by establishing equivalent weights for the three dimensions [125,32,33,69], or by addressing the absence of variables that reflect inequity in the dimensions of human development [94].

Research into efficiency in generating the HDI by trying to overcome some of its criticisms is a pending matter in the literature. The aim of this study is to evaluate how efficient the 32 states of Mexico were during 2010 in using their economic and social resources to generate welfare, and at the same time reduce the educational gap, the lack of access to health services and capability poverty. This paper aspires to contribute to the literature by determining an overall index of the efficiency level in the generation of human development through a two-level DEA with DDF. In this way, this efficiency measure incorporates two of the main criticisms of the HDI: arbitrariness in its weights and the absence of variables that reflect inequality in the different dimensions. The inclusion of DDF facilitates the incorporation of the inequity factor to quantify efficiency, thus identifying the maximum simultaneous increase/reduction of the vectors of good and bad outputs [109,23,86]. The advantages of applying a two-level DEA model are first that it allows efficiency to be calculated even with a large number of variables and a relatively small number of observations in the sample, and second it gives freedom to the weights of the dimensions that make up the overall index of efficiency in the generation of human development [63,78].

The rest of the paper is organized as follows. Section 2 describes the methodology used to measure the efficiency in generating social welfare. In Section 3, the selected variables and sources are detailed. The main results are then presented and discussed in Section 4, and finally, the conclusions are given.

2. Methodology

We assume that each Mexican state achieved its performance in each of the HDI dimensions (good outputs) from inputs associated with each factor. We also assume that there are bad outputs to be minimized in each dimension, associated with the level of inequity in each HDI factor [49,91,96]. The objective of the technical efficiency analysis is to quantify the existing potential to minimize the bad outputs, at the same time as maximizing HDI levels, without having to use more inputs than those observed in each Mexican state.

The problem is formulated in a generalized way in order to allow future modifications to the HDI by including more indicators per dimension. Let $j=(1\ldots N)$ be the states for which a level of y_{dj} was observed for the good output in dimension d of the HDI $d=(1\ldots D)$; b_{zk} is the bad output $z=(1\ldots Z)$ obtained in dimension by state k;x_{ij} is the input $i=(1\ldots I)$ used by state k to produce its good and bad HDI outputs. We denote Y as the vector of y_{dj}, B as the vector of b_{zj} and X as the vector of x_{ij}. The technology that defines the HDI generation process is obtained by the set:

$$P(X)=\{(Y,B)|\ X\ \ can\ \ produce\ \ (Y,B)\} \tag{1}$$

The axioms that $P(X)$ should meet are those usually applied in the theory of production (see, for example, [41]).

The literature has commonly measured the efficiency of any of the analyzed units—known in the literature as decision-making units (DMU), since they are assumed to be free to make their own management decisions—belonging to $P(X)$ by using directional distance functions (DDF), such as the following [109,70,86]:

$$D(X,Y,B)=\max\left(\beta\middle|\ \left(Y+\beta g_y, B-\beta g_b\right)\in P(X)\right) \tag{2}$$

The distance function (2) determines the maximum simultaneous increase/reduction (β) of the vectors of good and bad outputs on the vector's direction $g=\left(g_y,\ g_b\right)$. It is common in the literature to calculate the vector using $g=(Y,\ B)$, as suggested by Chung et al. [23] and Oh [86]. The DEA model generally used to estimate the DDF is (3):

$$\begin{aligned}
&Max=\phi+\varepsilon\left(\sum_{i=1}^{I}s_i^{+}+\sum_{d=1}^{D}s_d^{-}+\sum_{z=1}^{Z}s_z^{+}\right)\\
&s.t.\quad \sum_{j=1}^{N}\lambda_j x_{ij}+s_i^{+}=x_{io} \qquad i=1\ldots I\\
&\sum_{j=1}^{N}\lambda_j y_{dj}-s_d^{-}=(1+\phi)y_{do} \qquad d=1\ldots D\\
&\sum_{j=1}^{N}\lambda_j b_{zj}+s_z^{+}=(1-\phi)b_{zo} \qquad z=1\ldots Z\\
&\sum_{j=1}^{N}\lambda_j=1\\
&\lambda_j, s_d^{-}, s_z^{-}, s_i^{+}\geq 0,\ \ \phi\ \ unrestricted\ \ in\ \ sign
\end{aligned} \tag{3}$$

where ε is a small non-Archimedean number, ϕ the maximum radial increase/decrease for the good and bad outputs,