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A comprehensive enterprise classification approach based on three indicators of emissions, efficiency and location

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1 A comprehensive enterprise classification approach 2 based on three indicators of emissions, efficiency and 3 location

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8 **Abstract:** Enterprises, which are¹ the entities that must implement emission reduction policies, as well
9 as other regional management bodies exhibit significant differences with respect to certain indicators.
10 Previous studies mainly focus on one-indicator or one-sector evaluation methods, which are overly
11 simple and inadequate for enterprise analysis. To solve this problem, this paper selects three key
12 indicators for enterprise evaluation and proposes an integrated classification approach grouping
13 enterprises into sets. The proposed approach comprises one main model and three sub-models. The
14 sub-models (Emission Model, Data Envelopment Analysis Model and Geo-spatial Model) pre-compute
15 the indexation of emissions, overall efficiency and geo-location conditions as input data for the main
16 model. The main model synthesizes these three sub-models' inputs and classifies enterprises into
17 different classification sets. For verification, we conduct a case study of 8,106 manufacturing enterprises
18 in Shanghai. In the case study, the proportions of enterprises in top set, middle-top set, middle-low set
19 and low set were 19.5%, 47.5%, 29.4% and 3.6%, respectively. The classification approach provides
20 adequate quantitative technical support for flexible policy design and has the potential to promote
21 efficient regional emission reduction, optimize regional industrial structures and distribute enterprises
22 rationally.

23 **Key words:** local air pollutants; greenhouse gases; overall efficiency; location condition; evaluation;
24 classification

25 1. Introduction

26 China's rapid economic development, specifically its rapid urbanization and industrialization,
27 has contributed to a considerable increase in the country's consumption of fossil energy. In the past
28 two decades, an increasing number of serious air pollution issues (e.g., haze) have occurred in
29 wealthier regions, such as the Yangtze River Delta, the Pearl River Delta, and the
30 Beijing-Tianjin-Hebei Metropolitan Region. As one of the largest contributors to greenhouse gas

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