Detecting Energy Clusters from the Automobile Supply Chain: Spectral Clustering Approach

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In this paper, we demonstrate that a popular heuristic approach, Spectral Graph Approach is very useful in addressing the industrial cluster problem (see section 1.1 of Spielman and Teng (2007) for the short history and Chung (1997) for the mathematical properties). In fact, although there are many applied researches in the field of parallel computing (e.g., Hendrickson and Leland, 1995) and image segmentation (e.g., Shi and Malik, 2000), it seems that there are very few researches which attempt to detect the industrial clusters using the spectral graph theory in the field of applied economics. In a related study, Aroche-Reyes (2003) definitely introduced a “network cut criterion” in order to draw the border of any cluster and identified a tree of the fundamental production structure for Mexico using the input-output tables. However, Aroche-Reyes (2003) did not employ the spectral graph approach but employed the Prim’s algorithm in order to detect the spanning tree of the Mexico economy. An important feature of the spectral graph theory is that the border of any cluster can be drawn based on a criterion (cut value, normalized cut value, and so forth) (see von Luxburg, 2007; von Luxburg et al., 2008). Hence, the spectral graph theory is called a monothetic method. The well-known block triangulation methods of input-output matrix also belong to a family of the monothetic methods, because they largely depend on a criterion of maximizing the degree of linearity and check the relevance of the matrix triangulation (see Simpson and Tsukui, 1965; Fukui, 1986; Howe, 1991; Dietzenbacher, 1996). We understand that both spectral graph partitioning and block triangulation from the input-output theory belong to a family. Applying the 2000 energy input-output database to the spectral graph partitioning method, we attempted to detect the environmentally important clusters from the supply chain of automobile sector which plays a crucial role in Japanese economy. Subsequently, we argued peculiar features of the energy intensive clusters of the Japanese auto sector and policy implications of effectively saving energy by cooperating between different sectors within the clusters.