Addressing Key Drivers of Regional CO_2 Emissions of the Manufacturing Industry in Japan

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Executive summary

Japan ratified the Paris Agreement on November 8, 2016, and it has stated its aim of reducing its emissions by 2030 by 26.0% compared with 2013 levels. The Paris Agreement refers to the roles of non-state actors and therefore efforts at the local level are essential to the reduction of CO_2 emissions nationally. Prefectures in Japan are obliged to set their own targets and action plans for GHG emissions reductions. Because prefectures set ambitious targets, the combined target of all 47 prefectures is to reduce emissions by 2030 by 25.6%–28.0% compared with 2012 levels, which is greater than the national target. To achieve this target and to set targets beyond 2030, it is crucial to identify those factors that drive prefecture-level CO_2 emissions. In particular, considering the emissions situation outlined above, the identification of such factors and their changes in relation to the manufacturing industry of each prefecture is essential. The purpose of the present study was to adopt a decomposition approach (i.e., index decomposition analysis: IDA) to investigate those factors behind the changes in CO_2 emissions between 1990 and 2013 in relation to the Japanese manufacturing industry. We implemented IDA at the prefectural rather than the national level. If we analyzed the factors at a national level, the effects would be averaged. By performing prefectural-level analysis, we could identify the factors behind the emissions increases/decreases in detail.

We conducted IDA applying the logarithmic mean Divisia index (LMDI; additive decomposition) to investigate those factors behind the changes in CO_2 emissions in the manufacturing industry of the 47 prefectures in Japan. Four factors were considered in the decomposition: CO_2 emissions per energy use in sector *i* (carbon intensity effect), energy use per gross prefectural product (GPP) in sector *i* (energy intensity effect), share of GPP in sector *i* (structure effect), and total GPP in the manufacturing industry (activity effect). The data for the analysis were obtained from (1) Energy Consumption Statistics by Prefecture (CO_2 emissions and energy use) and Prefectural Accounts (GPP).

By decomposing the changes, we elucidated those sectors/factors that had caused substantial influence. The following findings emerged from our decomposition analysis. (1) The types and magnitudes of the influential factors regarding emissions changes varied by prefecture. (2) Among the four factors, the contribution of the energy intensity effect to increasing CO_2 emissions was greatest, and energy intensity increased in about half the prefectures. In addition, the impact of the carbon intensity effect on emissions change was much lower than the other factors, although it reduced overall emissions. (3) Among the eight industrial sectors, the

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chemistry and *metal* sectors were the two most influential in emissions changes in most prefectures. (4) In the *chemistry* sector, a greater number of prefectures had positive carbon intensity and structure effects, and a negative energy intensity effect. In the *metal* sector, a greater number of prefectures had negative carbon intensity and structure effects, and a positive energy intensity effect. (5) In Ibaraki and Chiba, the contributions of the *chemistry* and *metal* sectors to emissions changes were large and positive, whereas the contributions were spread across all sectors in Kumamoto.

The *chemistry* and *metal* sectors were the main causes of CO_2 emissions increases from the manufacturing industry between 1990 and 2013, with positive changes for each factor. Thus, reducing the factors from these sectors and making them negative will be essential if emissions from the manufacturing industry are to reach the reduction targets of the Paris Agreement and to be decreased further in the long term. Because increases in GPP contribute to economic development, the priority for emissions reduction is to address carbon and energy intensity. In relation to the *chemistry* and *metal* sectors, some prefectures were found to have decreased their carbon and/or energy intensity during the study period. Thus, the diffusion of technology and knowledge regarding the reduction of carbon and energy intensity has assisted in emissions reduction of these two sectors, and it is considered the same for other sectors. Furthermore, the roles of local governments to accelerate industrial symbiosis by gathering our results and their knowledge for the local industrial community will be important to furhter improve energy efficiecy and reduce CO_2 emission from the manufacturing industry.

Keywords Decomposition analysis; CO_2 emissions; manufacturing industry; prefectural-level analysis; Japan.

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