

Appendix A. Spatial weight matrices

Considering the diffusion of SO₂ emissions in the atmosphere, SO₂ pollutant that spreads to other cities exhibits a decreasing trend as the geographical distance increases. Generally, a weight matrix based on geographical proximity can be constructed using a binary measure of contiguity or continuous measure of distance. The first-order contiguity weights matrix can be specified as formula (A.1), whose elements w_{con_ij} are indicated as 1 if two cities are geographically adjacent; otherwise, w_{con_ij} is indicated as 0.

$$w_{con_ij} = \begin{cases} 1, & \text{if } i \text{ and } j \text{ are contiguous} \\ 0, & \text{if } i \text{ and } j \text{ are not contiguous} \end{cases} \quad (\text{A.1})$$

Meanwhile, continuous distance can be obtained using geographical coordinates of two cities using the distance decay function (Pijnenburg and Kholodilin, 2014). Thus, the reciprocal of geographical distance between different cities is regarded as a basic element to construct the spatial weight matrix. The inverse distance form of the geographical weight is specified as follows:

$$w_{dis_ij} = \begin{cases} 1/d_{ij}^\alpha, & i \neq j, \quad i = 1, \dots, N; j = 1, \dots, N \\ 0, & i = j, \quad i = 1, \dots, N; j = 1, \dots, N \end{cases} \quad (\text{A.2})$$

Where w_{dis_ij} reflects the element in the $N \times N$ vector spatial weight matrix; i and j stand for the objective prefecture-level cities; and d_{ij} denotes the straight-line distance between administrative geographical centres of two cities. α denotes the decay rate, which is usually equal to 1 and is known as an inverse distance weight matrix (W_{dis}). If α is equal to 2, then it is known as the inverse squared distance weight matrix (W_{squ}) (You and Lv, 2018). Hence, we mainly utilised W_{dis} for the analysis. W_{con} and W_{squ} were used to verify the estimation robustness. All weight matrixes were normalised so that the sum of the row elements is equal to 1.

References:

- Pijnenburg, K., Kholodilin, K.A., 2014. Do regions with entrepreneurial neighbours perform better?: A spatial econometric approach for german regions. *Regional Studies* 48, 866–882.
- You, W., Lv, Z., 2018. Spillover effects of economic globalization on CO₂ emissions: A spatial panel approach. *Energy Economics* 73, 248–257.