A Model of Stratified Production Process and Spatial Risk

In 2011, Japanese firms suffered great losses due to the Great East Japan Earthquake as well as Thailand floods. One of the reasons for their repetitive damages is that they depend on spatially dispersed supply chain. Basically, outsourcing becomes more attractive for final goods producers due to prevailing scale economy in modern machinery industries. The fragmentation of trade also works as dispersion or disintegration force as well. In addition, some firms have dispersed their plants against the risk of big earthquakes assumed around Tokyo or Nagoya (i.e., more developed metropolitan areas). In this case, however, such behavior brought about the contiguous damages for firms ironically. In the present study, we first build up a theoretical model that is able to explain the disintegration of production process over space due to scale economy or other factors of fragmentation. It is based on a multi-level Hotelling type spatial competition model in order to capture the characteristics of supply chain over space and cascade of risks. We assume a three level structure of circles. Consumers are distributed evenly over the lowest circle. On the second circle, there are final goods producers, for whom intermediate goods producers provide differentiated inputs from the top circle. Each producer can choose for a differentiated part between the integrated production in her own plant and the disintegrated pattern where final good producers buy inputs from some intermediate goods producers located at different places. In the latter, she should pay for transport costs to buy the input though. We show recent technical tendency of some factors such as reinforced scale economy at each stage of production may provide advantages of disintegration. Once the equilibrium distribution or location of intermediate goods producers and final goods producers is determined, we evaluate it by the location risk such as earthquake. It means, for example, that firms with dispersed supply chain may be likely to suffer relatively small but often damages if location risks are evenly distributed over the space. Moreover, we could examine the optimal location of firms including location risk for a given “utility” function of firms.

Key words: fragmentation, supply chain, location risk, spatial competition, natural disasters

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