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Optimal buffer stock placement under production and trade disruptions: a two-stage stochastic spatial price equilibrium model of global wheat trade

Polle Dankers
Tilburg University

Increasing international food trade has transformed the global food system. While it decreases vulnerability to domestic production shocks, it exposes countries to disruptions elsewhere, such as production shocks or logistic disruptions, e.g., the closure of maritime chokepoints. Buffer stocks can reduce this vulnerability. We investigate how a global planner should place these buffers, to be released via trade, to improve resilience to trade shocks.
Global trade is often investigated using spatial price equilibrium (SPE) models, while buffer stock placement is generally investigated via two-stage stochastic programming. We combine both, developing a two-stage stochastic spatial price equilibrium model of global trade with buffer placement as first-stage decision, and an SPE for each disruption scenario as recourse. Buffers are then placed where their expected marginal value is highest. The model is calibrated to observed trade, and applied to global wheat trade among 160 countries, under production shocks and closures of maritime chokepoints.
We find that buffer placement depends strongly on the flexibility of trade: when deviating from existing flows is costly, buffers are placed mainly at large exporters hit by production shocks, while with flexible trade placement shifts to Kazakhstan and Iraq. A total buffer of 8 Mt reduces the relative demand loss of the most affected importers in severe disruptions by about 30% and reduces the expected increase in demand prices from 5.9% to 2.2%.