

## Are quantitative models for disaster impact analysis accurate? A measurement framework and a validation case

Topic: Input-Output Modelling: Disaster Analyses

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Quantitative models are widely employed to assess disaster impacts, yet their accuracy remains under-examined due to scarce verifiable validation cases. This study addresses this gap by proposing a novel measurement framework for disaster impact analysis and rigorously testing its accuracy through a real-world validation case: the 2022 Shanghai COVID-19 lockdown. The specificity and short-lived nature of this event—a city-wide sealing policy with minimal confounding factors—provides a unique opportunity to benchmark model performance against actual economic data.

Our framework integrated a multi-regional input-output (MRIO) model with two critical innovations. First, on the production side, it quantified both upstream losses from disrupted supply chains and downstream losses via raw material inventory constraints. Second, on the consumption side, it captured immediate non-rigid spending reductions and long-term demand contractions caused by income loss, offering a dual-perspective analysis. Applied to Shanghai's lockdown, the model estimates a GDP loss of 153.8 billion yuan for Q2 2022, deviating by only 3.6% from official statistics. This close alignment demonstrates the framework's precision in retrospective impact assessment.

Beyond validation, the framework's flexibility is showcased through ex-ante simulations of hypothetical disasters across Chinese regions, revealing differentiated economic vulnerabilities. Policy simulations further illustrate how adjusting mitigation strategies—such as inventory buffers or household income support—can reduce losses by 12–18%, providing actionable insights for decision-makers.

The study's primary contribution lies in delivering a validated, transparent methodology for disaster impact analysis, supported by empirical evidence of its accuracy. By bridging the gap between modeled and observed outcomes, this framework advances the credibility of economic impact models. Its adaptability to diverse scenarios—from regional disruptions to global crises—positions it as a critical tool for evidence-based risk management and policy design.