

Flood footprint assessment: assessing impact of external assistance on post-disaster economic recovery

Topic: Input-Output Modelling: Disaster Analyses

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Mitigating the risks posed by natural disasters has become a pressing public concern due to their increasingly frequent and intense occurrences, which threaten human lives and socio-economic development. External assistance (EA), as a common form of support for post-disaster reconstruction, has been recognized as significant in several studies. However, the lack of an assessment method has made it unclear to what extent economic recovery can be affected by external assistance. This study aims to investigate the impact of EA on economic recovery following natural disasters from an economic system perspective. To address this issue, we propose a novel approach called EA-FFM that can effectively quantify the effect of EA on both industrial and regional levels using the EIF indicator (EIF is defined as an indicator to show the economic impact of EA on affected economy). The approach also allows us to apply the EA selection principle, which focuses on mitigating indirect economic loss by selecting the most appropriate EA scheme from among all available options.

To address this problem, we adopt the flood footprint as an indicator and improve the Flood Footprint Model by combining it with the consideration of EA. The Flood Footprint Model, which builds upon previous ARIIO models, can provide a dynamic modeling process of post-disaster recovery by considering productivity constraints, demand adaptation, and supply bottlenecks before and after a natural disaster, and it can quantify economic loss. The 2013 Super Typhoon Haiyan serves as a case study for conducting scenario analysis on alternative external assistance schemes. The devastation caused by Super Typhoon Haiyan in Hainan on November 9th, 2013 resulted in a total economic loss of 4.93 billion Chinese Yuan (CNY), equivalent to 1.57% of Hainan's GDP in 2013.

Our findings reveal that EA has a definite positive effect on economic risk reduction, and its influence on the economy is complex. In the Typhoon Haiyan case, we found that EA, which accounted for 2.4% of direct economic losses, resulted in a 7.31% reduction of indirect economic losses in Hainan. Furthermore, through scenario analysis on alternative EA schemes, we discuss that the ration scheme is a significant factor in determining EA's impact. Various distribution ways of the same EA value can result in different sectoral and regional EIFs. The proper EA scheme can be determined by adopting the EA selection principle, which minimizes indirect economic loss. The significance of the EA's impact at the industrial and regional levels is largely determined by factors such as total values of EA, rationing scheme, and even the 'key sectors' of EA, damage level of industrial productivity, inter-linkages of sectors, and the relationship of suppliers and consumers. The EA-FFM's high feasibility and flexibility have been validated through our successful application of it to the Typhoon Haiyan case study.

This study offers fresh perspectives on policy implications that pertain to natural disaster management and risk reduction. Specifically, the analysis emphasizes that the impact of EA should be assessed from an overall economic view. While some sectors may suffer high visible economic losses due to natural disasters, such as Typhoon Haiyan, the potential indirect risks faced by these sectors depend greatly on industrial resilience and interdependence within the economy. Directly affected sectors may potentially play a less significant role in supply chains. Accordingly, the Manufacturing sector, which experienced the largest indirect economic loss in the Typhoon Haiyan case, should receive greater attention and investment from related departments in order to reduce

risk. Policy decision-makers must also consider the allocation scheme for EA as well as its total amount. There is no one-size-fits-all rationing scheme for EA that applies to all natural disasters, so it's necessary to analyze each case uniquely. Moreover, the aim of EA must be established, considering differences in its effects across sectors and regions. If the priority is to target the entire economy, then the analysis of regional effects among available EA plans is more important. Alternatively, if certain sectors are prioritized, the industrial effects of EA should be compared.