Chapter 18 Appendix: Overview of case studies and findings (non-comprehensive)

Table 18–1: Case studies on the indirect higher-order effects of historical extreme weather events

Event	Study
2003 Hurricane Katrina (Louisiana)	Hallegatte (2008) • Adaptive regional input-output model for disaster modeling (ARIO) • Total economic costs exacerbate direct losses ($149 billion vs. $107 billion) • Positive and negative backward propagation mechanisms are essential for the assessment of disaster consequences
2010 harsh winter weather (Norway, Sweden, Switzerland and Poland)	Ludvigsen and Klæboe (2014) • Analytical regression model based on interviews with managers of rail cargo companies • Rail traffic disruptions spread to downstream and upstream segments of logistics channels, causing shippers and logistics operators to move freight away from rail to road transfer
2011 Thai floods	Haraguchi and Lall (2015) • Review of economic indicators with a focus on automobile and electronics industries • Automotive and electronic products supply chains had different mechanisms of risk transmission and response that translated into different times to recovery, loss and market performance at the individual company level • Properties of global supply network play crucial role w.r.t. loss transmission
2012 Hurricane Sandy	Kashiwagi et al. (2018) • Econometric study based on firm-level data • Significant impacts on supply chains inside the US, but effects on international supply chains not significant

Event	Study
2013 European floods (Germany)	Schulte in den Bäumen et al. (2015) • High-resolution model of the German economy based on sub-national MRIO data for Germany (GerMRIO) • Indirect losses in motor vehicle and food industries in several German states • Foreign production also affected • Regions and industries outside the affected areas experience about €400 million of the loss (estimated total loss: €6.3 billion) Further studies: Oosterhaven and Többen (2017)
2016 typhoon Megi (Taiwan)	Faturay et al. (2020) • Virtual laboratory to generate a time-series of subnational multi-regional input–output tables, capturing interregional transactions among 267 sectors across Taiwan's 22 city-counties (TaiwanLab) • Value-added loss in the order if NT$ 2.5 billion, about 40% of which was felt in agriculture, livestock, forestry, and fishery sectors • Losses resulting from upstream linkages were large, amounting to about half of value-added lost Further extreme events covered by study: 1999 Chichi earthquake, 2009 typhoon Morakot and 2016 Tainan earthquake (all Taiwan)

Event	Study
2017 tropical cyclone Debbie (Australia)	Lenzen et al. (2019) • Highly disaggregated MRIO tools developed within the Australian Industrial Ecology Virtual Laboratory (IELab) • Production layer decomposition to pinpoint the sequence of indirect impacts rippling across the regional supply-chain network • Industries and regions not directly affected by storm and flood damage suffered significant job and income losses throughout upstream supply chains

Table 18–2: Case studies on the indirect higher-order effects of historical non-meteorological extreme events

Event	Study
2011 Japanese earthquake and tsunami	MacKenzie et al. (2012) • MRIO-based model • Japanese demand was satisfied by other countries • Inventory in the production pipeline likely allowed consumer sales to remain strong Boehm et al. (2019) • Event study framework using firm-level micro data • U.S. affiliates of Japanese multinational firms suffered large drops in U.S. output in the months following the shock • The elasticity of substitution between imported and domestic inputs that would best match this behavior is very low – nearly that implied by a Leontief production function • Reliance on intra-firm imports by multinational affiliates from their source country is the most plausible explanation for such strong complementarities in production Further studies on the Earthquake and/or Tsunami: Kajitani and Tatano (2014), Arto et al. (2015)

Event	Study
2003 Electricity blackout (Northeastern USA)	Anderson et al. (2007) • Risk-based input-output methodology: Inoperability Input-Output model (IIM) • total impact on US workers, consumers, and taxpayers amounts to approximately $6.4 billion • Workers and investors lost $4.2 billion in income, due to reductions in wage and salary earnings and profits; rest is due to spoiled goods and the extra expenditures of governments and utility companies

Table 18–3: Case studies on the indirect higher-order effects of hypothetical extreme weather events

Event	Study
River flood events in Amsterdam and Rotterdam	Koks and Thissen (2016) • Recursive dynamic multiregional supply-use model, combining linear programming and input–output modeling (MRIA) • Most of the neighboring regions gain from the flood due to increased demand for reconstruction and production capacity constraints in the affected region. • Regions located further away or neighboring regions without a direct export link to the affected region mostly suffered small losses (due to the costs of increased inefficiencies in the production process) Further studies using the MRIA model: Koks et al. (2019) - hypothetical river floods and subsequent electricity outages in the UK.
Storm surges under climate change (Copenhagen)	Hallegatte et al. (2011) • Adaptive Regional Input-Output Model (ARIO) • Indirect economic losses are found to be significant and strongly nonlinear relative to direct losses
Severe winter storm in Northern Europe	Jonkeren and Giannopoulos (2014) • Inoperability input–output model (IIM) with economic resilience features (Resilience IIM); (i) shape of recovery path after disaster and (ii) measures which delay the onset of inoperability) • Model as tool to find optimal resilience strategies, i.e. a level of investment in resilience measures with which the total of resilience costs plus residual losses following from infrastructure failure are minimized

Event	Study