

“Developing a Multi-region Input-Output Framework from GTAP for Analyzing the Vulnerability of the Asia-Pacific Supply Chain to Natural Disasters”

Thomas Hertel, David Hummels and Terrie Walmsley

With the global economy increasingly inter-connected through international trade in intermediate inputs as well as consumer goods, the demand for analytical tools which trace out the implications of these linkages has grown exponentially. These have included studies of international supply chains (Koopman et al.), virtual water trade (Konar et al.) and GHG emissions associated with global trade flows (Peters et al.). All of these studies share a common need for a global data base which traces out these trade flows between sectors and between producers and consumers of final goods and services. In short, they all share a common need for a multi-region, input-output (MRIO) data base. In response to these demands, several projects have been formed with the goal of producing new MRIO data bases, including EXIPOL, WIOD and EORA. For the most part these are one-off efforts for which there is not currently funding available for future updates.

An alternative source of global economic data suitable for MRIO-type analysis is the GTAP data base (Narayanan, Aguiar and McDougall, 2012), which recently celebrated its 20th birthday, having accomplished 8 successive major releases. While the GTAP data base is most commonly used as the foundation for global Computable General Equilibrium (CGE) models, at its core it is very similar to an MRIO data base. However, rather than tracing bilateral trade flows to individual sectors, the GTAP data base aggregates these flows at the border, thereby reducing the maximum dimensions of any individual array from 4 (commodity x industry x region x region) to three (commodity x region x region). On the other hand, in contrast to the MRIO data bases, GTAP has extensive policy detail. It also has more complete regional coverage than the MRIO data bases, as its goal is to fully exhaust global economic activity. In short, it would appear that the MRIO community could benefit from cross-fertilization with the GTAP network, and vice versa. This paper will facilitate such cross-fertilization by exploring the use of import sourcing methods developed in the MRIO community in the context of the GTAP data base. In particular, highly disaggregated trade data are mapped to final uses (intermediate vs. consumer demand) and then aggregated to the GTAP commodity level. This results in a set of splits of the GTAP trade data by agent and source. Upon incorporation into GTAP, this yields a full, MRIO data base, the results of which can be compared to the standard GTAP data base in which sourcing by agent is uniform.

Having developed a GTAP-based MRIO, the paper illustrates its usefulness by applying this MRIO to an examination of the vulnerability of production in the Asia-Pacific region to a pre-determined set of shocks, including a negative technological change in specific manufacturing sectors/regions where production is geographically concentrated and therefore vulnerable to natural disasters.

As was discovered during the 2011 Earthquake/Tsunami in Japan, these increasingly complex global supply chains are extremely vulnerable to external shocks and supply disruptions. This enhanced MRIO data base will be used in conjunction with an expanded GTAP model (GTAP-SC for Supply Chain) which allows for import sourcing by agent. Specifically, GTAP-SC incorporates econometrically estimated parameters describing how economic agents respond to changing relative prices of alternative suppliers

of intermediate inputs, as might be induced by a natural disaster. In addition, the CGE model enforces economically sensible assumptions, such as balance of payments equilibrium and finite endowments which are not part of MRIO studies. We compare and contrast the predictions of GTAP-SC and the MRIO analysis to gain insight into the strengths and limitations of each approach. We will also develop an index of vulnerability, by sector and region, for different types of natural disasters, which would be useful in future planning exercises.