FY2014 Annual Report

Economy-wide modeling for analysis of major disruptive events: terrorism, natural disasters and accidents
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1. Executive Summary

This project focuses on the creation and adaption of computable general equilibrium (CGE) models to facilitate the calculation of the economic consequences of terrorism events, counter terrorism measures, natural disasters and accidents.

The research has three objectives. The first is general: to advance the application of economic modeling in the analysis of terrorism and other disruptive events and counter terrorism measures. Such analysis is an important input to policy decisions concerning appropriate responses to terrorism and other disruptive events. The second objective is to develop CGE models, particularly the USAGE-R model, as quick-response analytical tools. Such tools allow us to respond quickly to requests for economic modeling of localized terrorism events or natural disasters such as the destruction of a bridge over the Mississippi, a dirty bomb in LA or a flood surge in New Orleans. The third objective is to enhance existing models by introducing new analytical features reflecting innovative theory. If existing models are to survive and continue to be useful in applications relevant to disaster policy, then they must be continuously updated and modified to take on new dimensions. In recent years we have, for example, enhanced models: to deal with illegal immigration by including specifications of labor-supply decisions by illegals and substitution decisions by employers between legal and illegal labor; to deal with a widespread terrorism-related closure of U.S. ports by modifying the specification of household behavior to allow for adjustments that would take place in response to sudden severe shortages of imported commodities; and to deal with a severe but short-duration H1N1 epidemic by giving a CGE model a quarterly time dimension.

The main work planned for 2013-14 was to extend the regional detail of USAGE-R from the state level to the county level. This has been achieved. It was a major undertaking, consistent with the first and third objectives outlined above.

Using Census data we identified the industrial structure (up to 500 industries) of economic activity in most of the 3,077 counties of the U.S. Then using gravity formulas we estimated inter-county trade flows. In theory this is sufficient to create a 3,077-region bottom-up regional model. In practice, such a model is far too unwieldy for use in a policy situation. Consequently, as we have done with the state-level version of USAGE-R, we equipped the county version with a flexible aggregation facility. Users of the model will be able to choose both the industry and regional aggregation to suit their application.

This aggregation facility is an important part of achieving the second objective outlined above, the development of USAGE-R as a quick-response analytical tool. Flexible aggregation allows
us to respond quickly to requests for economic modeling of localized terrorism events or natural disasters. Most terrorism shocks and other disruptive events occur at a localized level (well below the state level). Thus, for analyzing such events, extending the USAGE-R capability to the county level is an important enhancement.

Another objective for 2013-14 has been to make our work better known to DHS. Towards this objective, the CoPS team visits Washington DC twice a year. In December 2013, a DHS staffer attended a week long training course on economic modelling that CoPS conducted in Washington DC.

2. Research Accomplishments
   2.1. Research Results

The main achievements for 2013-14 were the completion of the analysis of a chlorine attack scenario within a single-county dynamic CGE framework, and the development of a more general framework, the USAGE-R-County model, for projecting the economic effects of terrorism events at level of multiple counties.

In the chlorine work, we extended our comparative static single-county model to make it dynamic. We then undertook an economic consequence analysis of a terrorist attack with chlorine gas. We divided the event’s direct effects into resource losses (injuries, deaths, business interruption, medical expenses) and behavioral reactions (relating to wages, rates of return and willingness to pay) stemming from fear. We undertook a decomposition of aggregate economic effects in terms of these various loss components, allowing us to elucidate the relative sizes of potential loss channels. The work also developed a framework for understanding the geographic shifts of economic activity within the affected region and in neighboring regions in estimating the losses. Figure 1 presents one set of findings from the work, demonstrating the relative importance of behavioral effects in determining overall economic losses from terrorist attack, and highlighting how these effects can endure well beyond the year of the attack.
Having developed USAGE-R-County, we applied the model in an illustrative simulation of the effects of a hypothetical nuclear attack in LA. Following the approach developed in the chlorine paper for defining a catastrophic event in terms of a set of model compatible shocks, inputs to the USAGE-R-County model included assumptions concerning:

- The impact region (Californian Congressional District 34 (CA-34) in our example).
- The shutdown period (one year in our example).
- Immediate deaths (7000 in our example).
- Later deaths (35,000 in our example).
- Evacuation locations and expenditure ($25 billion in our example).
- Medical expenditures ($700 million in our example).
- Clean-up and decontamination expenditures ($40 billion in our example).
- Aversion behavior (A decrease in labour supply to the affected region by 50% at the initial wage rate, even after decontamination has occurred.).

A flavor of the results that come from USAGE-R-County can be seen in Figure 2. This shows effects on the economy of CA-34 in our illustrative simulation. The next challenge is to introduce realistic shocks rather than merely illustrative shocks.
2.2. Research Transition

The Centre of Policy Studies (CoPS) at Victoria University has a history stretching back 37 years in practical policy-oriented CGE modeling. In the U.S., CoPS works not only with CREATE but also with the U.S. International Trade Commission, the U.S. Departments of Commerce, Agriculture, Homeland Security, Energy, and Transport, the Mitre Corporation and CATO. Using versions of the USAGE model, CoPS has completed a large number of studies for these organizations covering topics in trade, environment, immigration, energy, macro-economic stabilization and air transport development. In the specific field of disruptive events, we have completed CGE analyses of the economic effects of: an RDD attack in Los Angeles; a severe H1N1 epidemic; and a security-related widespread closure of U.S. ports.

With regard to making our work known to DHS, CoPS researchers visit Washington twice a year. We maintain contact with officials at DHS Headquarters. In recent years we have had meetings with DHS staffers. In this way we keep DHS informed of our activities. We also rely on our CREATE colleague Adam Rose to keep our work in front of DHS.
2.3. Models, Databases, Software Tools, Invention Disclosures and Patents

Creation of USAGE-R-County.

<table>
<thead>
<tr>
<th>Project Leader(s)</th>
<th>Date Delivered</th>
<th>Item</th>
<th>Agency Receiving Product</th>
<th>Agency POC</th>
<th>Transitioning Status</th>
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<tbody>
<tr>
<td>Dixon</td>
<td>11/2013</td>
<td>Training in CGE modelling</td>
<td>Various U.S. government departments including DHS</td>
<td>N/A</td>
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## Software Products (Examples – PLS Enter Your Own)

<table>
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<tr>
<th>CREATE Project Leader(s)</th>
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<th>Type of Product</th>
<th>Application Area</th>
<th>Intended Users and/or Clients</th>
<th>Specific Users and/or Clients</th>
<th>Status</th>
<th>Other Comments</th>
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<tbody>
<tr>
<td>Dixon</td>
<td>Computable General Equilibrium (CGE) model, USAGE-R</td>
<td>Model and software tool</td>
<td>Economic impact modeling</td>
<td>Economists, decision-makers</td>
<td>CREATE</td>
<td>Early applications</td>
<td>Can be used for indirect economic impact calculations, including resilience</td>
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Dixon's project involves the creation of a Computable General Equilibrium (CGE) model, along with a usage-R model and software tool. The application area is economic impact modeling, with intended users consisting of economists and decision-makers. The status is early applications, and additional comments note that the model can be used for indirect economic impact calculations, including resilience.
3. Education Programs

CoPS taught a one-week intensive course in CGE modelling in Washington in November 2013, attended by a DHS researcher.

4. Outreach Programs

CoPS is now working with Adam Rose (CREATE) on a project for DNDO. This involves application of USAGE-R-County to specific events.

5. Project Performance Metrics

We list one publication below. Publications from previous years are given in earlier annual reports.

<table>
<thead>
<tr>
<th>CREATE PUBLICATIONS</th>
<th>Research Theme</th>
<th>Referred</th>
<th>Not Referred</th>
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<tr>
<td>Dixon et al. (Centre of Policy Studies, Victoria University)</td>
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