Assessing HS-Level Impacts Using the GTAP-HS Model

Angel Aguiar, Erwin Corong, Dominique van der Mensbrugghe
Center for Global Trade Analysis, Purdue University

and

Chris Rasmussen, Natalie Soroka, Yingying Xu
United States Department of Commerce

2020 GTAP Conference
Outline

• Motivation
• GTAP-HS
• Data workflow
• Model changes
• Analyses of simulation results
• Insights and conclusion
Motivation

• GTAP sectors can be too aggregated for detailed trade analysis

• Ideally, we could take one or more GTAP aggregated commodities and disaggregate them at the HS6 level

• For example, the motor vehicle and parts (MVH) sector can be disaggregated into a set of more disaggregated commodities at the HS6 level that defines that sector
GTAP Tools

• Model
  • Grant, Hertel and Rutherford (2009),
  • Narayanan, Hertel and Horridge (2010)
  • Aguiar, Corong and van der Mensbrugghe (2019)

• TASTE utility
  • TASTE utility provides HS level information (based on UN-ITC’s MAcMap data)
  • GTAP Data Base construction tariff information is based on MAcMap data
GTAP-HS

• Aguiar, Corong and van der Mensbrugghe (2019)
  • The GTAP-HS model technical Specification and User Manual
  • Updates Narayanan et al. (2010)

• Data workflow
  • Disaggregate GTAP commodities into sub-commodities at the HS6 level (or some aggregation specified by the user)
  • Main inputs are aggregated GTAP data (from GTAPAgg2) and HS-level (from TASTE) data for the GTAP sector being disaggregated
  • Automated data generation procedure

• Model
  • Based on GTAPv7 model
Data Modifications

- **Disaggregate import flows**
  - Use shares of HS6 level data to split GTAP imports

- **Determine finer sectors**
  - Re-aggregate based on new sector definitions and mappings

- **Disaggregate domestic and export flows**
  - Ensure that resulting database is still balanced
Data Modifications

• ITC’s MACMap
  • Trade and tariffs, 3 year average, trade is not balanced
  • Use as shares to split GTAP’s imports (balanced trade)

\[ VCIF_{k,s,d} = TASTE\_SHARES_{k,s,d} \times VCIF_{i,s,d} \]
\[ VMSEB_{k,s,d} = TASTE\_SHARES_{k,s,d} \times VMSEB_{i,s,d} \]
Disaggregated Production and Exports

• Domestic to import ratio in the disaggregated level is the same as in the GTAP parent level

• Trace imports to modify exports
  • International margin use is disaggregated proportional to $k$

• FOB exports at $k$ level uses imports and margins at $k$ level
  • $k$ level exports at basic prices are also derived using GTAP level taxes
Elasticities

- CES elasticities of imports (ESUBMK) and between domestic and imports (ESUBDK)
  - $k$ level is the same as in parent GTAP level (Go to formula of ESUBMK)

- CES elasticity to transform $i$ absorption into $k$’s (ESUBK)
  - Assumed to be low (0.5)

- CET elasticity to transform $i$ supply to $k$ (ETRAK)
  - -2 for aggregate commodities and -10 for commodities that are disaggregated
## Additional header arrays

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDBK(k,r)</td>
<td>Domestic supply of commodity k in region r</td>
</tr>
<tr>
<td>VXSBK(k,s,d)</td>
<td>Bilateral trade at suppliers price for k in sold in d</td>
</tr>
<tr>
<td>VFOBK(k,s,d)</td>
<td>Bilateral exports at border, FOB price</td>
</tr>
<tr>
<td>VCIFK(k,s,d)</td>
<td>Bilateral imports at border, CIF price</td>
</tr>
<tr>
<td>VMSBK(k,s,d)</td>
<td>Bilateral imports at tariff-inclusive price</td>
</tr>
<tr>
<td>VTWRK(m,k,s,d)</td>
<td>Value of bilateral trade and transport services by mode</td>
</tr>
</tbody>
</table>
Model modifications

GTAP: Top level Armington demands
- Agent-level sourcing (qfa, qfd, qfm; qpa, qpd, qpm…)
- National (domestic and import) sourcing (qa, qds, qms)

HS level
- National sourcing (qak, qdsk, qmsk)
Model modifications (Set Definitions)

Set

COMMD  # GTAP commodities subject to PE disaggregation#
read elements from file GTAPSETS header "COMD";

Subset

COMMD is subset of COMM;

Set

COMMN  # Normal GTAP commodities--i.e., NOT disaggregated#
= COMM - COMMD;

Set

COMMK  # PE Commodities#
read elements from file GTAPSETS header "COMK";

Mapping (onto)

MAPKC from COMMK to COMMD;
read (by_elements) MAPKC from file GTAPSETS header "MPCK";
Model modifications (Armington Demands)

Equation E\_qdsk
# demand for domestic commodity k #
(all, k, COMMK)(all, r, REG)
qdsk(k, r) = qak(k, r) - ESUBDK(k, r) * [pdsk(k, r) - pak(k, r)];

Equation E\_qmsk
# demand for imported commodity k #
(all, k, COMMK)(all, r, REG)
qmsk(k, r) = qak(k, r) - ESUBDK(k, r) * [pmsk(k, r) - pak(k, r)];

Equation E\_qxsk
# regional (Armington) demand for imported HS6 com. k by dest. d from source s #
(all, k, COMMK)(all, s, REG)(all, d, REG)
qxsk(k, s, d) = -amsk(k, s, d) + qmsk(k, d) - ESUBMK(k, d) * [pmdsk(k, s, d) - amsk(k, s, d) - pmsk(k, d)];
Model modifications (CET and market clearing for COMMK)

Equation E_qck
# eq'n distributes the HS6k commodities across COMMD #
(all, k, COMMK)(all, r, REG)
qck(k, r)
    = qc(MAPKC(k), r) - ETRAHS6(MAPKC(k), r) * [pds(k, r) -
pds(MAPKC(k), r)];

Equation E_pdsk
# market clearing for HS6K commodities #
(all, k, COMMK)(all, r, REG)
qck(k, r)
    = DBKSHR(k, r) * qdsk(k, r)
+ sum{d, REG, XSBKSHR(k, r, d) * qxsk(k, r, d)};
Model modifications (Linking equations)

Equation E_qxsslack1
# equation linking qxsk to GTAP-level qxs #
(all,c,COMMD)(all,s,REG)(all,d,REG)
   VXSB(c,s,d) * qxss(c,s,d)
   = \sum\{k,COMMK:MAPKC(k)=c, VXSBK(k,s,d) * qxsk(k,s,d)\};

Equation E_qmsslack1
# equation linking qmsk to GTAP-level qms #
(all,c,COMMD)(all,r,REG)
   VMB(c,r) * qms(c,r)
   = \sum\{k,COMMK:MAPKC(k)=c, VMBK(k,r) * qmsk(k,r)\} ;

Equation E_pfobslack1
# equation linking FOB prices to GTAP-level qms #
(all,c,COMMD)(all,s,REG)(all,d,REG)
   VFOB(c,s,d) * pfob(c,s,d)
   = \sum\{k,COMMK:MAPKC(k)=c, VFOBK(k,s,d) * pfobk(k,s,d)\};
Modeling set-up

• Data aggregation
  • Food, Energy, Motor Vehicles (MVH), Manufactures, and Services
  • Decompose MVH components at the HS6 level, then re-aggregate into 3 GTAP sub-sectors: Automobiles, Auto parts, and OtherAuto
  • Regional aggregation: US, UK, China, Canada, Germany, Japan, Korea, Mexico, Brazil, Rest of East Asia, Rest of EU, Rest of Latin America, and Rest of the World

• Simulation: Technical change in Automobiles sector
  • Compare and contrast the results generated from three models: (a) standard GTAP, (b) GTAP-HS and (c) standard GTAP model with MVH disaggregated into separate sectors (using naïve SPLITCOM approach)
## Sectors of interest

<table>
<thead>
<tr>
<th>Initial sectors</th>
<th>Auto</th>
<th>Auto parts (APS_)</th>
<th>Other (OTH_)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor vehicles (mvh)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Electronics (ele)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Other machinery (ome)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fabricated metal products (fmp)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Chemical rubber and plastic products (crp)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Other manufacturing (omf)</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mineral products (nmm)</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
Results
Insights and Conclusions

• We illustrated the GTAP-HS model’s usefulness for trade policy assessments

• Three GTAP model set-up we used generated similar macro-economic outcomes but with slightly differentiated sectoral results.

• We untangled the drivers of these changes and highlight the advantages of using GTAP-HS to better capture impacts on specific sub-sectors, particularly where the industries in question are directly interrelated.
Questions/Comments?
References


