Global Trade Analysis Project

Assessing HS-Level Impacts Using the GTAP-HS Model

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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 MAcMap data)
  - GTAP Data Base construction tariff information is based on MAcMap data

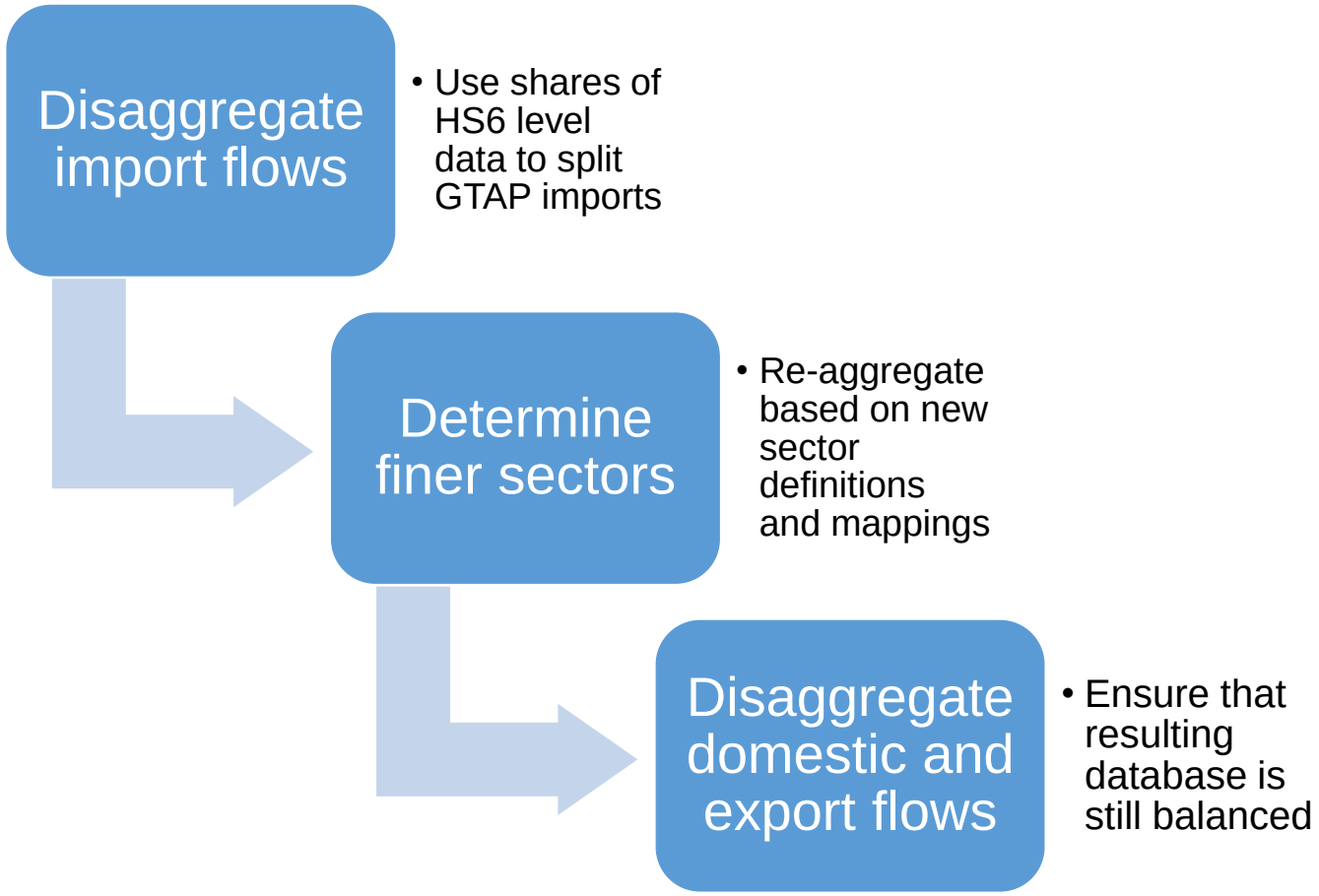
GTAP-HS

- **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



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)

- $VCIF_{k,s,d} = TASTE\_SHARES_{k,s,d} \times VCIF_{i,s,d}$
- $VMSB_{k,s,d} = TASTE\_SHARES_{k,s,d} \times VMSB_{i,s,d}$

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

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

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) * [pdsk(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) * qxs(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 #
(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

Initial sectors	Auto	Auto parts (APS_)	Other (OTH_)
Motor vehicles (mvh)	X	X	X
Electronics (ele)		X	X
Other machinery (ome)		X	X
Fabricated metal products (fmp)		X	X
Chemical rubber and plastic products(crp)		X	X
Other manufacturing (omf)		X	X
Mineral products (nmm)		X	X

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.**

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Questions/Comments?

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References

- Aguiar, A., E. Corong, and D. van der Mensbrugghe. 2019. “The GTAP-HS model technical Specification and User Manual.” Report Submitted to the US Department of Commerce.

- Corong, E., T. Hertel, R. McDougall, M. Tsigas, and D. van der Mensbrugghe. 2017. “The Standard GTAP Model, Version 7.” Journal of Global Economic Analysis, 2(1): 1–119. doi:10.21642/JGEA.020101AF.

- Narayanan, B.G., T.W. Hertel, and J.M. Horridge. 2010. “Disaggregated data and trade policy analysis: The value of linking partial and general equilibrium models.” *Economic Modelling*, 27(3): 755 – 766.

- Grant, J., T.W. Hertel, and T.F. Rutherford. 2009. “Dairy Tariff-Quota Liberalization: Contrasting Bilateral and Most Favored Nation Reform Options.” *American Journal of Agricultural Economics*, 91(3): 673–684.