The Global Trade Analysis Project

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Outline

• The Project
• The Network
• The Data Base
• The Model
• Other GTAP Offerings
• An Illustration of GTAP: The PE-GE model
The Project

- International network of economic/policy researchers and policy-makers
- Quantitative analysis of international policy issues within an economy-wide framework
- Co-ordination: Center for Global Trade Analysis, Purdue University
- Funding:
  - Consortium subscriptions
  - Data Base Sales
  - Project-based

The Network

- 31 Consortium Board Members (US Govt agencies, EC, OECD, WB, UN, WTO, etc.)
- Over 9000 network members from 159 countries
- Over 2000 contributing members from 99 countries
The Network

GTAP Data Base

- Multi-country multi-sector economic data
- Input-Output (I-O) data
- Trade data: imports, exports, margins.
- Macro-economic data: GDP, population, consumption, investment, government expenditure, savings…
- Energy data: volumes, taxes, prices
- Protection data: taxes, domestic support, subsidies, tariffs, preferences, quotas…
- Satellite data: Land-use, Emissions, Bio-fuels…
History

<table>
<thead>
<tr>
<th>Release</th>
<th>Released</th>
<th>Regions</th>
<th>Sectors</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTAP 1</td>
<td>1993</td>
<td>15</td>
<td>37</td>
<td>1990</td>
</tr>
<tr>
<td>GTAP 2</td>
<td>1994</td>
<td>24</td>
<td>37</td>
<td>1992</td>
</tr>
<tr>
<td>GTAP 3</td>
<td>1996</td>
<td>30</td>
<td>37</td>
<td>1992</td>
</tr>
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<td>GTAP 4</td>
<td>1998</td>
<td>45</td>
<td>50</td>
<td>1995</td>
</tr>
<tr>
<td>GTAP 5</td>
<td>2001</td>
<td>66</td>
<td>57</td>
<td>1997</td>
</tr>
<tr>
<td>GTAP 6</td>
<td>2005</td>
<td>87</td>
<td>57</td>
<td>2001</td>
</tr>
<tr>
<td>GTAP 7</td>
<td>2008</td>
<td>113</td>
<td>57</td>
<td>2004</td>
</tr>
</tbody>
</table>

How can you use GTAP Data?

- International Computable General Equilibrium Modeling: Some GTAP Applications
  - Global Trade Analysis: FTAs, PTAs, WTO, etc.
  - Poverty
  - Energy, Environment and climate change
  - Land Use and agricultural issues
  - Migration and labor issues
  - Growth and development
  - Factor movements and technology
How is GTAP Data Base constructed?

- Collect the I-O tables from contributors
- “Process” them
- Reconcile them with international datasets
- Assemble the data into a single consistent and balanced database

I-O Data

<table>
<thead>
<tr>
<th>Domestic inputs</th>
<th>Production</th>
<th>Final demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imported inputs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary factors</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data File Content

Construction Process
Clean, Disaggregate, Synthesize

• Clean
  – Remove small remaining problems with balance and sign.

• Disaggregate
  – Of the 113 regions in GTAP 7: only 35 I-O tables have all 57 sectors; no disaggregation needed
  – 40 tables need agricultural disaggregation; use agricultural I-O data set.
  – 17 tables need non-agricultural disaggregation; use representative table.

• Synthesize
  – Create 19 composite regions.

FIT: Updating and Reconciliation

• Eliminate changes in stocks
• Reconcile with international data sets
• Entropy theoretic approach
International Data Sets in GTAP

- agricultural data set
- macro data set
- trade data set
- Protection data set
- energy data set

Data Assembly

- FIT'ed I-O Tables
- Parameters
- Primary Factor Splits
- Income / Factor Taxes

Assemble

GTAP Data Base
Data Base Modification Tools

- Beginners: ViewHAR, GTAPAgg, FlexAgg
- GAMS users: HAR2GDX, GDX2HAR
- Advanced users:
  - SplitCom, MSplitcom—preserve the overall balance in the data while disaggregating the sectors using specified weights.
  - Altertax—tax rate/tariff changes while preserving the balance, using a specific GE closure with appropriate elasticities with least possible changes to other data

Main Data Construction Program

- one job with run time: 10 hours
- 215 data handling programs, 17k data files
- 22 top level modules: trade, energy, etc.
- with sub-modules: 38 modules total
- Make: build management tool to keep outputs up to date with inputs and programs
- error handling inbuilt
Formats and Software used

- initial data: HAR, GEMPACK text
- internal data: HAR
- data handling: TABLO
- text processing: Unix utilities
- miscellaneous: Bash, GAMS

GTAP Model

- Hertel (1997)
- Elasticities: calibrated/estimated econometrically
- Demand = Supply in all markets (price = marginal cost)
- Taxes: wedge between prod & cons prices
- Int’l trade: Armington CES substitution across sources
- Firm Production Inputs: intermediate & factors: Leontief
- Intermediate: imported/domestic: CES
- Factors: Labor, Capital, Land: CES
- Regional Household: Y=C+I+G+X-M: constant shares
- Private HHLG (C): CDE demand system: Hanoch (1975)
- Global savings (Fixed share of income, ROR): investment
- Welfare Decomposition: EV
Other GTAP Offerings

• GTAP Model and data extensions: Land use, agriculture, bio-fuels, dynamic, migration, climate change, poverty, imperfect competition
• Short courses
• Conferences
• Online resources
• Mailing list: GTAP-l
• Other models/utilities: GTAPinGAMS, FTAP, CRUSOE, etc.

An Illustration: the PE-GE model

• Tariff Variations at Disaggregate Level ➔ Tariff aggregation problems
• “False competition”
• So, disaggregated Partial Equilibrium (PE) models are used as inputs to negotiations. Is PE enough? What about welfare gains and economy-wide effects?
• We develop a GTAP PE-GE model with provisions to do tariff analysis at disaggregate level.
• Indian auto industry is a good example: heterogenous, divergent tariffs, contentious tariff cut proposals.
An Illustration: the PE-GE model

Model Summary
- CET and CES nests used to aggregate supply and demand, respectively; corresponding price linkages.
- Armington nest and CES nest between domestic and import demand: based on GTAP model.
- Market Clearing to determine Market Prices
- Transport Margins: Based on GTAP model
- Welfare Decomposition extended to the disaggregated level: AE and TOT Effects
- Slack Variables used to link GE and PE parts

Database
- GTAP Data Base version 6.2
- TASTE software for MacMAP HS6-level trade and tariff data, mapped to GTAP aggregation
- Tariff adjustments in GTAP to accommodate MacMAP: Altermac simulation
- Regions:
  - India (IND)
  - East and South East Asia (SEA)
  - Rest of the World (ROW)
An Illustration: the PE-GE model

Database (Contd…)

1. Food (food)
2. Sectors that supply Raw Materials to Auto (automs)
3. Energy (energy)
4. Auto (AUTO):
   a. Motor Cycles (MCYC)
   b. Motor Cycle Parts (MCYP)
   c. Automobiles other than motorcycles (ATML)
   d. Engines and other Parts of Automobiles (ATMP)
   e. Other Transport Equipment (OTHR)

The Database (Contd.)

<table>
<thead>
<tr>
<th>Reg.</th>
<th>SEA</th>
<th>ROW</th>
<th>SEA</th>
<th>ROW</th>
<th>SEA</th>
<th>ROW</th>
<th>SEA</th>
<th>ROW</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycle</td>
<td>59.70</td>
<td>48.16</td>
<td>0.00</td>
<td>0.00</td>
<td>0.06</td>
<td>0.01</td>
<td>0.78</td>
<td>0.22</td>
<td>1</td>
</tr>
<tr>
<td>Mcycle-parts</td>
<td>19.79</td>
<td>16.06</td>
<td>0.05</td>
<td>0.00</td>
<td>0.93</td>
<td>0.02</td>
<td>0.95</td>
<td>0.05</td>
<td>1</td>
</tr>
<tr>
<td>Automobiles</td>
<td>51.97</td>
<td>33.56</td>
<td>0.03</td>
<td>0.06</td>
<td>1.62</td>
<td>2.07</td>
<td>0.24</td>
<td>0.76</td>
<td>1</td>
</tr>
<tr>
<td>Engines and Auto Parts</td>
<td>19.80</td>
<td>16.06</td>
<td>0.59</td>
<td>0.21</td>
<td>11.74</td>
<td>3.31</td>
<td>0.62</td>
<td>0.38</td>
<td>1</td>
</tr>
<tr>
<td>Other Trans</td>
<td>12.86</td>
<td>7.93</td>
<td>0.33</td>
<td>0.73</td>
<td>4.22</td>
<td>5.79</td>
<td>0.21</td>
<td>0.79</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>1</td>
<td>18.56</td>
<td>11.20</td>
<td>0.37</td>
<td>0.63</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Database (Contd.)

• Some Inferences from the database:
  – Divergent tariffs: Highest for Automobiles, MCs
  – All tariffs for imports from SEA are higher than for those from ROW, most divergent for OtherTrans, Automobile, MC.
  – OtherTrans (ROW) and Engines&Parts (SEA) dominate India’s Auto imports
  – SEA’s share in India’s total imports is lower for AUTO than in MCs, MC parts and Engines&Parts

<table>
<thead>
<tr>
<th>PE Model</th>
<th>GE Model</th>
<th>PE-GE Model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exogenous:</strong></td>
<td>Changes in total output and demand in all sectors and regions.</td>
<td>Changes in endowment output, world price index for primary factors, distribution parameters for savings, government and private consumption and population.</td>
</tr>
</tbody>
</table>
| Changes in all price, tax and quantity variables for non-Auto sectors at i level. | Slack variables for consumer goods, endowments, income, profits, savings price and tradeables’ market clearing; All technical and tax change variables. | Slack variables for different prices, quantities and welfare-count-variables are exogenous for non-Auto sectors. All technical and tax change variables at i level, except $tma_n, tma_
u, tma_
u, tma_
u$ and $ams_n$ that are exogenous for non-Auto sectors. |
| Changes in import tax and import-augmented technical-change ($am_k$) variables at k-level. | Slack variable for tradeables market-clearing at k-level. | **Endogenous:** All other price, tax and quantity changes and slack variables. |
| Slack variable for tradeables market-clearing at k-level. | **Endogenous:** All other price and quantity changes and slack variables. | **Endogenous:** All other price, tax, technical and quantity changes and slack variables. |
### Results

**Imports from ROW**

<table>
<thead>
<tr>
<th>SSELECT Sectors</th>
<th>AUTO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PE-GE Model**

<table>
<thead>
<tr>
<th>Domestic Penetration</th>
<th>201.9</th>
<th>34.3</th>
<th>113.1</th>
<th>44.1</th>
<th>20.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution Effect</td>
<td>-16.0</td>
<td>-11.5</td>
<td>-13.5</td>
<td>-9.0</td>
<td>-5.4</td>
</tr>
<tr>
<td>Total Change in Imports (qcsk)</td>
<td>185.9</td>
<td>22.8</td>
<td>99.6</td>
<td>35.1</td>
<td>15.1</td>
</tr>
</tbody>
</table>

**PE Model**

<table>
<thead>
<tr>
<th>Domestic Penetration</th>
<th>156.5</th>
<th>19.5</th>
<th>85.0</th>
<th>27.3</th>
<th>52.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution Effect</td>
<td>-15.5</td>
<td>-9.5</td>
<td>-13.0</td>
<td>-8.5</td>
<td>-50.3</td>
</tr>
<tr>
<td>Total Change in Imports (qcsk)</td>
<td>141.0</td>
<td>10.0</td>
<td>72.0</td>
<td>18.8</td>
<td>1.9</td>
</tr>
</tbody>
</table>

### Results (Contd.)

**Imports from SEA**

<table>
<thead>
<tr>
<th>SSELECT Sectors</th>
<th>AUTO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PE-GE Model**

<table>
<thead>
<tr>
<th>Domestic Penetration</th>
<th>356.6</th>
<th>49.4</th>
<th>285.4</th>
<th>58.6</th>
<th>28.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution Effect</td>
<td>6.3</td>
<td>0.8</td>
<td>70.4</td>
<td>6.7</td>
<td>24.9</td>
</tr>
<tr>
<td>Total Change in Imports (qcsk)</td>
<td>362.9</td>
<td>50.2</td>
<td>355.8</td>
<td>65.2</td>
<td>53.4</td>
</tr>
</tbody>
</table>

**PE Model**

<table>
<thead>
<tr>
<th>Domestic Penetration</th>
<th>282.6</th>
<th>33.6</th>
<th>222.5</th>
<th>38.5</th>
<th>7.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substitution Effect</td>
<td>6.3</td>
<td>0.8</td>
<td>69.4</td>
<td>6.6</td>
<td>28.0</td>
</tr>
<tr>
<td>Total Change in Imports (qcsk)</td>
<td>288.9</td>
<td>34.4</td>
<td>291.9</td>
<td>45.1</td>
<td>35.5</td>
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</table>
Results (Contd.)

Results from Systematic Sensitivity Analysis

<table>
<thead>
<tr>
<th>Model</th>
<th>India’s Imports From ((q_{xsk})):</th>
<th>India’s Imports ((q_{ximk}))</th>
<th>Import Prices ((p_{ximk}))</th>
<th>Domestic Prices ((p_{xil}))</th>
<th>Market Prices ((p_{xmk}))</th>
<th>Import Prices From ((p_{msk})):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SEA</td>
<td>ROW</td>
<td>Lower Bound</td>
<td>Upper Bound</td>
<td>GE</td>
<td>PE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>67.3</td>
<td>72.5</td>
<td>76.7</td>
<td>49.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-12.9</td>
<td>-12.8</td>
<td>-12.4</td>
<td>-20.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-2.3</td>
<td>-0.5</td>
<td>-0.4</td>
<td>-12.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-16.3</td>
<td>-10.6</td>
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<td></td>
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</tr>
</tbody>
</table>

Results (Contd.)

Welfare: Aggregate Results

<table>
<thead>
<tr>
<th></th>
<th>Allocative Efficiency</th>
<th>Terms of Trade</th>
<th>Total Welfare Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GE</td>
<td>PE-GE</td>
<td>GE</td>
</tr>
<tr>
<td>SEA</td>
<td>4.7</td>
<td>(5.9, 10.4)</td>
<td>75.1</td>
</tr>
<tr>
<td>IND</td>
<td>11.3</td>
<td>(24.1, 27.7)</td>
<td>-96.2</td>
</tr>
<tr>
<td>ROW</td>
<td>15.9</td>
<td>(17.7, 23.2)</td>
<td>21.0</td>
</tr>
<tr>
<td>Total</td>
<td>31.9</td>
<td>(47.6, 61.3)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

32
Results (Contd.)

Welfare: Import-tax-related Results in Indian Auto Sector

<table>
<thead>
<tr>
<th>Sub-sector</th>
<th>Imports from SEA</th>
<th>Imports from ROW</th>
<th>IND Auto Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base Tariff</td>
<td>Import Change</td>
<td>Welfare Count</td>
</tr>
<tr>
<td>Motorcycles</td>
<td>59.7</td>
<td>2.8</td>
<td>0.6</td>
</tr>
<tr>
<td>MCycleparts</td>
<td>19.8</td>
<td>18.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Automobiles</td>
<td>52.0</td>
<td>85.9</td>
<td>17</td>
</tr>
<tr>
<td>EngineParts</td>
<td>19.8</td>
<td>300.3</td>
<td>27.6</td>
</tr>
<tr>
<td>OtherTrans</td>
<td>12.9</td>
<td>136.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Auto: PEGE</td>
<td>18.6</td>
<td>543.4</td>
<td>(52.4,56.1)</td>
</tr>
<tr>
<td>Auto: GE</td>
<td>18.6</td>
<td>595.2</td>
<td>50.7</td>
</tr>
</tbody>
</table>

Conclusions

• PE Model captures sub-sector info but ignores economy-wide impacts ➔ Huge price adjustments, little quantity changes!
• GE model ignores sub-sector-level details.
• PE-GE results: closer to GE, but quite different.
• Auto imports by India rise sharper in PE-GE
• Heavy influx of automobiles and Mcycles!
Conclusions (Contd…)

• “False Competition” in some sub-sectors
  ➔ Substitution from ROW to SEA: lesser extent in PE-GE, as SEA has a lower share in India’s AUTO imports, but not at SSECT level.
• Welfare differences are notable:
  – India’s net welfare loss is much lower in PE-GE
  – India loses more in TOT and gains more!
• Results not sensitive to assumed elasticities.