Illustrative analysis with GTAP-HS-TRQ modeling framework: USMCA expanded market access for U.S. dairy in Canada

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Objective

• Develop data base and CGE model to advance analysis of trade policies in dairy sectors
  • Construct GTAP-HS data: disaggregate output and trade in dairy products (mil) within the GTAP data base
  • Build GTAP-HS-TRQ model
    • Quantify impacts of trade policies at the detailed dairy commodity level, as well as other sectors and economy-wide impacts
    • Take into account tariff-rate quotas (TRQs)
  • Illustrate the value of this approach with analysis of expanded market access for US dairy commodities in Canada under USMCA
GTAP-HS database: key features

• GTAP 10p1 data base, reference year 2014

• Bilateral imports, protection rates, domestic production and demand for domestically produced commodities at the HS6 level within GTAP dairy products (mil) sector
  • FAOSTAT data on production, total country exports and imports (quantities, prices and values) of 23 dairy commodities at the country level
    • Other data sets to fill gaps in FAO data (Euromonitor International, OECD-FAO Agricultural Outlook)
    • Gap filling techniques
  • MACMAP data on HS6 bilateral trade values (CIF prices) and import tariff rates
  • MACMAP trade data and FAO production data use different classification systems (HS 2012 and CPC 2.1) => use intersection
    • MACMAP and FAO data are reconciled to match the GTAP data at the sectoral level

• In the final GTAP-HS data base
  • CGE level aggregation: 20 regions and 28 sectors, including mil
  • HS6 level: trade and domestic use of 9 commodities within GTAP sector “dairy products”
GTAP-HS model

• History of model development
  • Original concept was developed in Grant, Hertel, and Rutherford (2007)
  • Implemented in GTAP model (Narayanan et al. 2010)
  • Resynched with the latest code of the GTAP model (Aguiar et al. 2019)

• The general idea is that sectors of interest produce multiple commodities
  • Production sector definition follows the CGE model aggregation
  • Produced commodities and trade are defined at the HS6 level
    • In some cases, a more aggregate commodity categories (relative to the HS6 level) are used due to data limitations

• Implementation in CGE model
  • In production, an activity produces multiple commodities
  • In consumption, substitution among disaggregated commodities within aggregated commodity
  • Market clearing conditions
  • Price linkages
GTAP-HS-TRQ model

• Modify GTAP-HS model by incorporating structure that supports analysis of TRQ regimes
  • TRQ implementation builds on GTAP Technical paper 18 by Elbehri and Pearson (2005) and Beckman and Arita (2016)

• Collect additional data to support analysis of dairy trade at the detailed level
  • Tariff Analysis Online provided by WTO
  • Canada custom tariff schedule
  • Statistics Canada
  • Global Affairs Canada
  • USMCA Appendix 2: Tariff Schedule of Canada
Parameters at the HS6 level

• Specification of the GTAP-HS-TRQ model requires provision of selected supply and demand substitution elasticities at the detailed commodity level:
  
  • Elasticity of transformation between disaggregated commodities (milk, cheese, whey, etc.) supplied by an aggregate processed dairy sector (mil)
    
    -> Currently using value of “-2”; in parallel working on refining the supply response
  
  • Substitution between different import suppliers at the disaggregate level (e.g. bananas imported to U.S. from Ecuador, Costa Rica, Colombia, etc.)
    
    -> HS6 elasticity estimates provided by Fontagne et al. (2019) from CEPII. Trade weighted to match the dairy commodity classification of the GTAP-HS model
  
  • Substitution between domestic and imported commodities at the disaggregate level (e.g. domestic whey vs imported whey)
    
    -> Currently using half of the value of elasticity of substitution between import suppliers
Frequency density of HS6 elasticities

Note: Commodity and region-specific dairy trade elasticities are reported

Standard GTAP: 7.3
### Disaggregated dairy in the GTAP-HS-TRQ

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Description</th>
<th>HS6 codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>milknc</td>
<td>milk and cream, not concentrated nor containing added sugar or other sweetening matter</td>
<td>0401.10, 0401.20, 0401.40, 0401.50</td>
</tr>
<tr>
<td>milkconc</td>
<td>milk and cream, concentrated or containing added sugar or other sweetening matter</td>
<td>0402.10, 0402.21, 0402.29, 0402.91</td>
</tr>
<tr>
<td>milkoth</td>
<td>other milk and cream, concentrated or containing added sugar…</td>
<td>0402.99</td>
</tr>
<tr>
<td>butter</td>
<td>butter and other fats and oils derived from milk; dairy spreads</td>
<td>0405.10, 0405.90, 0405.20, 0404.90</td>
</tr>
<tr>
<td>cheese</td>
<td>cheese and curd</td>
<td>0406.10, 0406.20, 0406.30, 0406.40, 0406.90</td>
</tr>
<tr>
<td>yogurt</td>
<td>yogurt</td>
<td>0403.10</td>
</tr>
<tr>
<td>buttermilk</td>
<td>buttermilk and powdered buttermilk</td>
<td>0403.90</td>
</tr>
<tr>
<td>whey</td>
<td>whey and modified whey</td>
<td>0404.10</td>
</tr>
<tr>
<td>icecream</td>
<td>Ice cream</td>
<td>2105.00</td>
</tr>
</tbody>
</table>
Structure of output of U.S. dairy sector

- **Cheese**: 34%
- **Milknc**: 30%
- **Icecream**: 9%
- **Yoghurt**: 7%
- **Milkconc**: 6%
- **Milkoth**: 5%
- **Butter**: 4%
- **Whey**: 4%
- **Buttermilk**: 0.4%

Total output: 117 billion USD

Cheese and milknc together represent 64% of the value of output.
Structure of U.S. dairy exports

- **Milkconc**: 40%
- **Cheese**: 28%
- **Whey**: 14%
- **Butter**: 11%
- **Icecream**: 3%
- **Buttermilk**: 1%
- **Yoghurt**: 1%
- **Milkoth**: 0.3%

Total U.S. exports: 6 billion USD

Milkconc, cheese, whey and dairyoth together represent 93% of value of exports.
U.S. exports of cheese, dairyoth, milkconc and whey by destination (93% of total dairy exports)
U.S. exports of milknc, milkoth, buttermilk, yoghurt and icecream by destination (7% of total dairy exports)
Structure of U.S. imports of dairy products

Total U.S. dairy imports 2.4 billion USD

- Cheese: 64%
- Butter: 18%
- Ice cream: 6%
- Milk concentrate: 3%
- Yoghurt: 3%
- Milk: 2%
- Whey: 2%
- Milknc: 1%
- Buttermilk: 0.22%
Structure of Canadian dairy sector output

- Milknc: 40.4%
- Milkoth: 0.5%
- Milkconc: 6.1%
- Whey: 1.4%
- Yoghurt: 11.5%
- Icecream: 9.5%
- Butter: 9.7%
- Cheese: 20.6%
- Buttermilk: 0.5%

Total output: 15 billion USD
Structure of Canadian dairy exports

- icecream: 13%
- yoghurt: 9%
- whey: 16%
- milkoth: 1%
- milknc: 2%
- buttermilk: 2%
- milkconc: 26%
- cheese: 19%
- butter: 12%

Total exports 0.3 billion USD, 2% of output
Canadian exports of dairy by commodity and source
Structure of dairy imports in Canada

- Total imports 0.6 billion USD
- Imports are twice larger than exports

<table>
<thead>
<tr>
<th>Product</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>cheese</td>
<td>53.7%</td>
</tr>
<tr>
<td>milk</td>
<td>49.8%</td>
</tr>
<tr>
<td>yoghurt</td>
<td>0.5%</td>
</tr>
<tr>
<td>whey</td>
<td>17.3%</td>
</tr>
<tr>
<td>milknc</td>
<td>4.9%</td>
</tr>
<tr>
<td>milkconc</td>
<td>4.1%</td>
</tr>
<tr>
<td>butter</td>
<td>13.4%</td>
</tr>
<tr>
<td>icecream</td>
<td>5.3%</td>
</tr>
<tr>
<td>buttermilk</td>
<td>0.7%</td>
</tr>
</tbody>
</table>
Tariff-rate quotas

- Tariff-rate quotas (TRQs) are two-tiered tariffs characterized by a low tariff applied to a fixed amount of imports (the tariff quota) and usually a much higher tariff applied to out-of-quota imports.
- TRQs are pervasive in international dairy trade.
- US dairy exports to Canada are subject to TRQs.
- USMCA expands market access (quota) for US dairy commodities in Canada.
<table>
<thead>
<tr>
<th>Comm. in the model</th>
<th>HS-6 codes</th>
<th>Info</th>
<th>WTO within access commitment, MT</th>
<th>WTO in-quota tariff</th>
<th>WTO out-of-quota tariff</th>
<th>U.S. tariff-free access under NAFTA, MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>milknc</td>
<td>0401.10</td>
<td>fat≤1%</td>
<td>64,500</td>
<td>7.5%</td>
<td>241.3%</td>
<td>64,500</td>
</tr>
<tr>
<td></td>
<td>0401.20</td>
<td>1%&lt;fat≤6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0401.40</td>
<td>fat 6-10%</td>
<td>394</td>
<td>7.5%</td>
<td>292.5%</td>
<td>394</td>
</tr>
<tr>
<td></td>
<td>0401.50</td>
<td>fat =&gt;10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>milkconc</td>
<td>0402.10</td>
<td>fat≤1.5%</td>
<td>0</td>
<td>3.32c/kg</td>
<td>201.5%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0402.21</td>
<td>fat&gt;1.5%, n.s.</td>
<td>0</td>
<td>3.32c/kg</td>
<td>243%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0402.29</td>
<td>fat&gt;1.5%, other</td>
<td>0</td>
<td>3.32c/kg</td>
<td>243%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0402.91</td>
<td>evaporated</td>
<td>11.7 for Australia</td>
<td>2.84c/kg</td>
<td>259%</td>
<td>0</td>
</tr>
<tr>
<td>milkoth</td>
<td>0402.99</td>
<td>condensed</td>
<td>11.7 for Australia</td>
<td>2.84c/kg</td>
<td>259%</td>
<td>0</td>
</tr>
<tr>
<td>butter</td>
<td>0405.10</td>
<td>butter</td>
<td>3274, of which 2000 reserved for New Zealand</td>
<td>11.38c/kg</td>
<td>298.5%</td>
<td>1,274</td>
</tr>
<tr>
<td></td>
<td>0405.90</td>
<td>other</td>
<td>3274, of which 2000 reserved for New Zealand</td>
<td>7.5%</td>
<td>313.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0405.20</td>
<td>dairy spreads</td>
<td>4,345</td>
<td>3%</td>
<td>270%</td>
<td>4,345</td>
</tr>
<tr>
<td></td>
<td>0404.90</td>
<td>blend. dairy powder</td>
<td>4,345</td>
<td>3%</td>
<td>270%</td>
<td>4,345</td>
</tr>
<tr>
<td>Comm. in the model</td>
<td>HS-6 codes</td>
<td>Info</td>
<td>WTO within access commitment, MT</td>
<td>WTO in-quota tariff</td>
<td>WTO out-of-quota tariff</td>
<td>U.S. tariff-free access under NAFTA, MT</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------</td>
<td>-----------------------</td>
<td>---------------------------------</td>
<td>---------------------</td>
<td>-------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>cheese</td>
<td>0406.10</td>
<td>fresh</td>
<td>20412 with 66% is allocated to EU, leaving 6940 for other countries</td>
<td>3.32c/kg</td>
<td>245.6%</td>
<td>6940</td>
</tr>
<tr>
<td></td>
<td>0406.20</td>
<td>grated and powd.</td>
<td></td>
<td>2.84c/kg</td>
<td>245.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0406.30</td>
<td>other processed</td>
<td></td>
<td>3.32c/kg</td>
<td>245.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0406.40</td>
<td>veined</td>
<td></td>
<td>3.32c/kg</td>
<td>245.5%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0406.90</td>
<td>other cheese</td>
<td></td>
<td>2.84-3.32¢/kg</td>
<td>245.5%</td>
<td></td>
</tr>
<tr>
<td>yogurt</td>
<td>0402.10</td>
<td>yogurt</td>
<td>332</td>
<td>6.5%</td>
<td>237.5%</td>
<td>332</td>
</tr>
<tr>
<td>buttermilk</td>
<td>0403.90</td>
<td>buttermilk and powdered buttermilk</td>
<td>908 for New Zealand</td>
<td>3.32c/kg</td>
<td>208%</td>
<td>0</td>
</tr>
<tr>
<td>whey</td>
<td>0404.10</td>
<td>whey and modified whey</td>
<td></td>
<td>3.32c/kg</td>
<td>208%</td>
<td>3198</td>
</tr>
<tr>
<td>icecream</td>
<td>2105.00</td>
<td>ice cream</td>
<td>484</td>
<td>6.7%</td>
<td>277%</td>
<td>484</td>
</tr>
</tbody>
</table>
## U.S. dairy exports to Canada: commodities with zero applied import tariff

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Trade volume, MT</th>
<th>Current tariff-free access, MT</th>
<th>Import tariff, %</th>
<th>Canada suppl. imports (all partners)</th>
<th>Additional access under USMCA, MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>milknc</td>
<td>55,098</td>
<td>64,894</td>
<td>0</td>
<td>yes</td>
<td>68,855</td>
</tr>
<tr>
<td>butter</td>
<td>6,403</td>
<td>5,619</td>
<td>0</td>
<td>yes</td>
<td>7,119</td>
</tr>
<tr>
<td>cheese</td>
<td>8,398</td>
<td>6,940</td>
<td>0</td>
<td>yes</td>
<td>14,226</td>
</tr>
<tr>
<td>yogurt</td>
<td>794</td>
<td>332</td>
<td>0</td>
<td>yes</td>
<td>4,537</td>
</tr>
<tr>
<td>whey</td>
<td>52,823</td>
<td>3,198</td>
<td>0</td>
<td>yes</td>
<td>4,303*</td>
</tr>
<tr>
<td>whey powder</td>
<td>3,577</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>icecream</td>
<td>4,629</td>
<td>484</td>
<td>0</td>
<td>yes</td>
<td>785</td>
</tr>
<tr>
<td>Ice cream</td>
<td>660</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*After year 10, this TRQ will be eliminated.
## U.S. dairy exports to Canada: commodities with high applied tariff

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Volume, MT</th>
<th>Current tariff-free access, MT</th>
<th>Import tariff, %</th>
<th>Additional access under USMCA, MT</th>
</tr>
</thead>
<tbody>
<tr>
<td>milkconc</td>
<td>8003</td>
<td>0</td>
<td>191</td>
<td>11,973</td>
</tr>
<tr>
<td>milkoth</td>
<td>47</td>
<td>0</td>
<td>242</td>
<td>61</td>
</tr>
<tr>
<td>buttermilk</td>
<td>133</td>
<td>0</td>
<td>201</td>
<td>761</td>
</tr>
</tbody>
</table>
U.S. dairy imports in Canada and TRQ regimes

\[ P_d = P_w (1 + T_{out}) \]

\[ P_d = P_w (1 + T_{in}) \]

\[ T_{in} = 0 \]

Imports

Price

Import demand

At quota

Over quota

Quota

Imports

Over quota

In quota

milknc

whey

cheese

icecream

yogurt

milkoth

buttermilk

milkconc
How to implement these TRQs in the model?

• Only one of nine commodities falls into one of the three TRQ regimes
  • milknc is in quota
  • whey, butter, cheese, icecream and yogurt are above quota, but imported with zero tariff under supplementary imports authorized by Canada Minister
  • Quota is zero for milkoth, buttermilk and milkconc for U.S. exporters
    • Modeling complication: percent change applied to zero is zero

• Canadian Minister may, at his discretion, authorize imports of dairy products apart from the import access quantity, particularly if he/she judges that the importation of these products is required to meet Canadian market needs (Global Affairs Canada)

• Economic model equipped with TRQs may not be ideal/sufficient to model U.S.-Canada dairy trade

• Modelling effects of uncertainty in supply and demand on trade flows and production may be more appropriate
Illustration with GTAP-HS-TRQ model: expansion of market access for U.S. dairy in Canada

- Commodities with currently zero quota and high actual (observed) import tariff (milkoth, buttermilk, milkconc)
  - Assume “at quota” regime
    - Quota equals to observed trade volume
    - Actual tariff is less than “out-of-quota” tariff
    - No change to GTAP-HS database is required

- “In quota” milknc
  - Assume “at quota” regime
    - Justification: experts suggest that quota is filled for this commodity by Canadian households purchases of U.S. milk on U.S. territory and bringing them into Canada
    - Using Altertax, modify initial GTAP-HS data base by incorporating half of out-of-quota tariff to create “at quota” case

- Over quota commodities with zero tariff due to supplemental imports (whey, butter, cheese, icecream, yogurt)
  - Assume they are in “over quota” regime
    - Justification: potential hidden rents
    - Using Altertax, modify initial GTAP-HS data base by incorporating out-of-quota tariff to create “over quota” case
## Results: TRQ regimes, import tariffs and quantities

<table>
<thead>
<tr>
<th>Dairy product</th>
<th>Actual import tariff, power*</th>
<th>Base import tariff, power**</th>
<th>Base TRQ regime</th>
<th>Increase in quota, %</th>
<th>Policy TRQ regime</th>
<th>Policy import tariff, % change in power</th>
<th>Policy import quantity, % change</th>
</tr>
</thead>
<tbody>
<tr>
<td>buttermilk</td>
<td>3.014</td>
<td>3.014</td>
<td>at quota</td>
<td>572</td>
<td>at quota</td>
<td>-34</td>
<td>572</td>
</tr>
<tr>
<td>milkoth</td>
<td>3.420</td>
<td>3.420</td>
<td>at quota</td>
<td>130</td>
<td>at quota</td>
<td>-18</td>
<td>130</td>
</tr>
<tr>
<td>milkconc</td>
<td>2.912</td>
<td>2.912</td>
<td>at quota</td>
<td>150</td>
<td>at quota</td>
<td>-27</td>
<td>150</td>
</tr>
<tr>
<td>milknc</td>
<td>1.000</td>
<td>1.708</td>
<td>at quota</td>
<td>206</td>
<td>at quota</td>
<td>-19</td>
<td>206</td>
</tr>
<tr>
<td>butter</td>
<td>1.000</td>
<td>3.700</td>
<td>above quota</td>
<td>111</td>
<td>at quota</td>
<td>-18</td>
<td>85</td>
</tr>
<tr>
<td>cheese</td>
<td>1.000</td>
<td>3.455</td>
<td>above quota</td>
<td>205</td>
<td>at quota</td>
<td>-15</td>
<td>152</td>
</tr>
<tr>
<td>yogurt</td>
<td>1.000</td>
<td>3.375</td>
<td>above quota</td>
<td>1367</td>
<td>at quota</td>
<td>-37</td>
<td>516</td>
</tr>
<tr>
<td>whey</td>
<td>1.000</td>
<td>1.120</td>
<td>above quota</td>
<td>9</td>
<td>at quota</td>
<td>-5</td>
<td>8</td>
</tr>
<tr>
<td>icecream</td>
<td>1.000</td>
<td>1.404</td>
<td>above quota</td>
<td>23</td>
<td>at quota</td>
<td>-2</td>
<td>18</td>
</tr>
</tbody>
</table>

*Power of import tariff in the initial GTAP-HS data base

**Power of import tariff in the altered GTAP-HS data base

Nota, increase in market access is modeled using altered GTAP-HS data base
Results: prices, output and trade in Canada

Change in quota and resulted changes in trade flows, % change

Impacts on Canadian dairy markets, % change
Results: prices, output and trade in United States

<table>
<thead>
<tr>
<th>Aggr. dairy</th>
<th>U.S.</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output, %</td>
<td>0.1</td>
<td>-1.5</td>
</tr>
<tr>
<td>Price, %</td>
<td>0.0</td>
<td>-0.1</td>
</tr>
</tbody>
</table>
Impacts of the expanded market access for U.S. dairy in Canada

- Increase in traded quantity and reduction in actual import tariff for all U.S. dairy commodities imported by Canada
- Change from “above quota” to “at quota” regime for cheese, yogurt, whey, ice cream, and butter
- No change in “at quota” regime for all milk and cream (milknc, milkconc, milkoth) and buttermilk
- Small reduction (increase) in price and output of aggregated dairy in Canada (U.S.)
- Noticeable changes for some of the disaggregated commodities
  - 8% reduction in buttermilk output in Canada
  - Six-fold increase in exports of U.S. yogurt to Canada
- Increase in total quota rents for each dairy commodity, except whey
Summary

• Developed GTAP-HS-TRQ framework allows for analysis of tariff rate quotas at detailed commodity level
  • Exogenous changes in market access and in and over quota tariffs
  • Endogenous changes in trade flows, import tariffs and quota rents

• Analysis of expanded market access for U.S. dairy in Canada under USMCA is complicated
  • Supplementary imports by Canada that fluctuate from year to year; they result in above quota trade flows with zero tariff

• To demonstrate modeling with GTAP-HS-TRQ, we made assumptions
  • Initial quota
  • Modify GTAP-HS data base by introducing import tariff in cases with above quota trade flows but zero tariffs

• Under the assumptions, expanded market access results in increase in U.S. dairy exports to Canada, change in regime from “above quota” to “at quota” for five of nine dairy commodities, reduction in actual import tariffs on all U.S. dairy, but does not result in tariff free access for any of the U.S. dairy commodities
Selected references


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