Agricultural trade liberalization in a world of uncertainty: a CGE model

by

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CGE and agricultural trade liberalization

- CGE good to take care of sectoral interactions
- Easy to make use of (thanks to GAMS/GTAP!)
- Yet dangerous!
- be careful not to confuse model and reality!

Such confusions occurred when evaluating benefits from agricultural trade liberalisation
The problem of agricultural trade liberalization

• **Agriculture disconnected from market since Roosevelt**
  – Concern with food security issues
  – Ezekiel analysis of price instability

• **Reinserted into WTO negotiations in Marrakech**
  – "Farm problem" (Olson, Gardner) issues
  – Overproduction problems in developed countries
  – Large efficiency gains expected from comparative advantages

• **CGE models played a role in evaluating change**
  – Gains significant, but less than expected
  – Stability issues neglected
Why is stability important in agriculture?

- **Large efficiency gains may be expected from stabilized prices**
  - Farmers (and bankers) are risk averse
  - Risk premium are inefficient

- **Neglecting instability may underestimate benefits from liberalisation**
  - Mutualising losses may have an insurance effect, and decrease climate induced price fluctuations (Bale and Lutz)

- **Neglecting instability may overestimate benefits from liberalisation**
  - If genuine market instability always keeps prices away of equilibrium
Now, CGE's ignore instability!

- They fail to take account of the facts at the origin of price intervention in agriculture, and thus, of the very problem they are addressing.
- They thus may under- or over-estimate benefits from liberalisation, and misguide political bodies.

But how can we introduce risk and instability into a CGE model?
Three key points in modelling risk and instability in CGE's

- First order conditions in presence of risk
- The possible local instability of market equilibriums
- How is capital allocated to sectors?
First order conditions in presence of risk:

- Neglecting risk leads to the standard first order condition:
  \[ \hat{p}_j \frac{\partial q_j}{\partial x_i} = p_i \]
  \( q_j \): quantity of output j; \( p_i \): equilibrium price of input i; \( \hat{p}_j \): expected price of output j
  \( x_i \): quantity of input i

- Introducing risk gives:
  \[ \tilde{p}_j \frac{\partial q_j}{\partial x_i} = p_i \]
  \( \tilde{p}_j \): Certainty equivalent of expected price \( \hat{p}_j \)

Under standard Markowitz utility function,

\[ \tilde{p}_j = \hat{p}_j - A \hat{\sigma}_j^2 q_j \]

- This is easy to put in a CGE model!
Modelling instability

• Sources of instability

• Exogenous: No problems...

• Endogenous:
  – Lags in delivery
    [while standard CGE's assume consumption and production are simultaneous]
  – Imperfect expectations
    [while standard CGE's assume expectations are not only rational but also perfect]
  – Poorly elastic demand
    [how are demand elasticities in most models ?]

• The road to explosive cobwebs
  [but risk as a return string]
How is capital allocated to sectors?

- The third component: Non shiftable capital
  - If capital is sector specific, savings must be allocated between sectors
  - Then, a classical Markowitz model makes the trick: In a separate module, households choose $z$ to maximize:

  \[ U = \sum_{k} \hat{\pi}_k z_k - A \hat{\sigma}^2_k z_k^2 \]

  with:
  - $\hat{\pi}_k$: Expected profitability of capital in sector $k$
  - $\hat{\sigma}_k$: Expected variance of profitability in $k$
  - $z_k$: share of savings invested in sector $k$
  - $A$: risk aversion coefficient of household

- Clearly, risk matters again
These ideas have been implemented in a large model in progress

- A GTAP model

- Two versions: Standard CGE, Incertitude

- World aggregations: 3 regions / 10 sectors, 12 regions / 10 sectors

- 6 sectors related to agriculture
Model presentation

- main characteristics shared by the 2 versions:
  - economy wide model, world coverage
  - recursive dynamic
  - production function: CES of CI (aggregate intermediate consumption) and VA (aggregated added value)
  - consumption: linear expenditure system
  - international trade: armington, bilateral flow
  - GTAP parameters, parametric difference between regions
  - Endogenous volume and prices for goods and factors
  - closure: Investment = Savings, endogenous trade balance
The 10 Sectors

1. Paddy
2. Grains: Wheat, others cereal grains
3. Autres cultures: Vegetables-fruits-nuts, oil seeds, sugar cane-sugar beet, plant-based fibers, others crops
4. Productions animales: Bovine cattle-sheep-goats-horses, other animal products, raw milk, wool, silk worm cocoons, fishing
5. Sylviculture: Forestry
6. Industries agro-alimentaires (9 secteurs GTAP)
7. Industries du bois
8. Manufactures (15 secteurs GTAP)
9. Energie et ressources naturelles (7 secteurs GTAP)
10. Services (4 secteurs GTAP)
Other features

five production factors:
• Land: used only by agricultural sectors, perfect mobility, flexible prices
• Natural resources: used only by forestry and energy-resources sectors, perfect mobility, flexible prices
• Highly qualified workers: mobility inside aggregated sectors, rigid wages
• Low qualified workers: mobility inside aggregated sectors, flexible wages
• Capital: sector specific, flexible prices

2 types of households: Middle-Rich / Middle-Poor

2 modules:
  Real: physical flows of products
  Financial: investment decision
  consumption and production decision
Preliminary results

Gains associated with trade liberalization in the standard version

Losses associated with trade liberalization in the version considering risk and uncertainty
Research agenda and conclusion

In progress:
Calibrating, performing sensitivity analysis and validating on real data the reference scenario.

Improving capital module: endogenous exchange and interest rates

But we can be sure of:

- Liberalization gains may be considerably reduced by uncertainty
- Necessity to define market friendly intervention, which may prevent crisis
An example:

Price (constant 1998 $) and production of US wheat 1840-2000
The agricultural exception

Tomatoes retail price index in large American cities, as compared to new car retail price index

Source: Economagic.com