Estimating Macro and Micro Armington Elasticities among Agricultural Products

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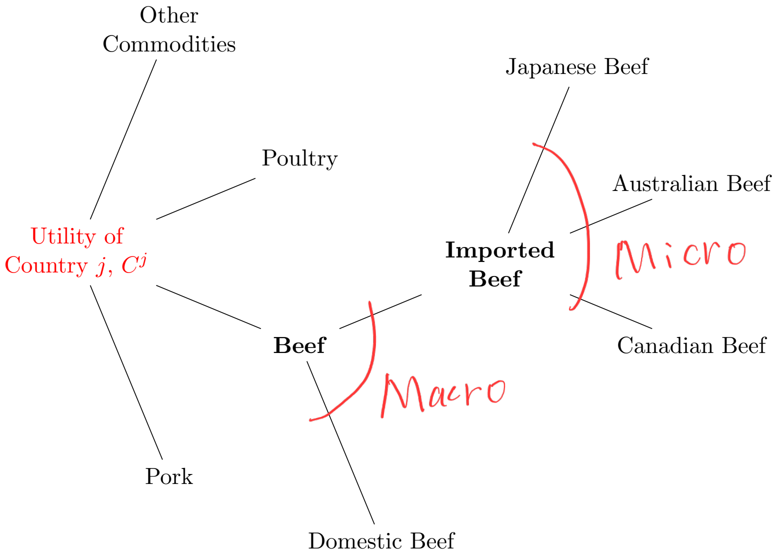
Motivation

1. Armington elasticities are key to understand the effects of price (or tariff) change on trade
    - ex. How does Japanese import of beef change if the import tariff reduced from 38.5% to 9% in 2033 after joining CPTPP? (macro-elasticity)
    - ex. How does Chinese import from U.S. change if tariff of soybeans from U.S. increase by 1%? (micro-elasticity)
2. They are used in quantifying the welfare gain/loss due to trade policy change (Bouet et al. , 2005) (Fajgelbaum et al., 2020).

An Armington Model Setup (Feenstra et. al. 2018)



Previous Studies

1. Agricultural Trade
   - Used more flexible demand models, such as AIDS and Rotterdam models. (Alston et al., 1990; Moschini, Moro and Green, 1994; Davis and Kruse, 1993; Davis and Jesen, 1994)
   - Usually focused on specific commodities in a specific domestic market or from a specific origin.
2. International Trade
   - Use the demand system to estimate multiple trade elasticites with highly disaggregated data. (Feenstra, 1994; Feenstra et al 2018; Soderbery, 2015; 2018)
   - Use gravity like models to estimate sector-level (Caliendo and Parro, 2014), or product level elasticities. (Hertel et. al., 2004;Fontagne et. al., 2021)
   - Short and long-run elasticities (Gallaway et.al. 2003; Boehm et. al., 2021)

Contributions

- We estimate Armington elasticities of multiple (38) agricultural commodities.
- We estimate both micro- and macro-elasticities at commodity level simultaneously using global production and trade data.

Endogeneity of Prices

- We do not observe canonically defined prices, we use unit values instead in the model.
- Traditionally unit values do not correct for variety change. (Feenstra 1994; Feenstra et. al., 2018)

Estimate Micro and Macro System (Feenstra et. al., 2018)

- Endogeneity is handled by adding a supply side.
- Run Non-linear Least Square of stacked equations.

$$\overline{Y}_g^{iF} = \sum_{n=1}^{2} \theta_{ng} \overline{X}_{ng}^{ij} + \sum_{n=3}^{4} (\omega_g - 1)\theta_{ng} \overline{X}_{ng}^{ij} + (\omega_g - 1)^2 \theta_{5g} \overline{X}_{5g}^{j} + \overline{\mu}_g^{ij} \tag{1}$$

$$\left[\Delta \ln \frac{UV^{ij}}{UV^{Fj}}\right]^2$$

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$$\overline{Y}_g^{Fj} = \phi_1 \overline{X}_{1g}^{Fj} + \phi_1 \overline{X}_{2g}^{Fj} + \overline{\mu}_g^{Fj} \tag{2}$$

where $\theta_{1g} = \frac{\rho_{1g}}{(\sigma_g - 1)^2(1-\rho_{1g})}, \theta_{2g} = \frac{2\rho_{1g}-1}{(\sigma_g-1)(1-\rho_{1g})}, \theta_{3g} = \frac{-(1+\rho_{2g}-2\rho_{1g})}{(\sigma_g-1)(1-\rho_{1g})}, \theta_{4g} = \frac{-(\rho_{2g}-2\rho_{1g})}{(\sigma_g-1)^2(1-\rho_{1g})}, \theta_{5g} = \frac{-(\rho_{2g}-\rho_{1g})}{(\sigma_g-1)^2(1-\rho_{1g})}$, and $\phi_1 = \frac{\rho_F}{(\omega-1)^2(1-\rho^F)}$, $\phi_2 = \frac{2\rho_F - 1}{(\omega-1)(1-\rho^F)}$.

Data

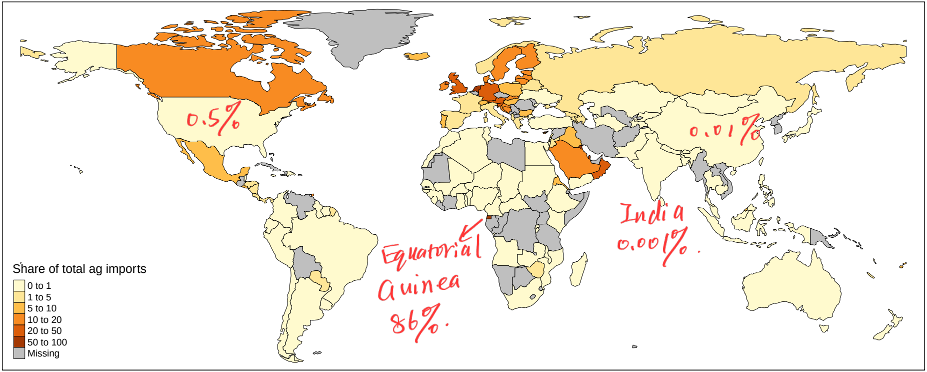
- Two data sources
  1. Bilateral Trade flows of agricultural commodities between the world and US were obtained from UN Comtrade Database. Exporter reported data.
  2. FAO STAT: domestic production and producer prices
- 38 agricultural products in 5 categories were finally matched in FAO sample. 118 importing countries.
- Time span: 1998-2017
- Measurement of domestic supply.

$$TotalSupply = \underbrace{(Production - Export)}_{\text{share of home supply}} + Import$$

Thirty-eight Commodities in the Sample

Meats	Crops	Fresh Fruit	Fresh Veg.	Tree Nuts
Meat, beef	Cotton	Apples	Carrots/turnips	Almonds
Meat, pork	Corn	Berries	Cauliflower/broccoli	Pistachios
Meat, poultry	Rice	Cherries	Lettuce	Walnuts
	Sorghum	Grapefruit	Onions	
	Wheat	Grapes	Peppers	
	Peanuts	Lemons	Potatoes	
	Soybeans	Melons	Sweet Potatoes	
	Beans	Oranges	Tomatoes	
	Chick peas	Peaches		
	Lentils	Pear		
	Peas	Strawberries		
	Tobacco			

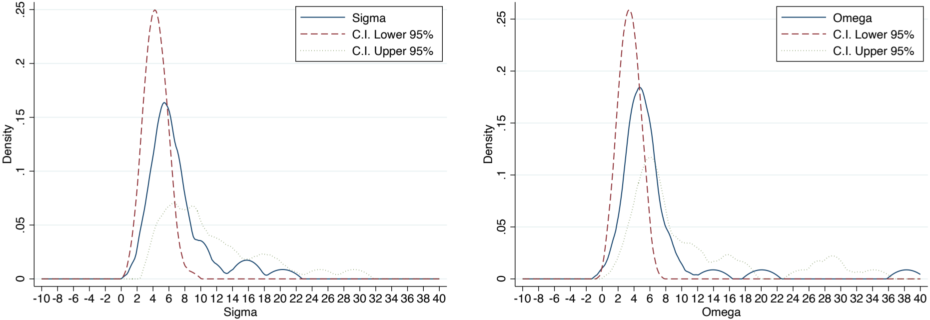
A Hundred and Eighteen Countries in the Sample



Estimation Strategy

- We follow Feenstra et. al. (2018) and run a simultaneous equation model of micro and macro systems.
- We run the NLS with parameters of elasticities substituted in.

Distribution of Micro- and Macro-Elasticities



Note: The figure displays the distribution of elasticities over commodities. The median of the micro-elasticities is 6.39. The median of macro- elasticities is 4.99. We reject macro is one half of micro.

Comparison of Micro-elasticities with Fontagne (2021)

Category	Products	This Study	CEPII	Difference
Meats	Pork	4.2	15.8	274%
	Poultry	5.0	4.2	-16%
Crops	Corn	4.4	4.6	6%
	Cotton	15.9	13.7	-14%
	Peanuts	90.3	7.2	-92%
	Rice	3.2	7.5	135%
	Sorghum	6.7	5.0	-25%
	Soybeans	5.3	7.2	36%
	Wheat	4.1	3.6	-12%
Fresh Fruit	Apples	6.9	5.3	-23%
	Berries	5.8	12.8	121%
	Cherries	11.6	38.5	233%
	Grapefruit	8.9	20.7	132%
	Grapes	8.9	6.9	-23%
	Melons	6.5	14.8	126%
	Peaches	5.4	9.0	68%
	Pear	7.2	5.9	-18%
	Strawberries	6.1	5.0	-18%
Fresh Veg.	Carrots & turnips	6.4	10.5	64%
	Lettuce	4.4	7.9	79%
	Onions	5.5	3.6	-35%
	Peppers	5.5	6.8	23%
	Potatoes	5.9	3.7	-37%
	Sweet Potatoes	3.3	7.0	113%
	Tomatoes	6.7	5.3	-21%
Tree Nuts	Walnuts	6.6	12.1	84%

Policy Implications: Effects of Tariff Change

- We predict additional 25% increase in tariff will decrease Chinese imports of US soybean by 73%
- In 2018, actual US exports of soybean to China amounted to \$3.1 billion, compared to \$12.2 billion in the previous year, a dropped by 75% worth of value , which is not far from our coarse prediction of 73%!

Conclusion

- Feenstra's framework performs well for agricultural products even though we are not using as highly disaggregated data as previous studies.
- Our estimates of Armington elasticities is consistent with facts.
- We find previous studies using gravity model tend to report larger estimates of micro-elasticities.