UNIVERSITÀ DEGLI STUDI DI MILANO
FACOLTÀ DI AGRARIA

The sensitivity of trade flows to trade barriers

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Research Objective

- To provide estimates of the elasticity of substitution on 18 food sectors using four estimation techniques:
  - OLS
  - Heckman-two stage procedure
  - Eaton-Tamura Tobit model
  - Poisson Pseudo Maximum-Likelihood

- To give dimension to trade flow sensitivity, simulating the effect of a full trade liberalization scenario.

Main Finding

- Strong variation in the elasticity of substitution across procedures and products
  - the estimated values across product and methods range from 1.5 to 14, with a **median** value of 3.48
  - elasticity Rank **across methods:** $\sigma_{PPML} > \sigma_{HEKIT} > \sigma_{OLS}$
- Trade liberalization strongly increases food exports
  - especially from emerging and developing countries.

Outline

- Motivation and previous evidence
- Gravity model, elasticity and simulation
- Estimation methods and Data
- Empirical results
- Simulation results
- Conclusions

Motivation and Previous Evidence

- Renewed interest in the use of gravity equations to explain bilateral trade flows
  - Theoretical foundation (Anderson and vanWincoop, 2004)
  - Identification of import substitution elasticity (Lai and Zhu, 2004; Lai and Trefler, 2004; Bergstrand et al. 2007)
  - Estimate of gains from trade liberalization (Lai and Zhu, 2004; Lai and Trefler, 2004; Ghazalian et al., 2007)
- Some problems
  - Zero in the trade matrix (Helpman et al. 2008)
  - Controversy over the correct estimation method (Schaefer et al. 2008, Santos Silva and Tenreyro 2008)

Gravity Model and Substitution Elasticity

- Standard CES monopolistic competition trade model (Krugman, 1980; Feenstra, 2002)
  - theoretical importance in the trade literature
  - clear-cut empirical predictions about relationship between trade costs and bilateral trade flows.
- We Follow Lai and Zhu (2004), Lai and Trefler (2004)
  - They add a rich set of international asymmetries and differences in production costs **to identify the elasticiy of substitution**

Gravity Model and Substitution Elasticity

- The bilateral trade equation from *j* to *i* (M_{ij}) is
- $$\ln M_{ij} = \beta_0 + \lambda_j + \chi_i + (1-\sigma)\gamma \ln D_{ij} + (1-\sigma)\ln \tau_{ij} + u_{ij}$$
  - λ_j and χ_i are the **fixed effects** capturing the unobserved number of varieties and the price term of *j* (exporter), and the expenditure and the unobserved price term of *i* (importer): equivalent to MTR index of Anderson and vanWincoop
  - In our specific (single product) setting fixed effects also capture across-countries differences in production costs
  - D_{ij} is the **transport costs** (proxy by distance between *j* and *i*)
  - τ_{ij} is the ad-valorem **bilateral tariff**
- Then the elasticiy of substitution σ is:

$$\beta_2 = (1-\sigma) \rightarrow \sigma = 1-\beta_2$$

Gravity Model and Simulation

- The simulation is based on a trade costs shock (tariff removal)
- This shock induces two effects:
  - A **direct** trade impact through the trade costs function.
  - An **indirect** trade impact through the multilateral resistance terms.

• Our simulation is based on a **fixed effect** model, so MTR are not identified. Thus we are forced to measure **only** the direct (first order) effect.

• Formally, the first order condition is:

$$\frac{d\ln M_{ij}}{d\ln \tau_{ij}} = \beta_2 + \frac{d\Pi_j}{d\ln \tau_{ij}} + \frac{dP_i}{d\ln \tau_{ij}}$$

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Estimation Methods

- The OLS estimation equation (for $M_{ij}>0$) represents our benchmark
  - But when taking logs, 'zero' observations are dropped from the sample, because log(0) is undefined.
  - at disaggregated level, as in this paper, the issue is severe: i.e. we loose from 60 to 77% of the information

- Three main approaches recently proposed in literature
  - Heckman's sample selection model (Helpman et al. 2008)
  - The Tobit model proposed by Eaton-Tamura (1994) (Martin and Pham, 2008)
  - The Poisson Model (Santos Silva and Tenreyro, 2006)

Sample and Data

- 193 exporters, 99 importers
- 18 food industry sectors (ISIC rev.3 4-digit)

  - Trade: UN Comtrade database (average across 2002-03-04 years)
  - Distance, common language, common border, colonial relationship and common colonizer: CEPII
  - Bilateral Tariff: MAcMap (aggregated at the ISIC 4-digit level using import weights based on the reference group method)

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Empirical Results at ISIC 4-digit Level

- Tariff coefficients of gravity regression estimated for each 4-digit ISIC sector separately

		OLS	Heckman	E-T Tobit	PPML
1511	Meat	**-2,050**	**-1,424**	-0,016	-1,083
1512	Fish	**-8,190**	**-6,128**	**-2,266**	**-11,540**
1513	Fruit Products	**-3,234**	**-2,132**	**-1,420**	**-7,695**
1514	Vegetable and Animal Oil	**-3,766**	**-3,129**	**-1,614**	-1,007
1520	Dairy Products	**-4,011**	**-2,933**	**-1,357**	**-2,989**
1531	Grain Mill Products	**-2,700**	**-2,382**	**-1,332**	**-3,590**
1532	Starch Products	**-3,440**	**-2,855**	**-1,078**	**-2,409**
1533	Animal Feed	**-3,758**	*-2,068*	0,219	*-3,007*
1541	Bakery Products	**-4,187**	**-4,417**	**-4,655**	**-13,160**
1542	Sugar	*-0,790*	-0,214	**0,792**	**-2,313**
1543	Cocoa and Chocolate Prod.	**-6,633**	**-6,214**	**-5,527**	**-13,150**
1544	Macaroni Noodles Couscous	-0,822	-0,507	**-1,602**	**-5,886**
1549	Other Food Products	**-2,533**	*-2,131*	**-1,117**	**-7,707**
1551	Spirits	**-1,401**	-1,077	0,434	-2,199
1552	Wines	**-1,791**	**-1,448**	**-1,183**	**-8,448**
1553	Malt	**-3,916**	**-4,605**	**-5,485**	**-5,717**
1554	Soft Drinks	**-3,295**	*-3,034*	**-1,628**	*-5,113*
1600	Tobacco	**-1,539**	**-1,692**	**-2,426**	**-4,387**

Empirical Results at ISIC 4-digit Level

- 15 of 18 products are statistically significant at the 5% level or more
- Pattern of estimated elasticity across all methods:
  - range from 1.5 to 14
  - mean equal to 4.32
  - median equal to 3.48
- Results broadly in line with previous evidence:
  - Hummels, 2001; Hertel et al 2004
  - Broda and Weinstein, 2006 - mean and median 4.49 and 5.48

Empirical Results at ISIC 4-digit Level

Substitution elasticity	Estimation method: OLS	Heckman	E-T Tobit Heterosc.	PPML
Maximum →	**9,19** Fish	**7,21** Cocoa and Chocolate Prod.	**6,53** Cocoa and Chocolate Prod.	**14,16** Cocoa and Chocolate Prod.
Minimum →	**2,40** Spirits	**2,08** Spirits	**2,08** Starch Products	**3,83** Starch Products
Mean	**4,53**	**3,98**	**3,34**	**7,85**
Median	**4,37**	**3,62**	**2,61**	**6,80**
Deviation from OLS		**-16%**	**-34%**	

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Simulation: Which Estimation Strategy?

- Two formal tests:

- **Mis-specification test (RESET test)**
  - Heckman and the PPML procedure generally pass the RESET test

- **Goodness-of-fit test (Theil's U-statistic)**
  - OLS and the Heckman procedure give best forecast accuracy (Theil's U-statistic)

- The RESET test and the U-statistic, taken together, suggest that the **best estimation method** for our purpose is the Heckman two-stage procedure

Simulation: Trade Liberalization

- The calculated tariff effects uses the estimates of the Heckman procedure for the 18 food sectors

- We aggregated results across three exporting country groups to better evaluate the tariff liberalization effects:
  - high income countries (World Bank)
  - developing countries (World Bank)
  - emerging countries (FTSE group classification)

Simulation: Trade Liberalization

	Exporter			
	High Income	Developing	Emerging	World
Tariff effect (%)	10,4%	22,4%	30,9%	16,4%
Trade value (million US$)	242.324	24.648	89.903	356.875

- Trade liberalization increases food industry world trade by 16% in the observed period
  - Francois et al. (2005): 21% on agricultural and food trade using global computable general equilibrium model
- The effect of tariff removal is particularly important for the 'emerging' and 'developing' country groups
- 'High income' countries grow by about 10% (their trade value represents more than two third of world trade)
  - Anderson et al. (2006): 16% obtained for 'high income' export grow of, both, agricultural and food trade, using a dynamic computable general equilibrium model.

Simulation: Trade Liberalization at Product Level

	Exporter			
Product	High Income	Develo ping	Emerging	**World**
Meat			%	**13%**
Fish	15%	12%	26%	**19%**
Fruit Products	5%	10%	21%	**11%**
Veg. and Animal Oil	8%	7%	18%	**13%**
Dairy Products	15%	85%	86%	**22%**
Grain Mill Products	14%	51%	211%	**86%**
Starch Products	8%	41%	34%	**13%**
Animal Feed	3%	27%	15%	**5%**
Bakery Products	7%	20%	27%	**10%**
Sugar	1%	7%	7%	**5%**
Cocoa and Choc. Prod.	13%	45%	77%	**26%**
Macaroni N.Couscous	2%	3%	5%	**2%**
Other Food Products	8%	13%	21%	**11%**
Spirits	4%	4%	4%	**4%**
Wines	5%	19%	13%	**6%**
Malt	71%	44%	41%	**63%**
Soft Drinks	6%	18%	16%	**8%**
Tobacco	18%	24%	135%	**27%**
Processed Food	10%	22%	31%	**16%**

Hertel and Keeney (2006): 10.8%
Ghazalian et al. (2007): 18%

Simulation: Bilateral Trade Liberalization Effects

Importer	Exporter			
	High Income	Developing	Emerging	World
		Tariff effect (%)		
High Income	4,2%	18,2%	31,2%	10,5%
Developing	76,3%	31,3%	40,4%	54,9%
Emerging	31,8%	26,6%	24,7%	28,1%
World	10,4%	22,4%	30,9%	16,4%
		Trade value (million US$)		
High Income	208.043	14.777	57.917	280.736
Developing	12.416	4.256	11.237	27.909
Emerging	21.865	5.615	20.750	48.230
World	242.324	24.648	89.903	356.875

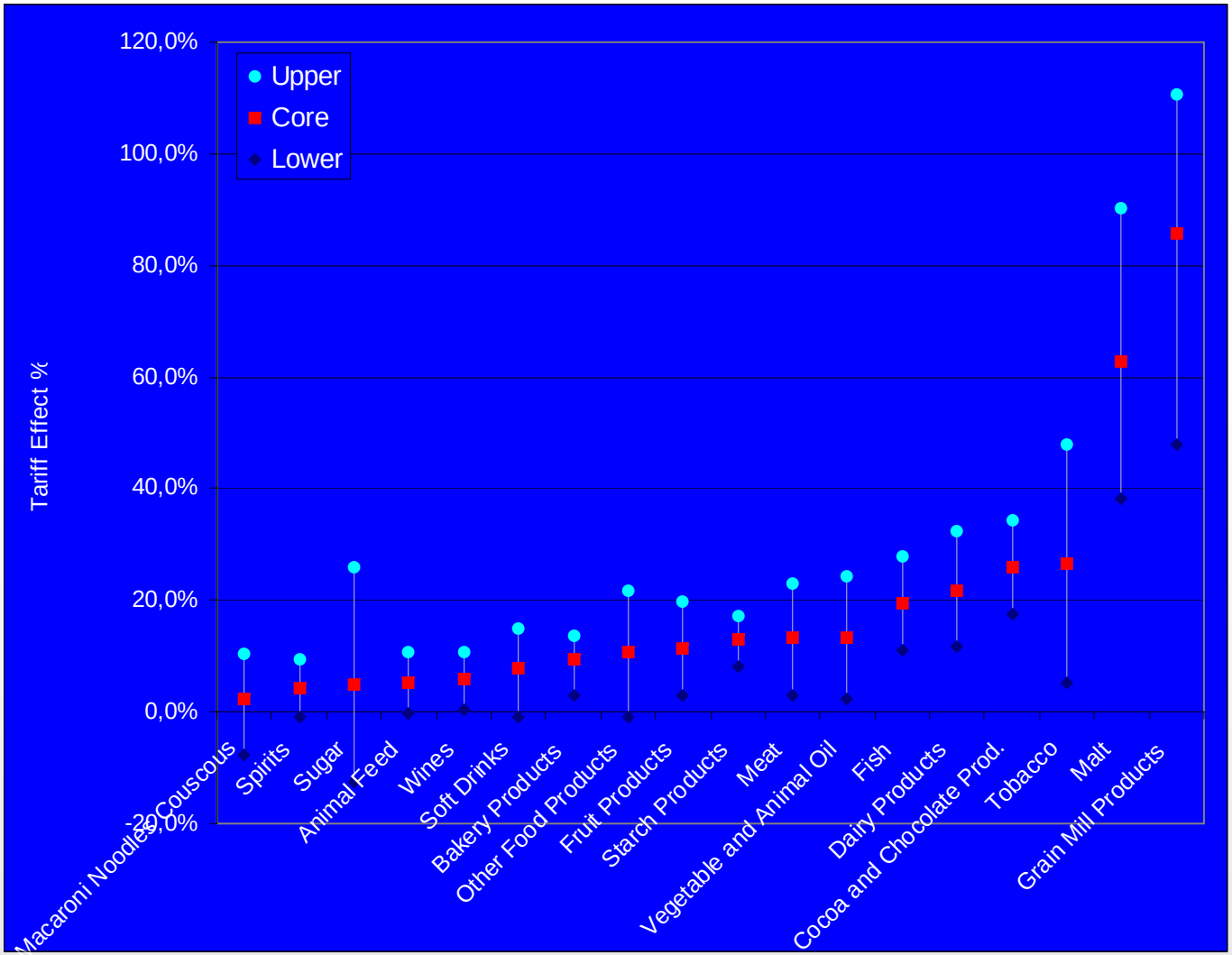
Simulation Uncertainty

- In this simulation we used estimated values, which are subject to sampling error and, thus, to uncertainty

- Thus we repeat the calculation twice more using:
  - The core estimate + 2 standard deviations
  - The core estimate - 2 standard deviations

- This is a very approximate approach, but it produces a **zone of results.** (very preliminary…)

Simulation: the Zone of Results



Conclusions

- Identification of import substitution elasticity using gravity model
  - the elasticities are very sensitive to the econometric technique.
  - Our substitution elasticity estimates are in the range of the most recent evidence confirming the validity of the gravity-like model to identify this important structural parameter.
- Heckman two step procedure perform well, especially when the estimated model is used for statistical forecast
- The simulation of a full trade liberalization scenario produces bilateral trade effects that are not so far from actual evidence based on more complex approaches.
  - thus more investments in econometric work to estimate the gains from trade liberalization could represent an interesting avenue for future researches

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Thank you

Prin 2007
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AAEA&ACCI
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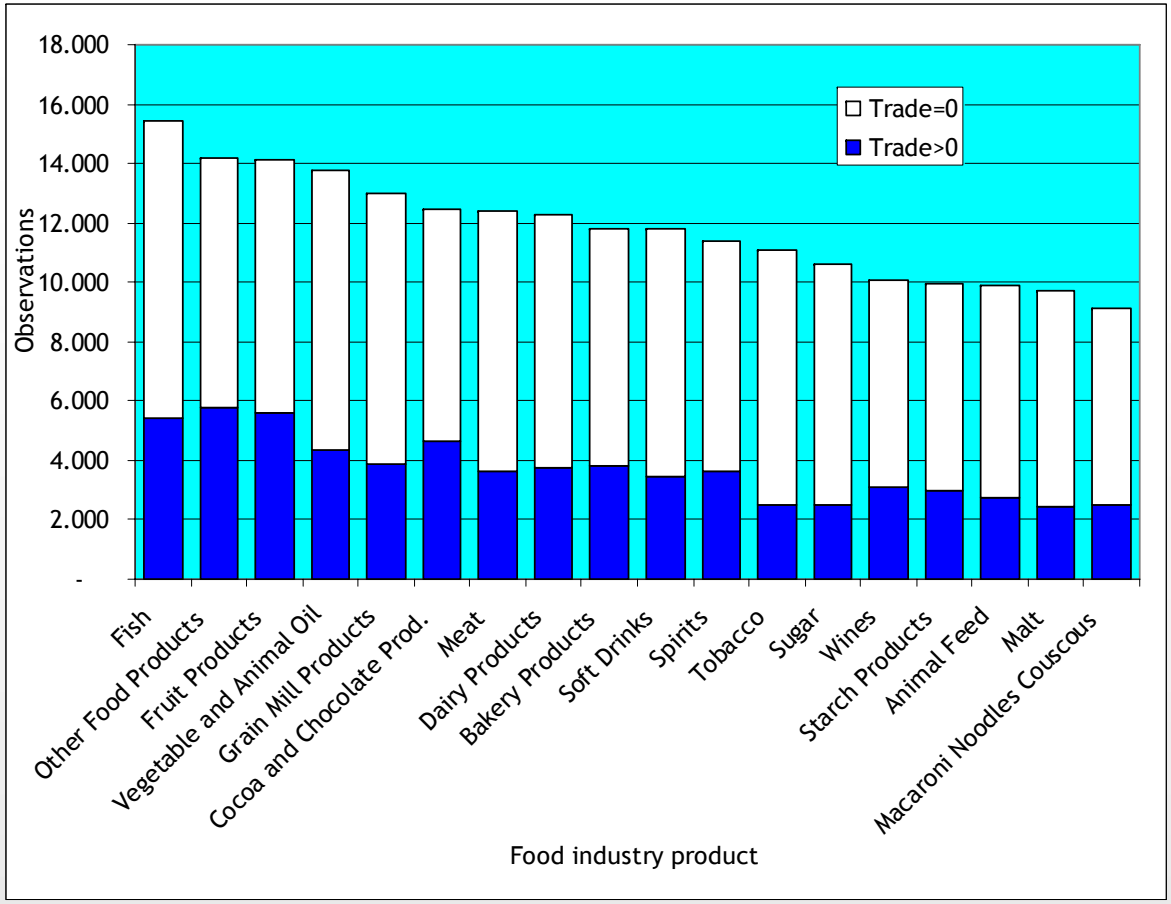
Data

Zero trade flow in the 18 food industry sectors

between 60%-77% of observations



Empirical Results on Pooled Data Level

	OLS	*Probit*	Heckman	E-T Tobit	PPML>0
Log Distance	**-1,361**	**-0,770**	**-1,604**	**-1,678**	**-1,065**
	(0,06)	(0,02)	(0,09)	(0,03)	(0,07)
Log (1+ tariff)	**-1,561**	**-0,526**	**-1,607**	**-1,550**	**-1,199**
	(0,24)	(0,06)	(0,22)	(0,11)	(0,44)
Common Language	**0,300**	**0,292**		**0,566**	0,244
	(0,15)	(0,05)		(0,07)	(0,13)
Common Border	**1,025**	**0,683**	**1,226**	**0,656**	**0,511**
	(0,13)	(0,09)	(0,14)	(0,08)	(0,14)
Colonial Relationship	**0,768**	**0,843**		**0,893**	0,220
	(0,17)	(0,08)		(0,08)	(0,15)
Common Colonizer	**1,615**	**1,102**	**2,082**	**2,624**	**1,604**
	(0,28)	(0,05)	(0,31)	(0,11)	(0,33)

σ = 2.5 – 2.6
Lai and Trefler (2004): 2.53