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**Firm Heterogeneity, Non-Tariff Measures, and International Trade Agreements:
The Case of US-EU TTIP Agreement on Beef Trade**

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Selected Paper prepared for presentation at the International Agricultural Trade Research Consortium's (IATRC's) 2015 Annual Meeting: Trade and Societal Well-Being, December 13-15, 2015, Clearwater Beach, FL.

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Firm Heterogeneity, Non-Tariff Measures, and International Trade Agreements

The Case of US-EU TTIP Agreement on Beef Trade

Ph.D. Dissertation Summary

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Monday, December 14

Clearwater Beach, Florida

Emerging international trade agreements

- Hormone ban on beef in the EU
 - U.S. beef exporters sell hormone-free beef into the EU market
- Non-Hormone Treated Cattle (NHTC) Program
 - Pay for on-site visits by the Agricultural Marketing Service (AMS)
 - Segregate the production process
 - Adapt packaging
- Reducing NTMs on beef exports from the U.S. to the EU



Catching up with the trade theory

- Armington-based CGE models do not
 - explain trade growth along the extensive margin
 - account for heterogeneity across firms
 - account for fixed costs of entering a market
- The firm heterogeneity model of Melitz (2003)
 - is able to explain micro-level findings on firm heterogeneity
 - provides additional insights on trade mechanisms
- **A need for readily accessible policy-oriented CGE model featuring firm heterogeneity**

Recent research

- Stylized models that experiment with aggregate industries
 - Zhai (2008)
 - Balistreri and Rutherford (2013)
 - Dixon, Jerie and Rimmer (2015)
 - Oyamada (2014)
- **We need parameterization at a more disaggregated and policy-relevant scale**

Roadmap

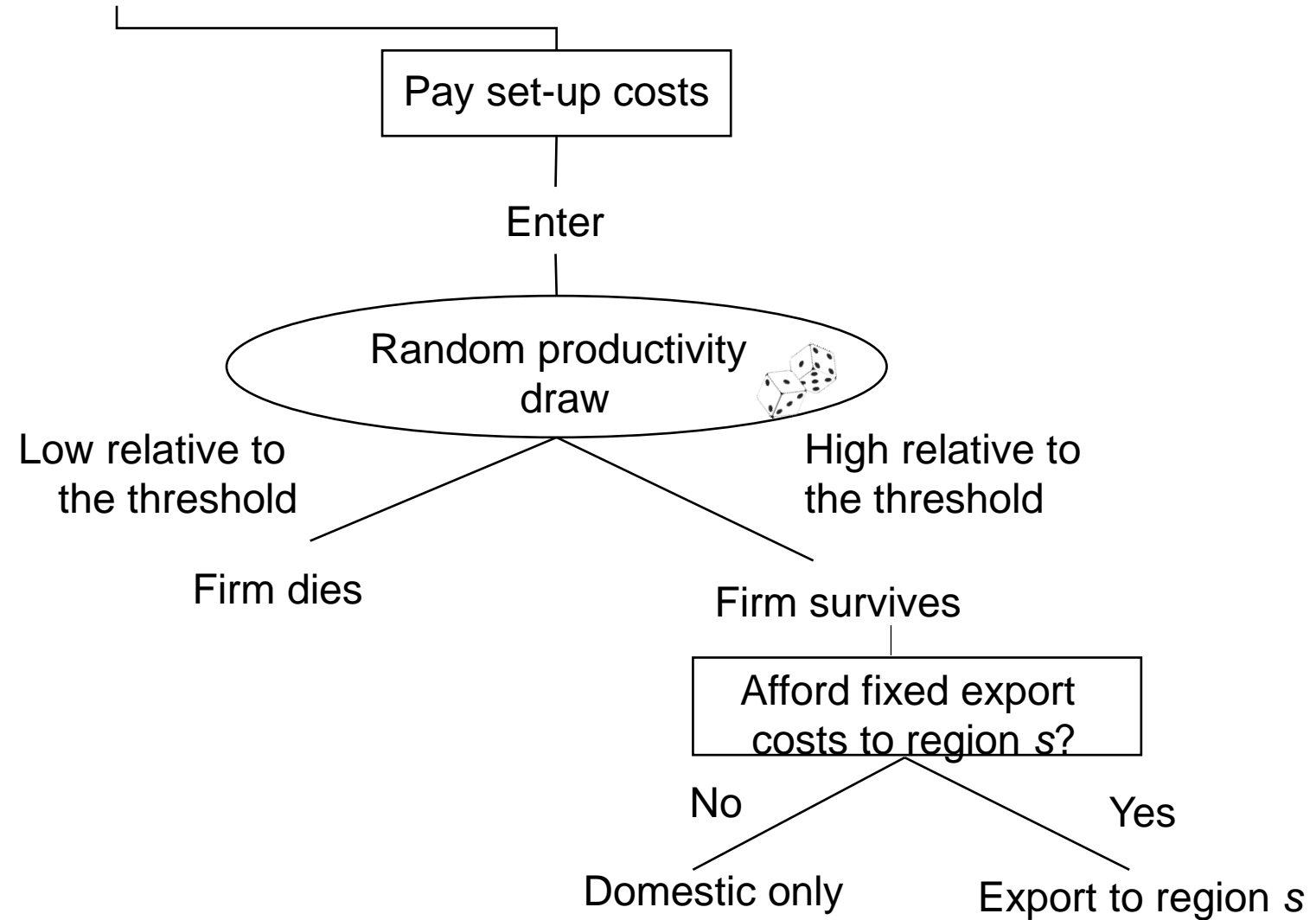
- Model overview
- Empirical challenges
- Policy analysis
- Conclusions and future prospects

Introducing firm heterogeneity into GTAP

- **We build on the monopolistically competitive GTAP model developed by Swaminathan and Hertel (1996)**
- **We endogenize factor neutral productivity shifters of the production function (as in GTAP)**
 - Productivity is linked to endogenous productivity thresholds
 - Productivity is partitioned into domestic and export markets
- **Our model allows for**
 - comprehensive treatment of intermediate input trade
 - flexible treatment of the factor composition of fixed costs
 - exploring the implications of entry and exit of firms in the domestic and export markets,
 - welfare decomposition that explicitly shows the productivity, variety, and scale effects.

The Melitz Model

Potential Entrants



Firm profit – productivity threshold

- Profit of a firm in industry i from sales to region s

$$\Pi_{irs} = \underbrace{\left[\frac{P_{irs}}{T_{irs}} - \frac{C_{ir}}{\Phi_{irs}} \right] Q_{irs}}_{\text{Variable profit}} - \underbrace{W_{ir} F_{irs}}_{\text{Fixed trade costs}}$$

Small Φ : low productivity, high costs
Large Φ : high productivity, low costs

- Profit of the marginal firm determines the productivity threshold for entering market s

$$\Pi_{irs}(\Phi_{irs}^*) = 0$$

- where Φ_{irs}^* is the productivity threshold for a firm that exports product i from region r to s .

i: Industry
r: Source
s: Destination

Industry profit – firm entry/exit

- Industry profit in sector i of region r

$$\Pi_{ir} = \underbrace{\sum_s N_{irs} \Pi_{irs}}_{\text{Total Profit from Sales}} - \underbrace{N_{ir}^p W_{ir} H_{ir}}_{\text{Fixed Set-up Costs}}$$

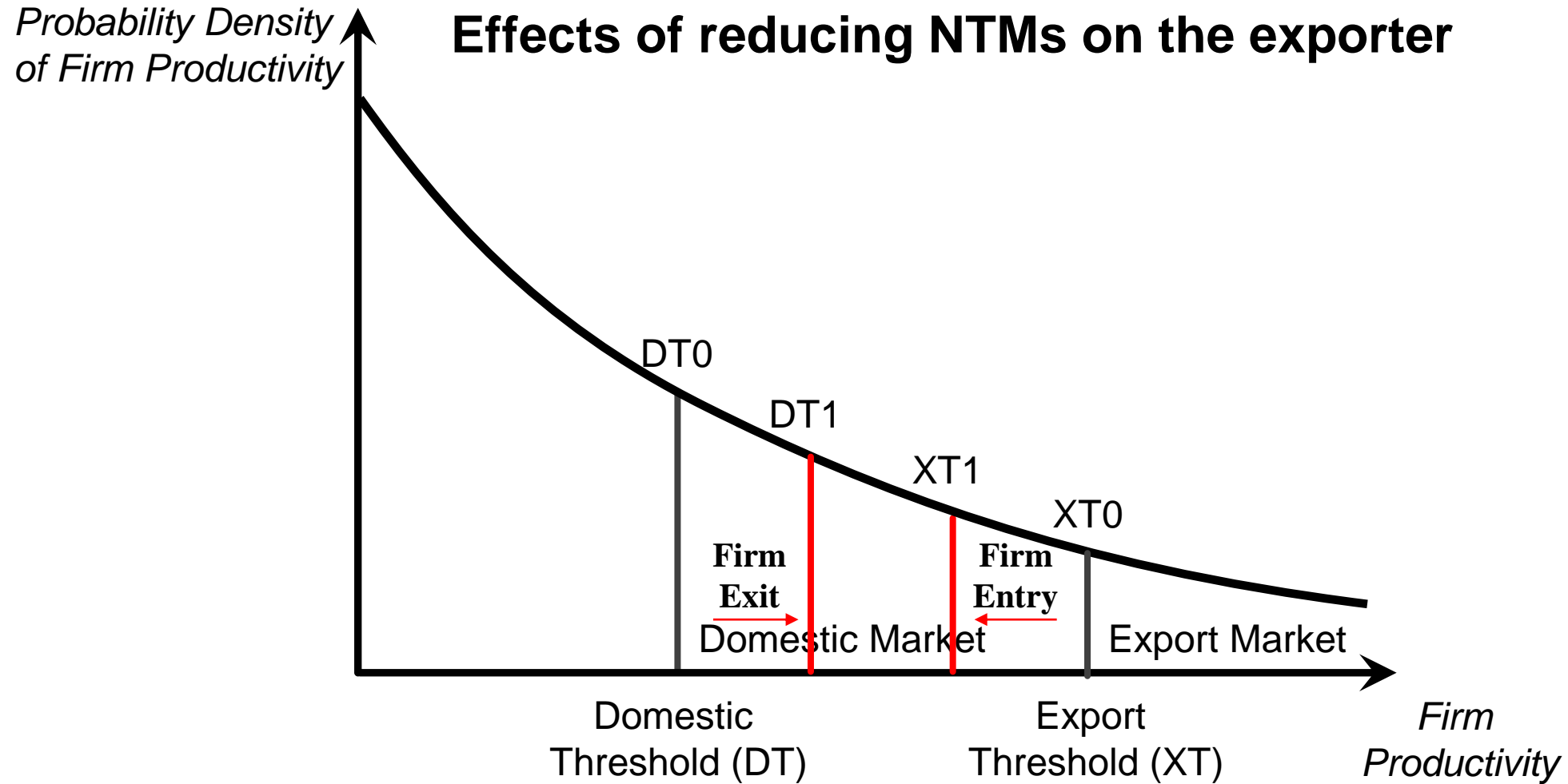
- Zero profits condition determines the endogenous number of firms in the industry due to entry/exit of firms

$$N_{irs} = N_{ir}^p \left[1 - G(\Phi_{irs}^*) \right] = N_{ir}^p (\Phi_{irs}^*)^{-\gamma_i}, \quad \gamma_i > 0$$

- where $1 - G(\Phi_{irs}^*)$ is the probability of being active in the r - s bilateral trade.

i: Industry
r: Source
s: Destination

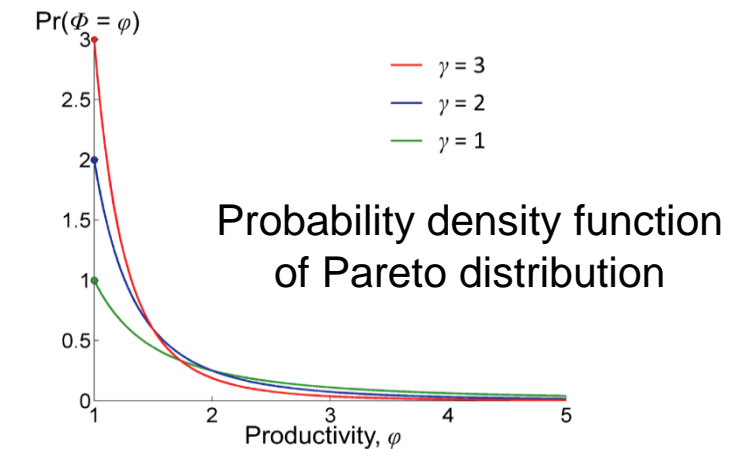
Endogenous productivity change



Source: Adapted from Greenaway and Kneller (2007)

Parameterization of the model

- Two key parameters in firm heterogeneity
 - shape parameter of Pareto distribution, γ
 - elasticity of substitution across varieties, σ
 - with a mathematical constraint, $\gamma > \sigma - 1$



- Can we still use Armington elasticities?
- Elasticity estimates in traditional gravity equations when firm heterogeneity is present confound demand-side and supply-side effects

An alternative approach

- Current approaches in the literature
 - Use existing elasticity estimates to infer shape parameters from firms' sales distributions
 - Present parameter estimates for industries at the aggregated level
- Studies with disaggregated level of industries
 - Spearot (2015): Country level data, GTAP industry definition, only estimates shape parameters
- Alternative approach
 - Country-level data
 - Use the shape parameter information to infer the elasticity of substitution

Two stage estimation

- Export participation equation

$$\Pr(T_{rst} = 1) = \alpha_0 - \delta\gamma \ln D_{rs} + E_r + E_s + E_t + \alpha_4 \theta_{rs} + \alpha_5 \psi_{rst} + \eta_{rst}$$

\uparrow \uparrow \uparrow \uparrow \uparrow \uparrow
Distance *Exporter* *Importer* *Year* *Country-pair* *Trade-impeding or*
 fixed *fixed* *Dummy* *specific fixed* *facilitating variables*
 effects *effects* *trade barriers*

- Export flows equation

$$\ln M_{rst} = \beta_0 - \delta(\sigma - 1) \ln D_{rs} + E_r + E_s + E_t + \beta_4 \psi_{rst} + \varepsilon_{rst}$$

\uparrow \uparrow \uparrow \uparrow \uparrow
Distance *Exporter* *Importer* *Year* *Trade-impeding or*
 fixed *fixed* *Dummy* *facilitating variables*
 effects *effects*

- Solving for the elasticity of substitution

$$\frac{-\delta\gamma}{-\delta(\sigma - 1)} = \frac{\gamma}{(\sigma - 1)} \leftarrow \text{Data from Spearot (2015)}$$

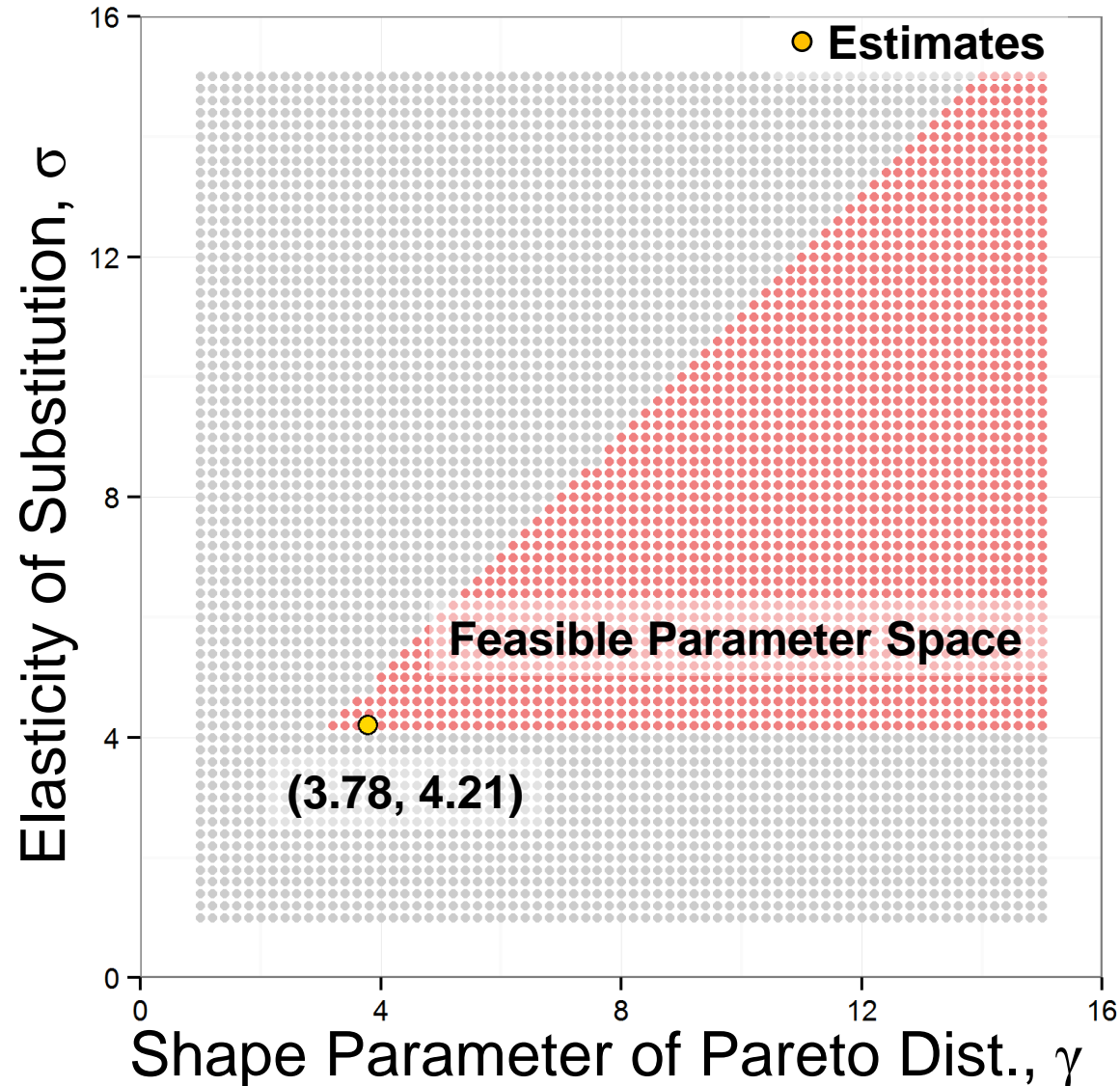
r: Source
s: Destination
t: Year

Elasticity of substitution for beef

		Beef Industry
Export Participation (1 st Stage)	$-\delta\gamma$	-0.92
Export Flows (2 nd Stage)	$-\delta(\sigma-1)$	-0.78
Shape Parameter	γ	3.78
Elasticity of Substitution (Melitz)	σ	4.21
GTAP Armington Elasticity	σ	7.70

- Elasticity of substitution for beef in firm heterogeneity is considerably lower than the GTAP Armington elasticity for beef

Feasible parameter space for beef

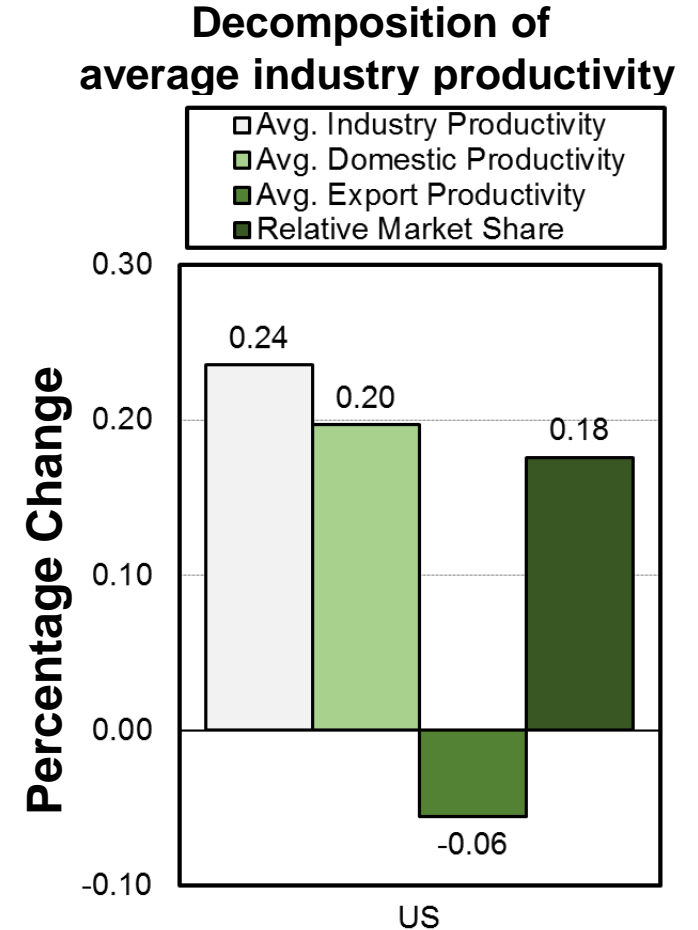
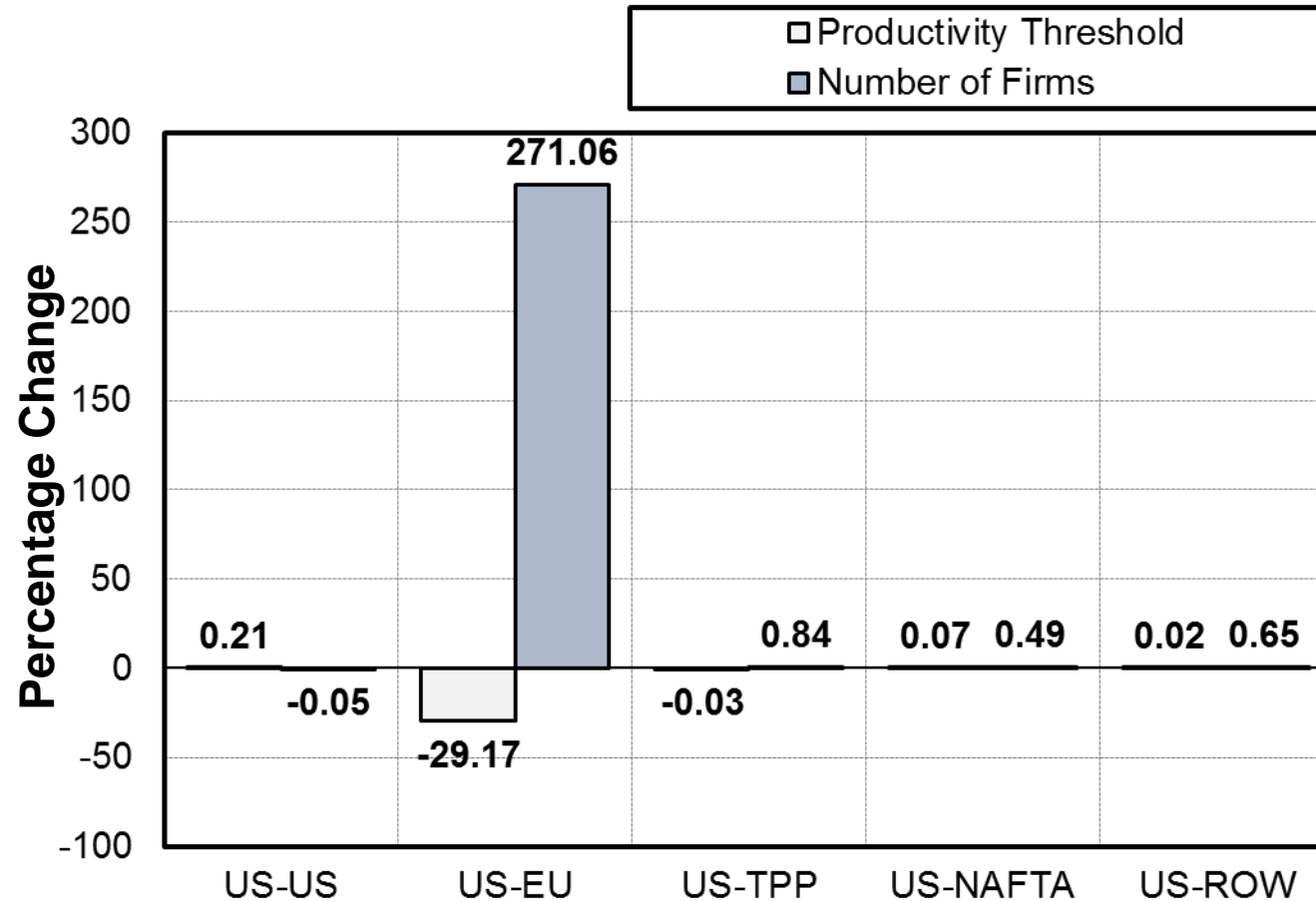


- Model calibration in firm heterogeneity is feasible only for a certain set of parameter estimates
- Mathematical conditions restrict the parameter space from above

Policy scenarios

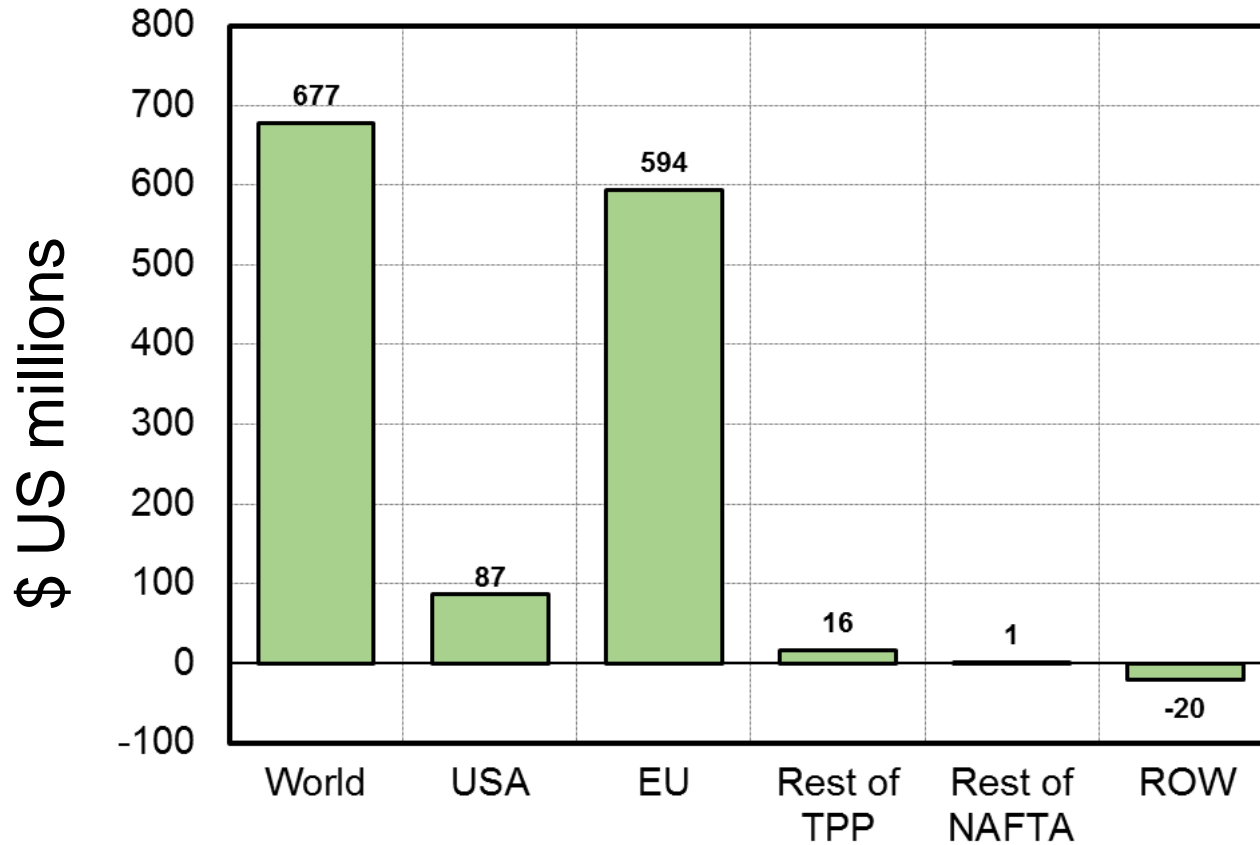
- GTAP Version 9
- 5 regions and 13 sectors (heterogeneous beef and manufacturing)
- How to model NTMs?
 - Transferring rents (tariff equivalent)
 - Saving resources (efficiency of inputs)
- Reducing **fixed costs of exporting** beef from the US to the EU
- Abstracting from tariff-rate quotas (TRQ)

Firm entry and productivity in the US beef industry



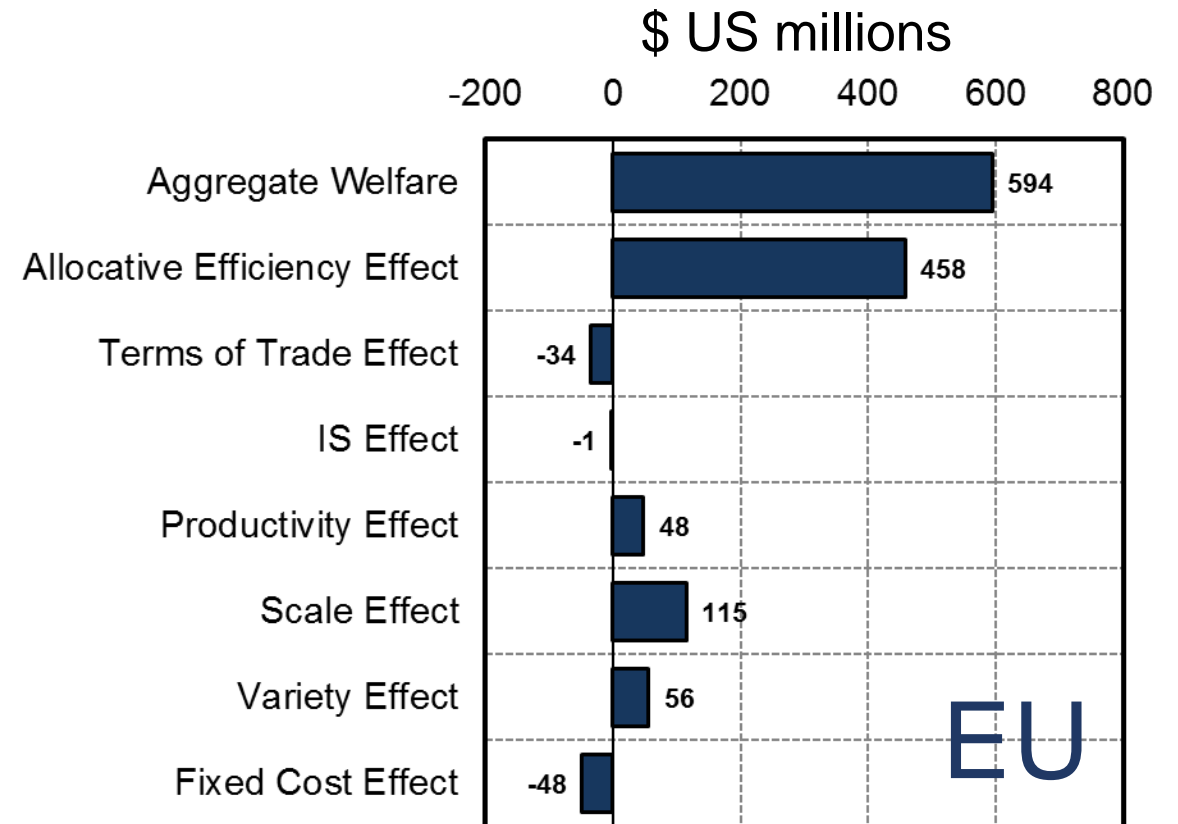
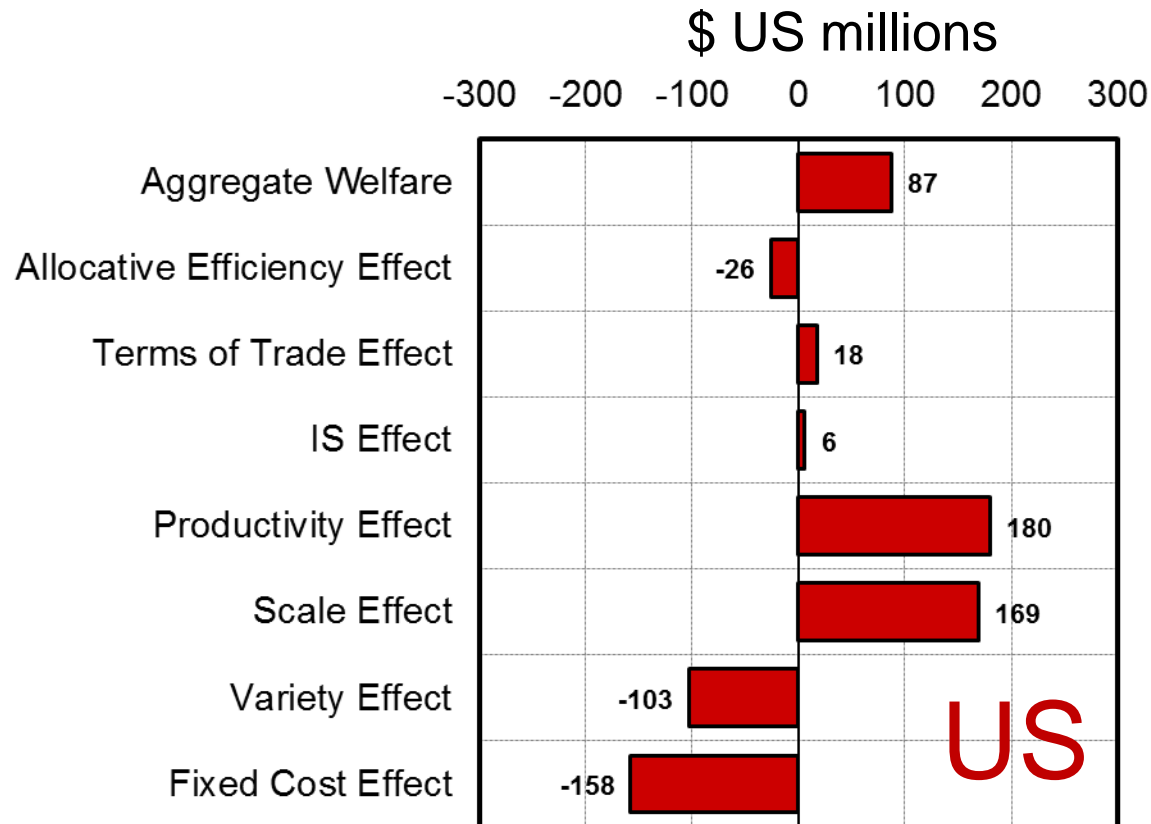
- Productivity threshold for the US-EU beef trade decreases
- Average industry productivity for beef increases in the US

Welfare implications of fixed cost reduction



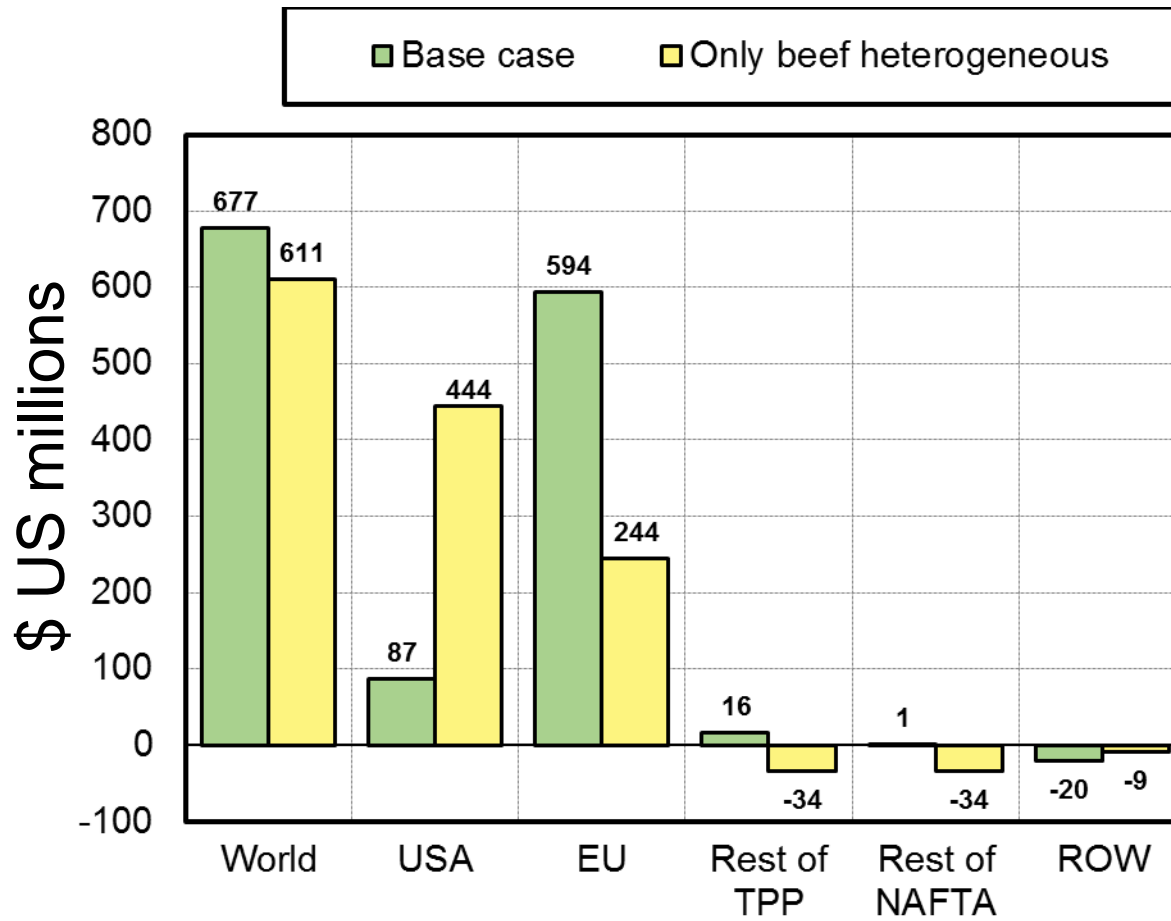
- Global welfare gain
- The EU benefits more than the US

Welfare decomposition in the US and the EU



- Significant productivity and scale effects in the US and EU
- Modest terms of trade effects

Ignoring heterogeneity in manufactures



- Same shock
- The US gains relatively more when only beef is heterogeneous
- The EU gains relatively less when only beef is heterogeneous
- Stronger terms of trade effects

Implications and future prospects

- Model structure has important policy implications
- Firm heterogeneity module of GTAP allows for
 - Endogenous industry productivity
 - Reallocation of firm shares in domestic and export markets
 - Additional sources of welfare due to productivity, variety and scale effects
- Empirical work should focus on estimating the elasticity and shape parameter pair
- Next steps
 - Identification of parameters
 - Incorporation of TRQs

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External Images

- (1) <http://rr1farms.com/images/NHTC%20seal.jpg>
- (2) <http://chestsculpting.com/images/Organic%20Meat.jpg>