Firm Heterogeneity in GTAP
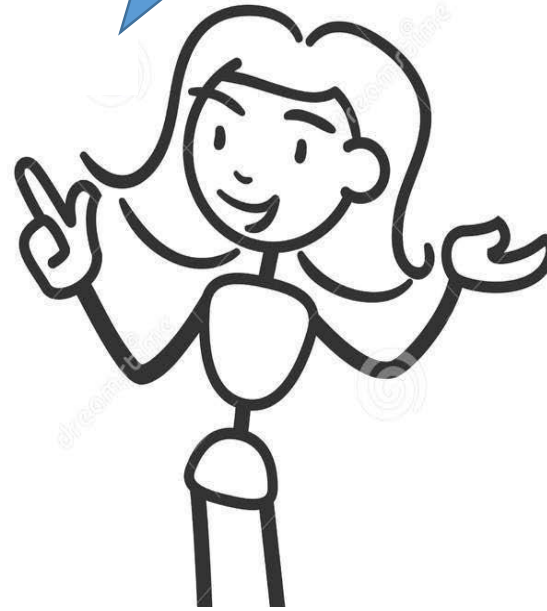
Firms are heterogeneous in their productivity along a Pareto distribution
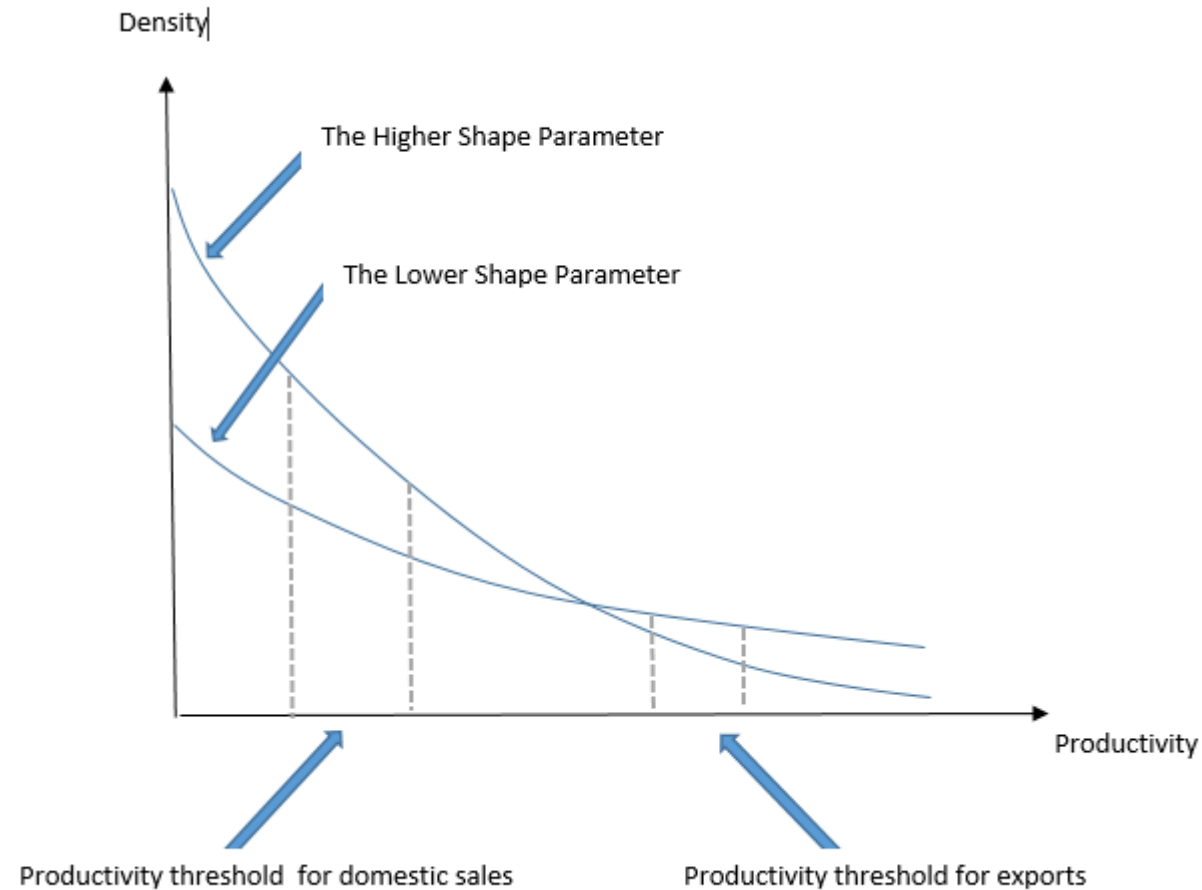
- The shape of the distribution is exogenous

- The thresholds are endogenously determined by a function of the fixed costs, variable production costs, and after tax revenue
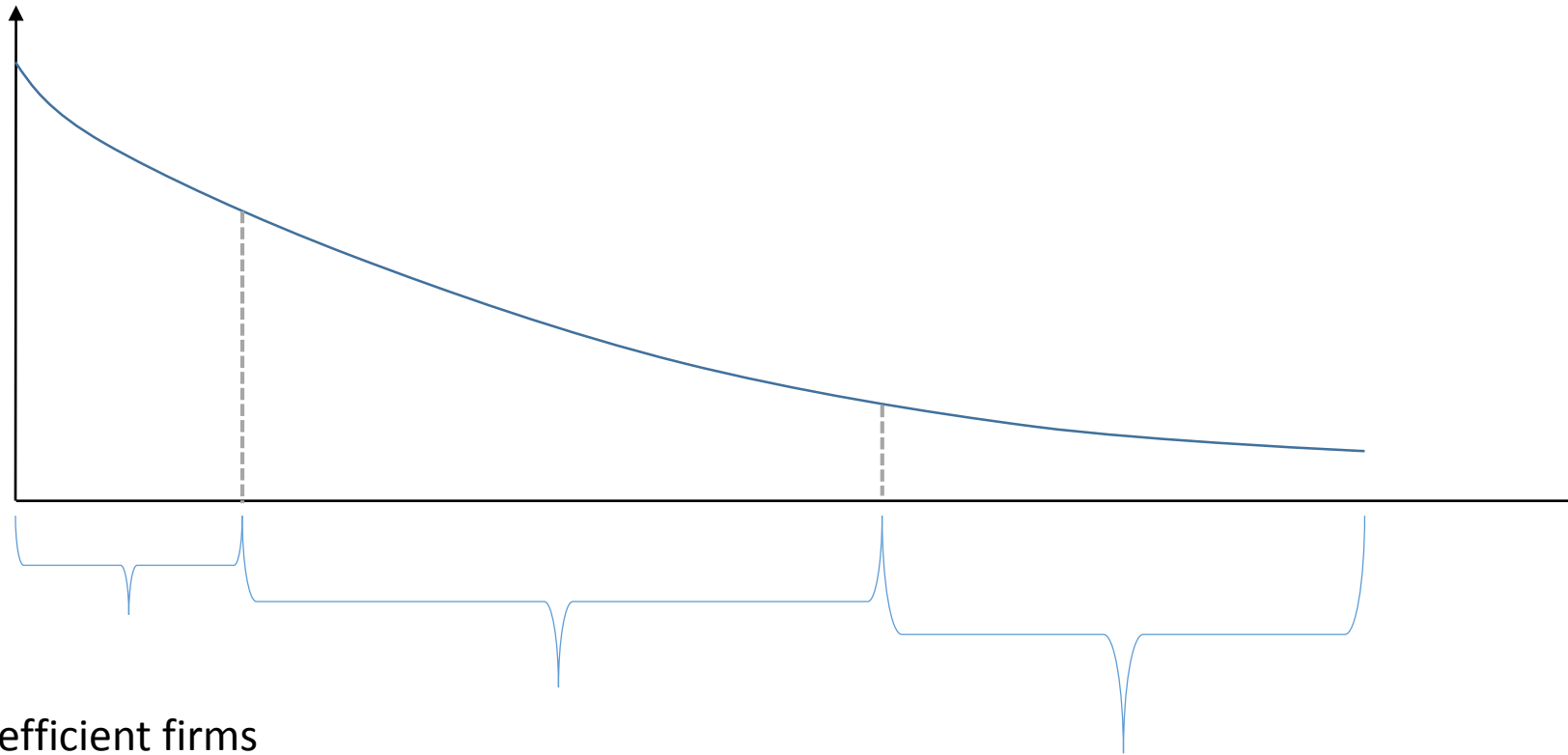
Inefficient firms incapable of competing in the domestic market

Domestic firms capable of competing domestically, but cannot export

Most efficient firms are competing in the domestic market and international markets

Parameter changes in the heterogeneous firms model

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- "Shape" parameter refers to the Pareto distribution

- Lower makes the firms more homogeneous in their productivity

- Higher makes the firms more heterogeneous in their productivity

Density

The Higher Shape Parameter

The Lower Shape Parameter

Productivity

Productivity threshold for domestic sales

Productivity threshold for exports

- Productivity thresholds refer to the sunk costs of becoming a domestic producer or an exporter

"AVAFD" is the fixed costs of entering the domestic market

"AVAFX" is the fixed costs of firms to begin exporting their goods

Heterogeneous firms model implications

- Endogenous industry productivity

- Endogenous firm shares of domestic and export markets

- The HF model includes additional equivalent variation factors
    - Variety of firms/goods in industry
    - Economies of scale diminish the fixed costs per unit
    - Productivity increases the efficiency of the production function

- Policy changes can be simulated in a more accurate environment

Schedule for the super duper awesome and amazing heterogeneous firms group

- Kun Li and Mike Webb
  - What are the effects of a reduction in Japanese non-tariff barriers?

- Un Jung Whang and Seetha Bandara
  - What are the implications of the shape of the Pareto distribution?

- Jeff Condon and Chris Bachmann
  - What happens if taxes change?

Non-tariff measures in a model with monopolistic competition and fixed costs

Mike Webb and Kun Li

17 July 2015

NTM Reduction Experiment

- Simulate an effective reduction in the fixed costs for US manufacturers to export to Japan (a reduction in NTMs).

- The GTAP-HET model has firms pay a fixed cost to supply the domestic market and a separate fixed cost to export to region s. This enables us to capture a reduction in non-tariff measures through effectively reducing the fixed cost for US manufacturers to export to Japan *(avafxall(MFNG, USA, JPN))*.

- Calibrated to lead to a 14% increase in US manufactures exports to Japan (the same outcome as a 1% tariff cut).

Tariff Liberalization vs NTM reduction: Same trade effects but opposite output effects…

Japanese tariff reduction

	USA	JPN	ROW
Manufactures Sales qs(MNFG, r,s)			
USA	-0.076	14.016	-0.303
JPN	0.826	-0.212	0.584
ROW	0.232	-0.851	-0.003
Output qo(j,r)			
MNFG	0.008	-0.021	-0.001
NonMNFG	-0.001	0.006	0.000
CGDS	0.009	0.021	-0.007

Japanese NTM reduction

	USA	JPN	ROW
Manufactures Sales qs(MNFG, r,s)			
USA	-0.093	14.016	-0.312
JPN	0.813	-0.244	0.575
ROW	0.229	-0.878	-0.002
Output qo(j,r)			
MNFG	-0.008	-0.049	-0.001
NonMNFG	-0.002	0.013	0.000
CGDS	-0.003	0.027	-0.003

US manufacturing prices, costs and output

| USA Manufactures Sector	
Change in average variable cost	0.034
Intermediate input cost contribution	0.011
Value added input cost contribution	0.003
Firm efficiency cost contribution	0.020
Output per firm qof(j,r)	-0.036

- Change in supplier price is equal to change in average variable cost since model has constant mark ups.

- US manufacturers costs rise because of increases in costs of intermediate input and value added inputs <u>and</u> because they are less efficient.

- Less efficient, since each firm produces less so spreads its fixed cost over less units.

Industry Composition Effects: NTM Simulation
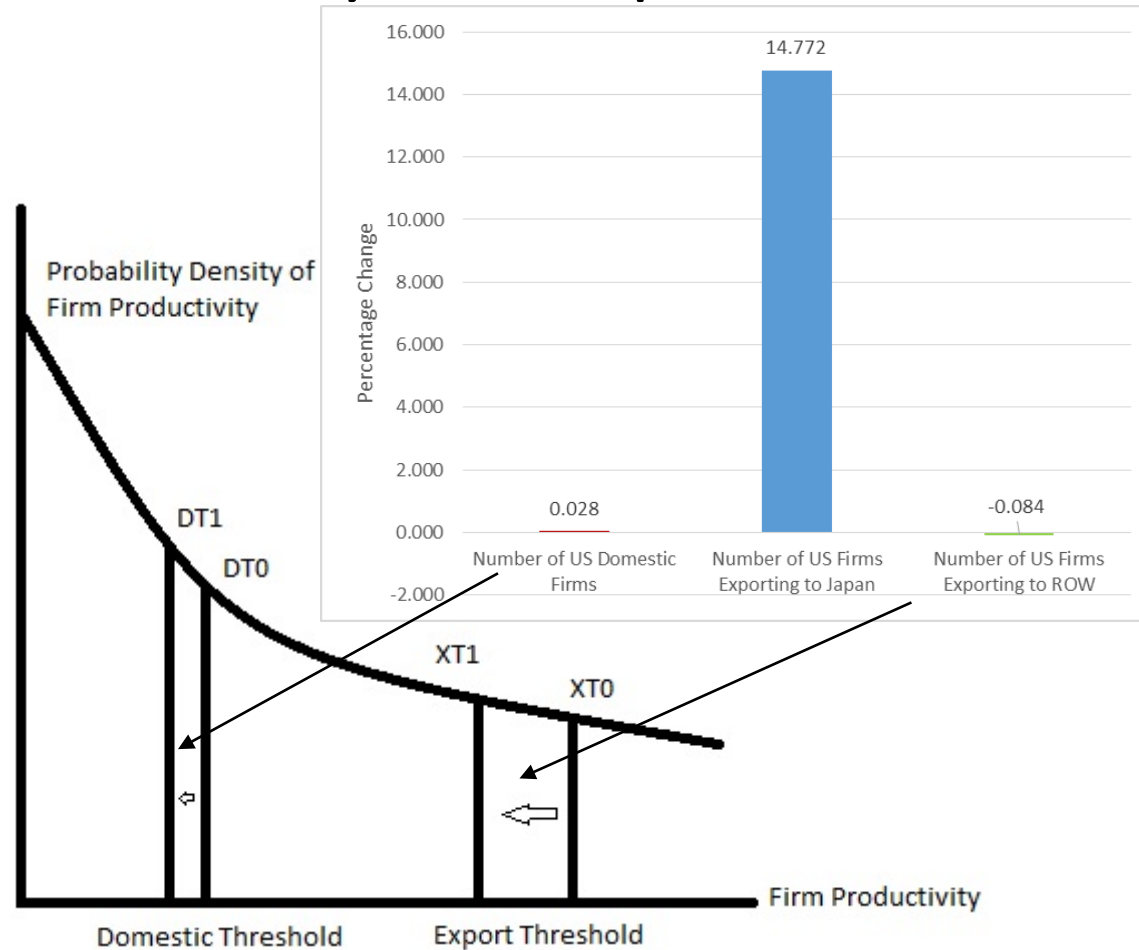
- The threshold for US manufacturers to export to Japan decreases due to the NTM reduction.

- The threshold for US manufacturers to enter the domestic market decreases as greater US exports leaves more of the US market for domestic only firms.

- With tariff liberalization, the export threshold decreases by less and the domestic threshold increases leading to less firms which are more efficient.

Industry Composition Effects: Tariff Liberalization
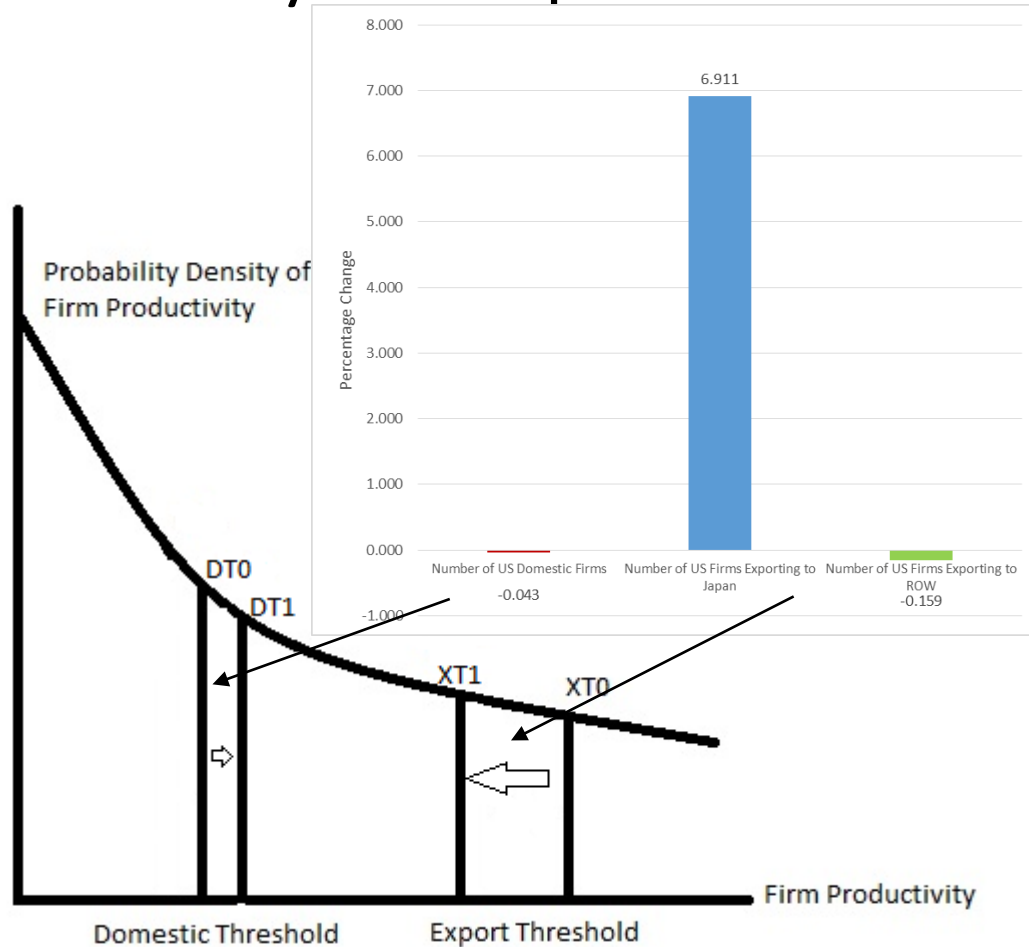
- With tariff liberalization, the export threshold decreases by less than in the NTM case and the domestic threshold increases leading to less firms which are more efficient.

Welfare

Welfare Comparation

NTB Reduction (MNFG, USA, JPN)   1% Tariff Reduction (MNFG, USA, JPN)

- In terms of welfare
- Japan gains from NTM reduction, while it loses from tariff reduction
- USA gains less from NTM reduction than from tariff reduction
- As non-member of an FTA, ROW loses from both

- Welfare decomposition

	WELFARE	1 alloc	2 endw	3 tech	4 pop	5 tot	6 IS	7 pref	8 scale	9 var	Total
	1 USA	47	0	-903	0	467	99	0	-322	661	48
EV decompose NTM	2 JPN	144	0	-407	0	-385	31	0	437	540	360
	3 ROW	114	0	-24	0	-82	-130	0	20	58	-44
	Total	305	0	-1334	0	0	0	0	135	1258	364
	WELFARE	1 alloc	2 endw	3 tech	4 pop	5 tot	6 IS	7 pref	8 scale	9 var	Total
	1 USA	117	0	-384	0	393	165	0	459	5	755
EV decompose TARIFF	2 JPN	146	0	-396	0	-373	25	0	430	-78	-248
	3 ROW	109	0	-33	0	-19	-190	0	19	-66	-179
	Total	373	0	-813	0	0	0	0	908	-140	328

- Main difference: Variety contribution; scale contribution

- Japan gains much more variety from imports from USA

	NTM Reduction			Tariff Reduction		
	1 USA	2 JPN	3 ROW	1 USA	2 JPN	3 ROW
1 USA	263	1436	-145	-401	693	-276
2 JPN	98	-624	277	103	-508	295
3 ROW	299	-272	-74	302	-264	-85
Total	661	540	58	5	-78	-66

- USA exports productivity threshold to Japan reduces by more in NTM reduction simulation. More firms exports to Japan i.e. more variety in Japanese imports

	NTM Reduction			Tariff Reduction		
	1 USA	2 JPN	3 ROW	1 USA	2 JPN	3 ROW
1 USA	0	-2.2	0.02	0	-1.07	0.03
2 JPN	-0.07	0	-0.05	-0.07	0	-0.05
3 ROW	-0.02	0.07	0	-0.02	0.07	0
Total	-0.09	-2.12	-0.04	-0.09	-1	-0.02

- Scale effect: manufacturing output decreases but more firms enter the industry because of the reduction of the domestic entry threshold. Each firm has to produce on a smaller scale.

- In tariff reduction, manufacturing output increases, less firms are in the industry because of the increase of the domestic entry threshold. Each firm is producing on a bigger scale.

- Tech effect

- In both simulations, export entry threshold decrease leads to a reduction of the exporting firm aggregate productivity

- In NTM simulation, domestic entry threshold decrease leads to a reduction of the domestic firm aggregate productivity

- In tariff reduction, domestic entry threshold increases leads to higher aggregate productivity.

- This experiment shows the exploratory power of the GTAP-HET model for topical trade issues such as NTM reductions.
- Thank you.

The Change in Shape Parameter and Elasticity of Substitution

Unjung Whang

Seetha Bandara

Change in Parameters

- Tariff shock: Consider "Free trade from USA to JAPAN"

  ➤ Shock tms("MNFG","USA","JPN") = -3.6560

- Change in Shape Parameter( ) of Productivity γ Distribution (*Pareto* Distribution)

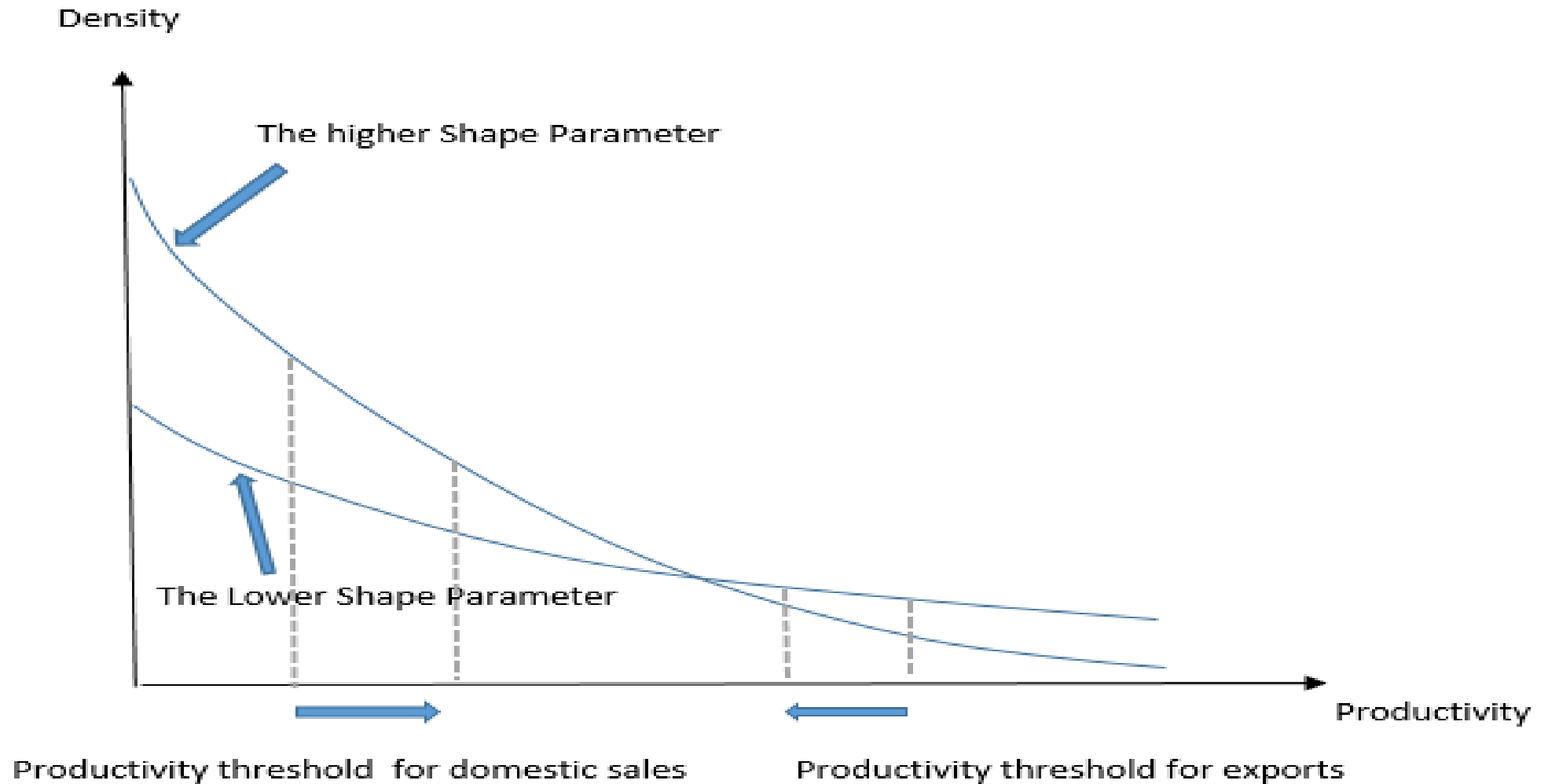 ➤ the lower, , is related to the greater density of less-productive firms relative to that of more-productive firms

- Change in the Elasticity of Substitution across goods( ) σ

  ➤ how easy it is to substitute one good to another
  ➤ the larger, , is associated with the more competitive market

Simple Figure of *Pareto* Dist. and
What if tariff reduction from USA to JPN?

Density

The higher Shape Parameter

The Lower Shape Parameter

Productivity

Productivity threshold for domestic sales

Productivity threshold for exports

% Change in Prod. Thresholds

- When $\varphi < \varphi_d$, firms die.
- When $\varphi > \varphi_x$, firms export.
  - where, φ_d = productivity threshold for domestic sales
  - where, φ_x = productivity threshold for exports

➢ Tariff reduction: easier to export → some domestic firms become exporters, so that φ_x decreases.

➢ Exporters use more resources to sale abroad more → less productive domestic firms are forced to exit, so that φ_d increases.

φ_d

	Shape Parameter = 6.2		Shape Parameter = 10	
	φ_d	φ_x	φ_d	φ_x
USA	0.030	-3.854	0.036	-3.816
JAPAN	0.069	-0.301	0.075	-0.323

Welfare Decomposition

	Allocation		Tech. Change		TOT		Scale Effect		Total	
	USA	JPN	USA	JPN	USA	JPN	USA	JPN	USA	JPN
$\gamma=6.2$	516	158	-1679	-1748	1726	-1654	2021	1903	3325	-1533
$\gamma=10$	697	234	-2723	-3043	1878	-1791	3327	3230	3964	-1554

- Scale Effect: related to IRS (Fixed costs in the model)
  - smaller mass of domestic firm in the market increase output per firms
  - with higher γ, larger portion of unproductive firms are out of market, so that scale effect increases.

- Tech. Change Effect: three components (ao(+), aodt(-), axdt(-))
  - ao(aggregate productivity): increases, but not much

  - aodt: i) average domestic productivity goes up → positive welfare effect
      ii) lose their production capacity → negative welfare effect

  - Aodx: more export firms in the market → lower average productivity → welfare loss

- Total Effect: USA gains more from JAPAN's tariff cut in an industry with a higher shape parameter.

Welfare Decomposition- σ change

WELFARE	Allocative Efficiency	Technical change	TOT effect	Scale effect	Variety effect	Total
USA	516	-1679	1726	2021	18	3325
JPN	158	-1748	-1654	1903	-298	-1533
ROW	494	-160	-74.7	101	-288	-757
Total	1168	-3588	-2.45	4025	-568	1036
Lower sigma 4.96						
USA	490	-2362	1669	3023	23.5	3552
JPN	153	-2529	-1608	2770	-359	-1470
3 ROW	393	-232	-63.4	123	-356	-947
Total	1036	-5124	-2.31	5916	-691	1135

Scale Effect of the σ change

Net effect of the Sigma change

Industry output
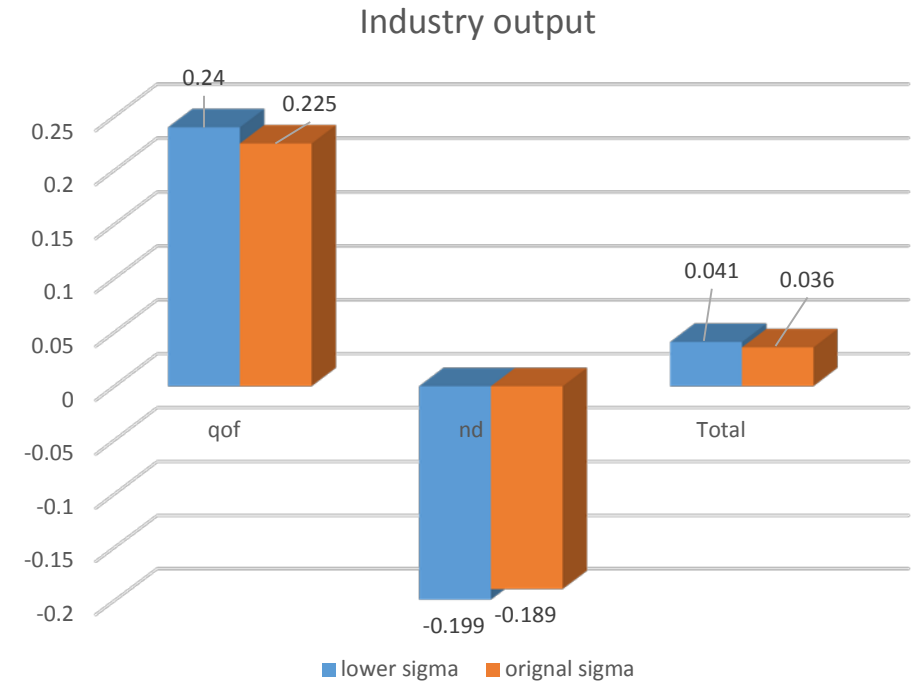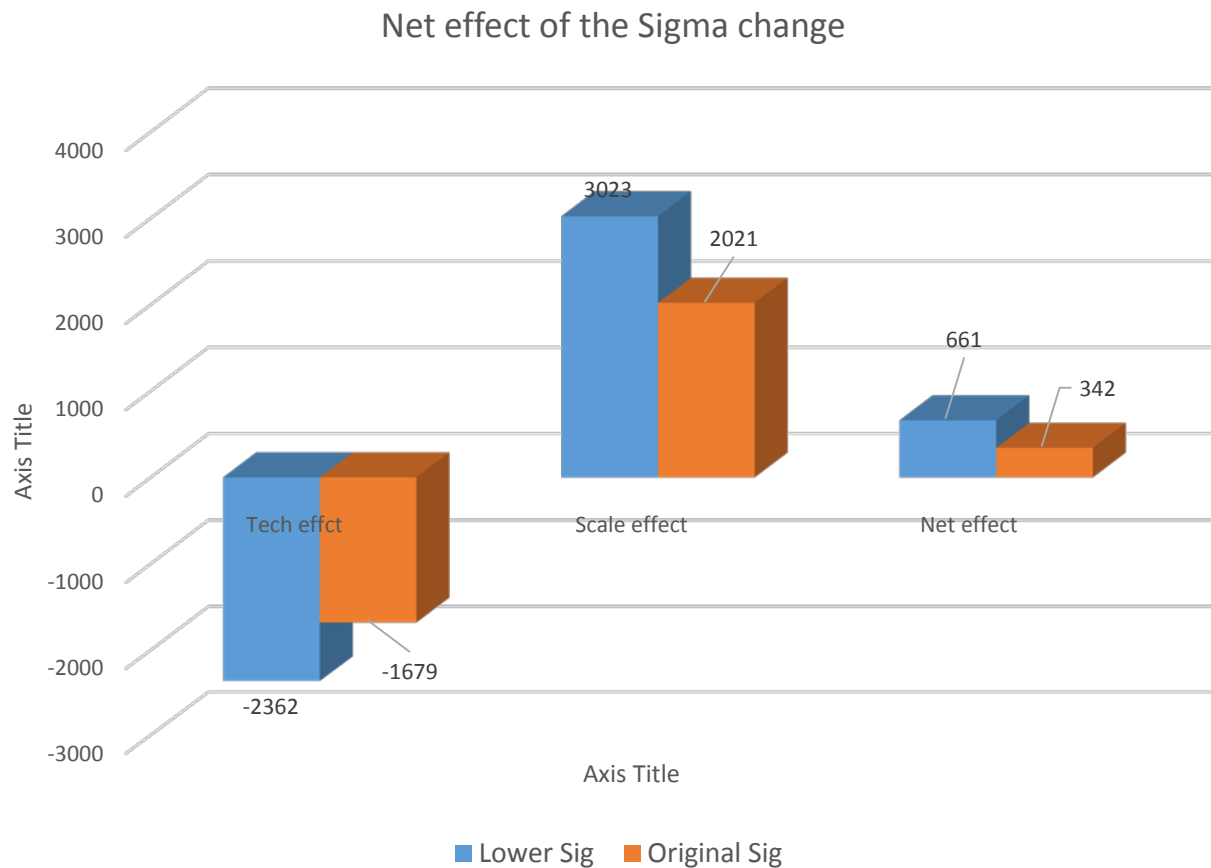
Technical Change effect of σ change

CNTtech	output	Domestic thresh	Export thresh	Total
USA	**107**	-1821	-648	-2362
JPN	4.84	-1796	-738	-2529
ROW	3.9	-158	-78.1	-232
Total	116	-3776	-1464	-5124

aoxt	USA	JPN	ROW	Total
USA	0	**-4.14**	0.12	-4.02
JPN	-0.313	0	-0.223	-0.536
ROW	-0.088	0.321	0	0.234
Total	-0.401	-3.81	-0.102	-4.32

TempCoeff	USA
1 e1_SVC	0.052
2 e1_SVAV	0.018
3 e1_MARKUP	0.048
4 e2_MARKUP	-0.084
5 dthreshslack	0
Total	0.034

Verity effect of the σ change

Total contribution to regional EV of variety effects of i in r

CNTnxisr	USA	JPN	ROW	Total
USA	-2796	4713	-1917	0.659
JPN	722	-3280	2061	-497
ROW	2097	-1792	-500	-195
Total	23.5	-359	-356	-691

CNTvarr	firm	private	govt	Total
USA	-178	201	-0.056	23.5
JPN	-406	47.9	-0.567	-359
ROW	-261	-93.6	-1.05	-356
Total	-845	156	-1.67	-691

Total contribution to regional EV of variety effects of i from s in r

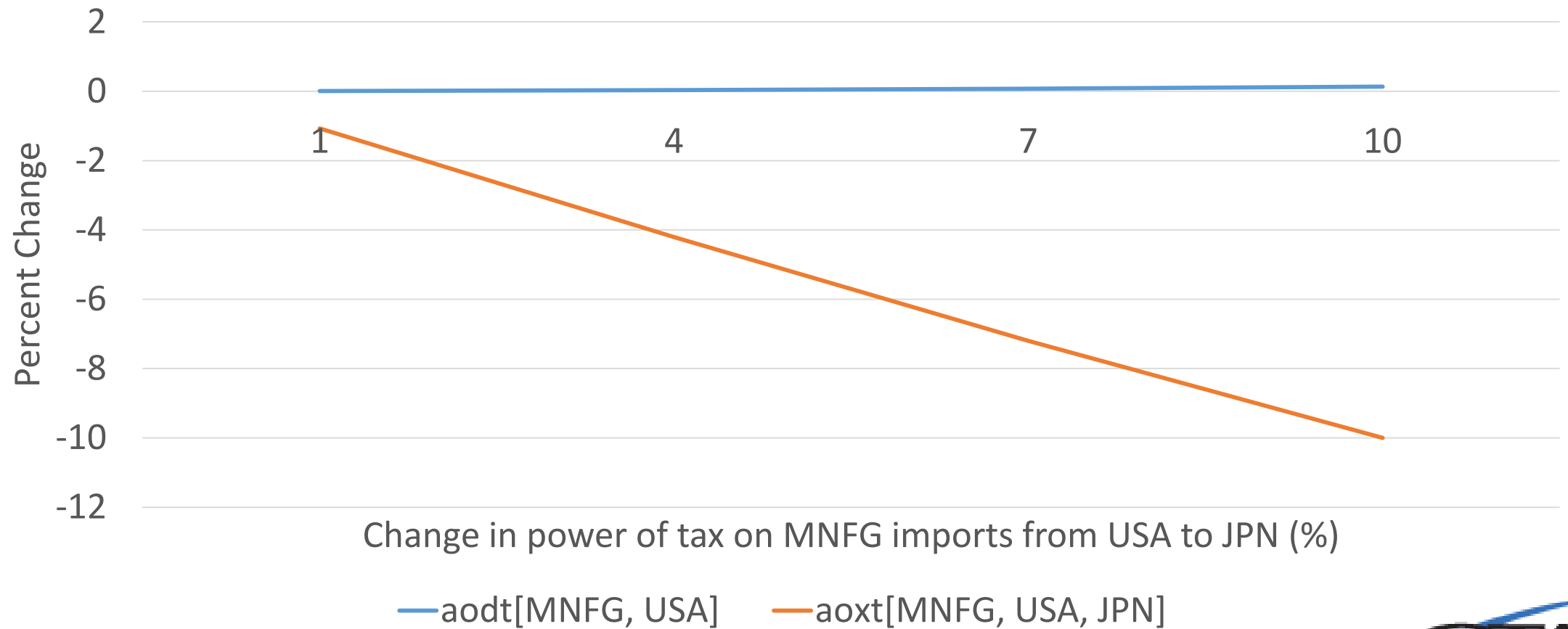| CNTvarisr	1 USA	2 JPN	3 ROW	Total
firm	-2078	487	1413	-178
private	-718	236	684	201
govt	-0.064	0.002	0.006	-0.056
Total	-2796	722	2097	23.5

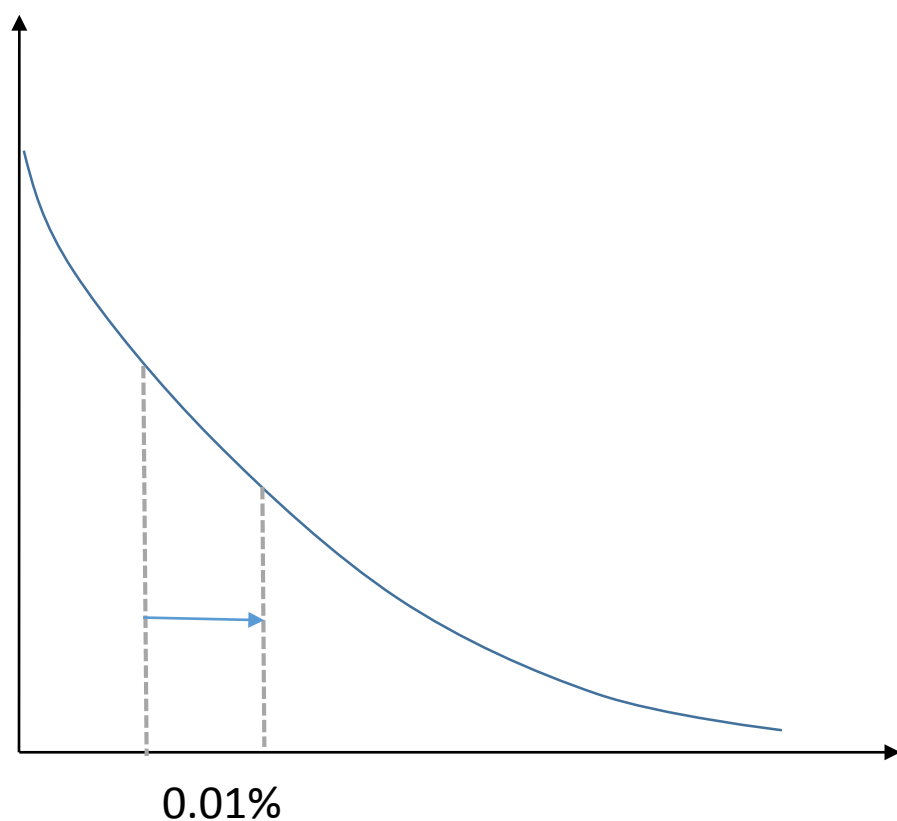# The Effect of Taxes on Productivity Thresholds

Chris Bachmann

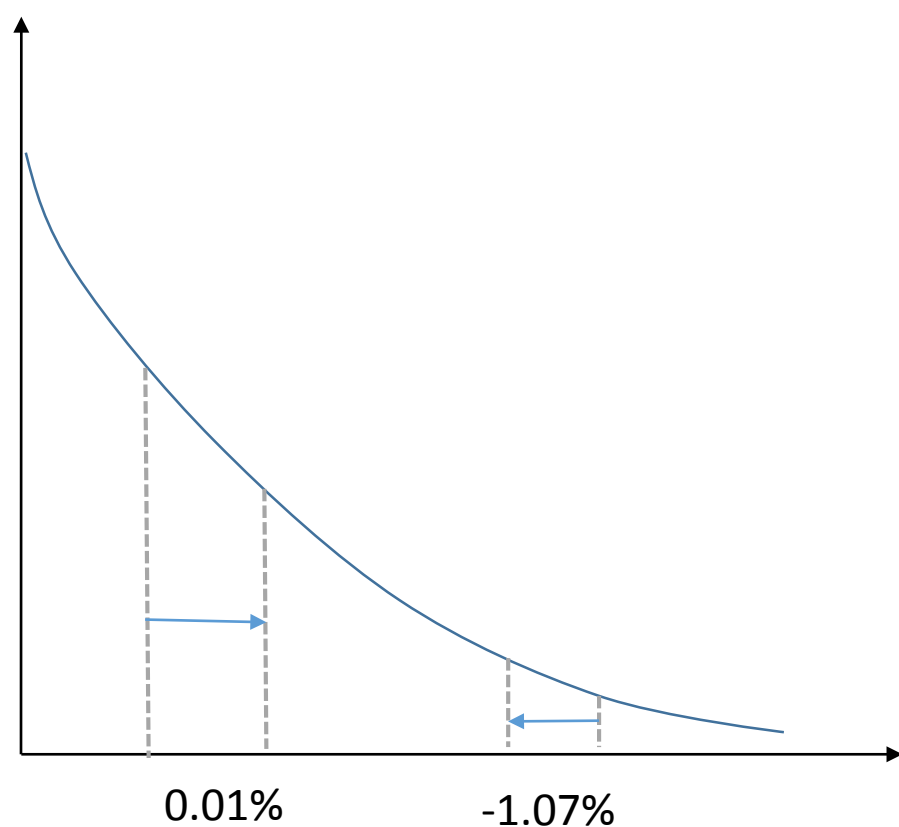Jeff Condon

Productivity thresholds

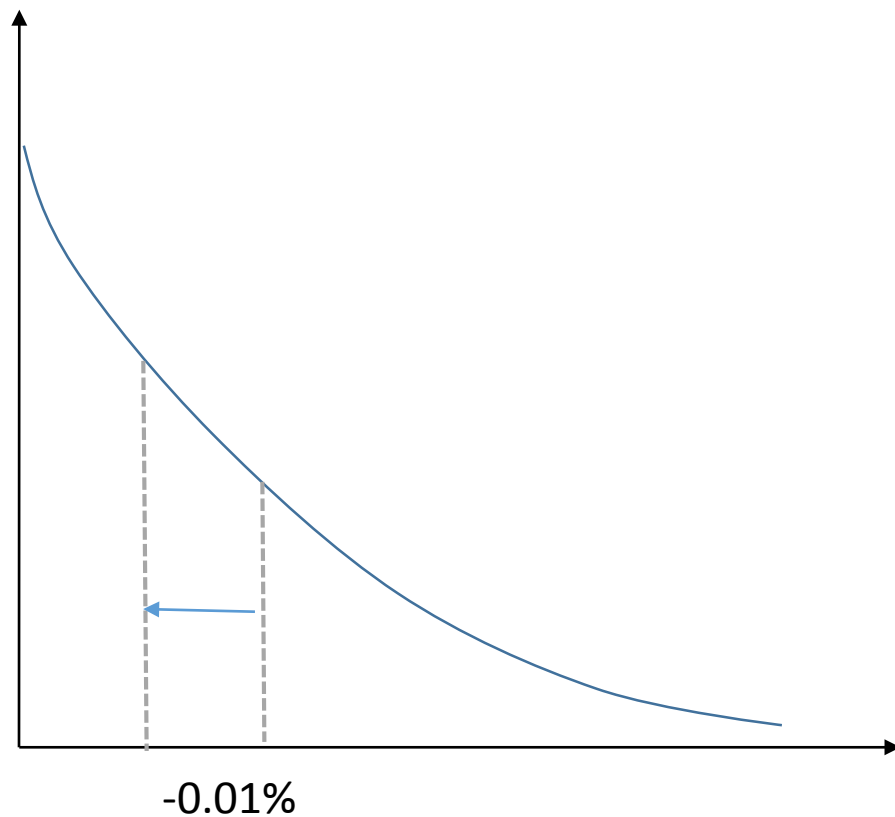# 1% subsidy on exports of MNFG from USA to JPN

0.01%

Domestic productivity threshold increases
    Fixed cost per sale increases
    Fixed costs to enter domestic market increase
    (*Sales in domestic market decreases*)
    Firms price of value added increases
    Value added demand for fixed domestic costs decreases
    Number of domestic firms decreases

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1% subsidy on exports of MNFG from USA to JPN
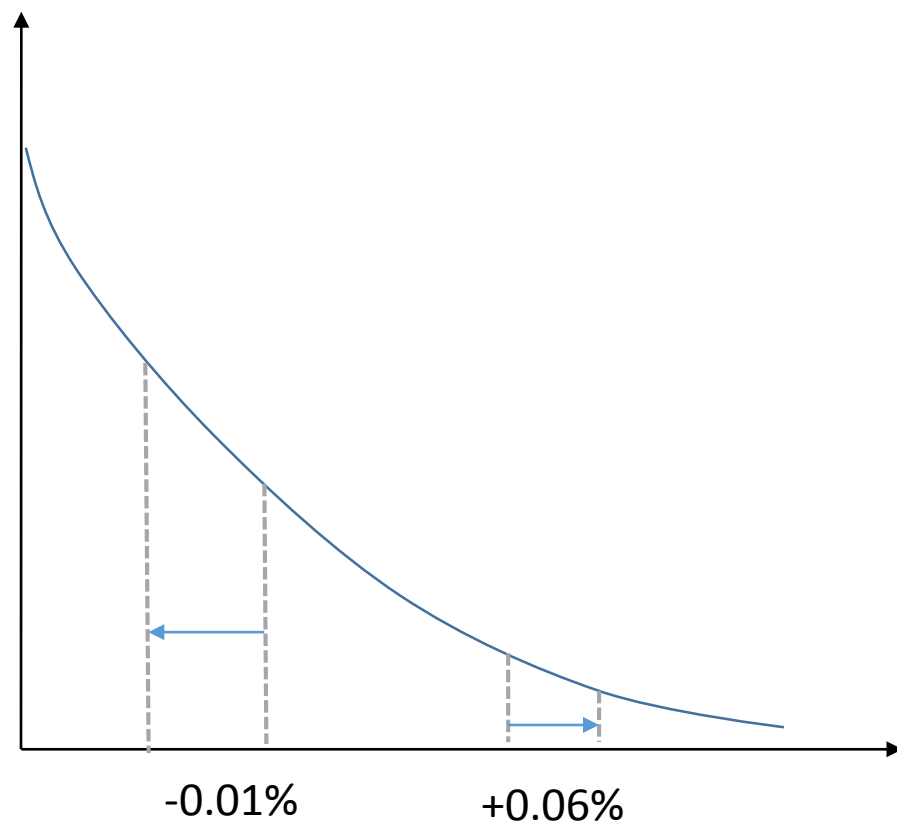

0.01%   -1.07%

Export productivity threshold decreases
  Fixed cost per sale decreases
  Fixed cost to enter market increases
  (But *sales in export market increase **more**!*)
  Firms price of value added increases
  Value added demand for fixed export costs increases
  Number of export firms increases

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1% subsidy on MNFG output in USA


-0.01%

Domestic productivity threshold decreases
   Fixed cost per sale increases
   (*But fixed cost per dollar of revenue decreases – because of the subsidy!*)
   Fixed costs to enter domestic market increase
   (*Sales in domestic market increases less*)
   Firms price of value added increases
   Value added demand for fixed domestic costs decreases
   Number of domestic firms decreases

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1% subsidy on MNFG output in USA

-0.01%   +0.06%

Export productivity threshold increases
  Fixed cost per sale increases
  Fixed cost to enter market increases
  (*Sales in export market increase **less**!*)
  Firms price of value added increases
  Value added demand for fixed export costs decreases
  Number of export firms decreases

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Productivity thresholds
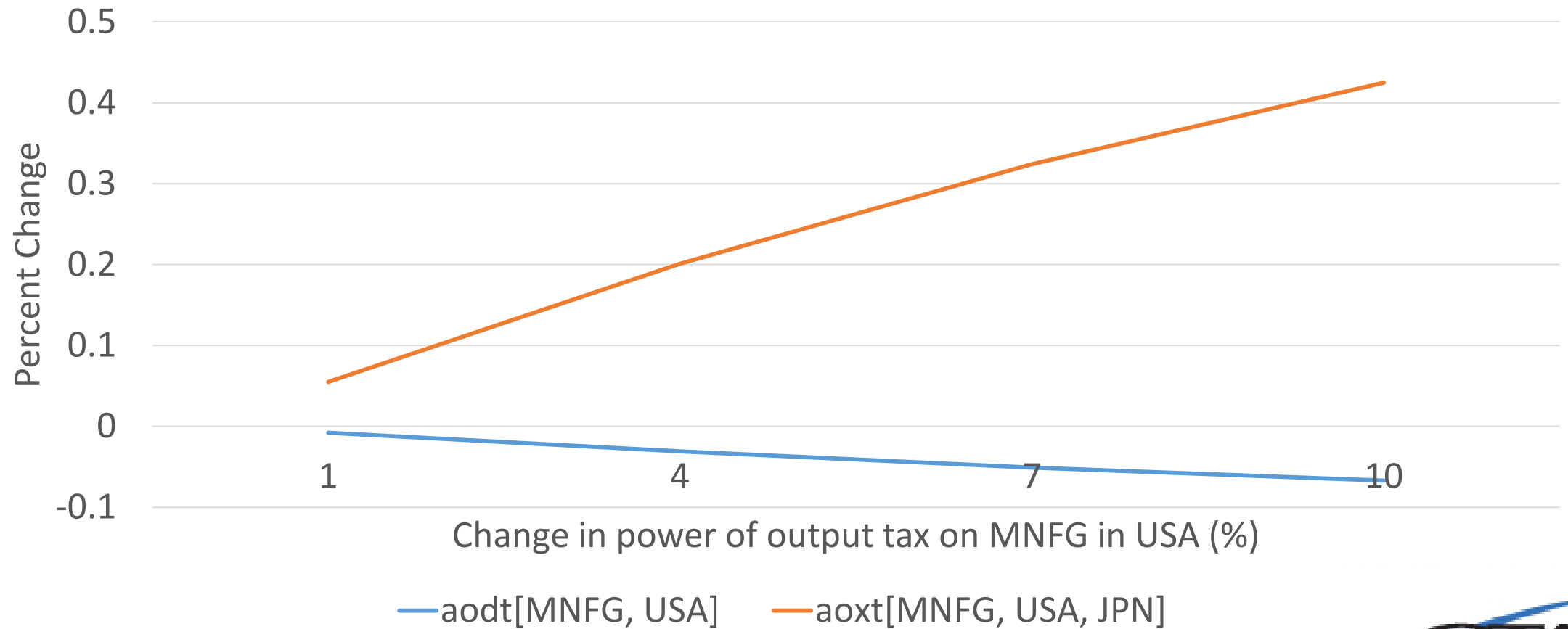
Findings (based on our little evidence)

- Tariff reductions/export subsidies
  - Increases number of exporting firms
  - Decreases number of domestic firms
- Output subsidy
  - Decreases number of domestic *and* exporting firms
  - Quantity of output per firm increases
- Domestic productivity threshold is quite sticky
- Productivity thresholds move in opposite directions

Future work

- Questions:
  - Under what conditions would both productivity thresholds move in the same direction in a CGE model?
    - One idea: introduce a tariff cut (or export subsidy) in a pair with large bilateral trade in a particular industry (e.g., Canada and the US automotive industry).
      - Expectation: export threshold decreases (as before)

        domestic threshold also decreases (saves on intermediate cost reductions, indirectly introduced by the tariff cut)
  - Why is the domestic market productivity threshold so sticky (relative to the export market productivity threshold)?