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Original thinking... applied

Challenges in the Economic Assessment of Food Safety Incidents

October 12th, 2021

EUCHINASAFE

中欧食品安全

Introductions

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Agenda

October 11th, 2021

1. Introduction to Economics for Food Scientists
    A. History of Economics
    B. Economics Themes and Supply and Demand
    C. Market Failure and the Role of Government

October 12th, 2021

1. Challenges in the Economic Assessment of Food Safety Incidents
    A. Economic Assessment of Food Safety
    B. Assessing Preferences for Food Safety
    C. Global Trade and Food: Biosecurity and Ecosystem Risk

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Economic Assessment of Food Safety

Measuring Costs of Food Safety Issues

Cost of Illness (CoI)

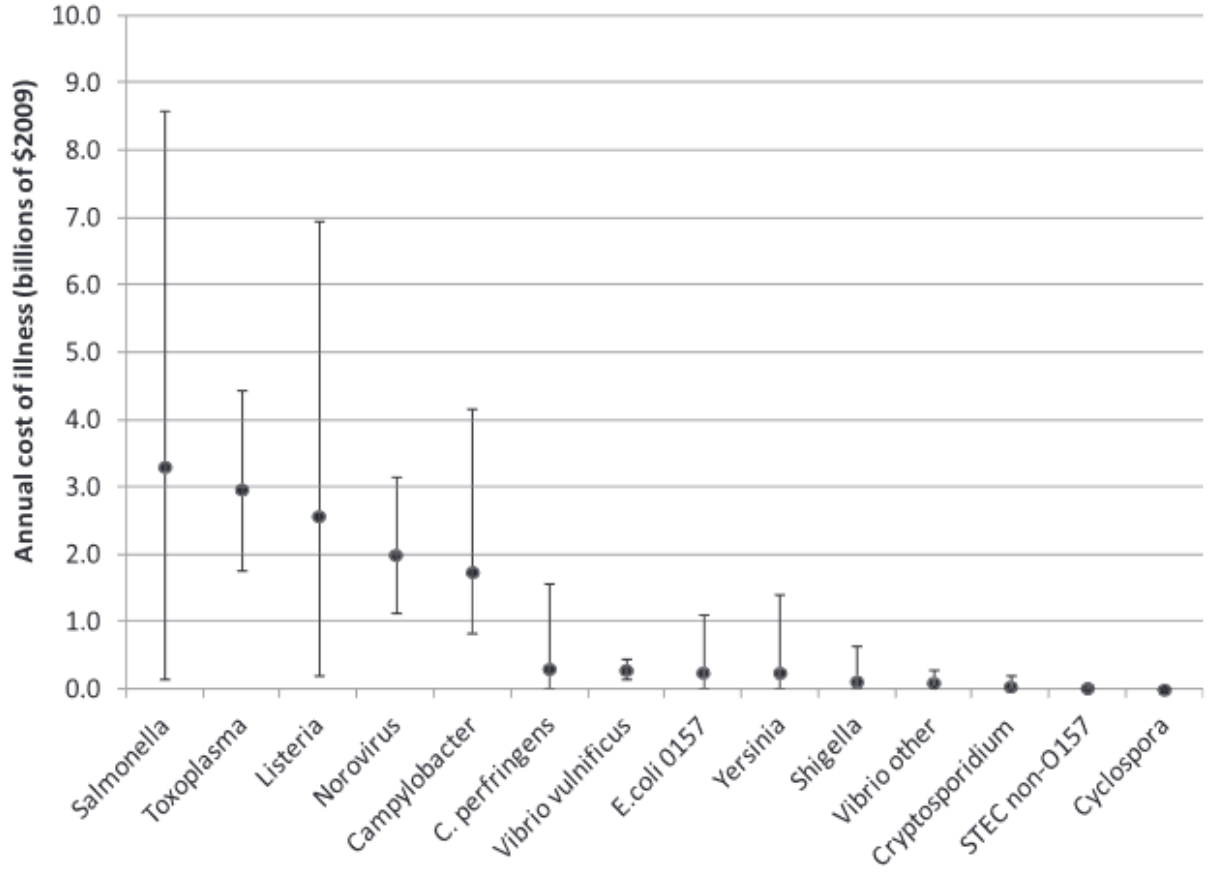
- Sum of medical expenses and lost wages due to illness

Health-Adjusted Life Years (HALYs)

1. Quality Adjusted Life Years (QALYs)
   - An individuals' comfort and ability to engage in normal activities
2. Disability Adjusted Life Years (DALYs)
   - Sum of the number of years of life lost to mortality and the number of years of life lived with morbidity.

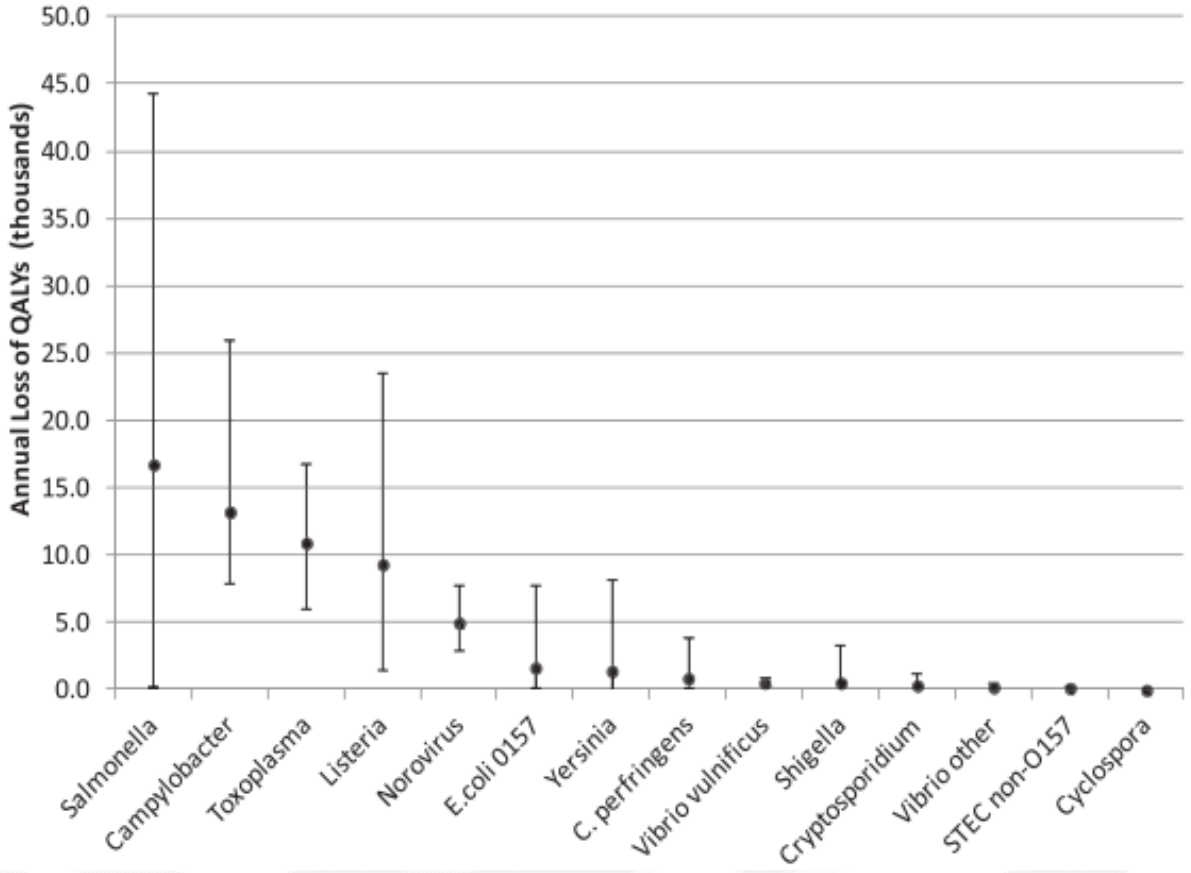
$$Value\ of\ a\ Statistical\ Life = Willingness\ to\ Pay \times \frac{Number\ of\ People}{Expected\ Reduction\ in\ Deaths}$$

Cost of Illness



Hoffmann S, Batz MB, Morris JG Jr. Annual cost of illness and quality-adjusted life year losses in the United States due to 14 foodborne pathogens. *J Food Prot*. 2012 Jul;75(7):1292-302. doi: 10.4315/0362-028X.JFP-11-417. PMID: 22980013.

Quality-Adjusted Life Years (QALYs)



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Key questions

Do the benefits of food regulation outweigh their cost?

Could we deliver a particular level of food safety more efficiently?

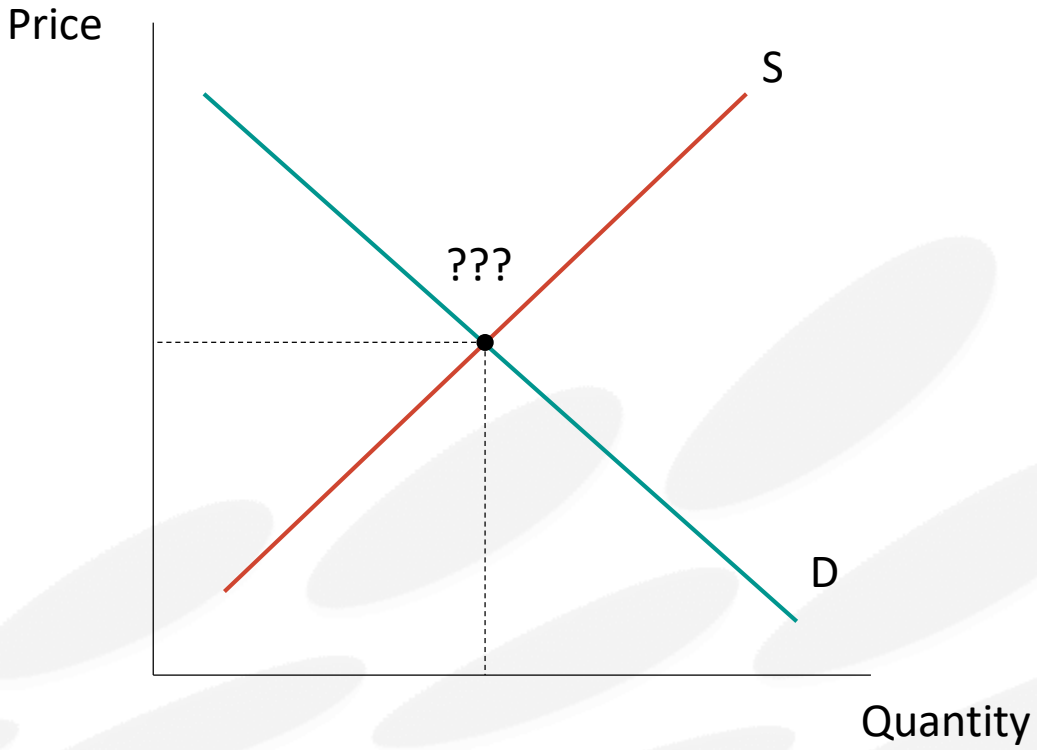
The Market for Food Safety

Assuming full information, the consumer demand for food safety is downward sloping

The supply of food safety is upward sloping

When is traditional supply-demand analysis inappropriate?

$$Remember\ these? \begin{cases} Concentrated\ market\ power \\ Public\ goods \\ Incomplete\ information \\ Principal-agent\ problem \\ Moral\ hazard \\ Externalities \end{cases}$$



Evaluation of food safety interventions

Regulatory cost benefit analysis initiated by Demsetz (1969):

1. Market mechanisms can often be employed and are more likely to allow consumers to choose the optimal level of food safety
2. Regulations are justified only if they pass a benefit cost test
3. Informed individual choice of food safety level is preferred to statutory safety standards when risk preferences vary from person to person (steak tartare, unpasteurised cheeses)
4. Even when regulation is justified, the costs of regulation can be minimised by the appropriate design of regulation (performance standards preferred to specification standards)

Demsetz, Harold. "Information and Efficiency: Another Viewpoint." *The Journal of Law & Economics* 12, no. 1 (1969): 1–22. http://www.jstor.org/stable/724977.

Cost Benefit Analysis

Does not make a choice for us

- It provides information that can be used to evaluate the implications of different choices.

Does not "price" nature or human lives.

- CBA methods summarize the trade-offs that people make in giving one thing to get something else.

Provides an organizational framework for identifying, quantifying, and comparing the costs and benefits (measured in money) of a proposed policy action.

The final decision is informed, though not necessarily determined, by a comparison of the total costs and benefits.

8 Steps of Effective CBA

1. Identification of alternative projects/polices
   - All available options (i.e., label types for food, production standards)

2. Whose costs and benefits should be considered?
   - Global, national, regional, local (i.e., global trade)

3. Potential impacts & measurement indicators
   - Impacts as benefits and costs – (reduction in food borne illness vs higher food price)

4. Quantitative prediction of impacts over time
   - Life of project or in each time period

8 Steps of Effective CBA

5. Monetize all impacts
    - Market and non-market valuation
6. Discounting to present value
7. Compute net present value
    - Time flow of costs and benefits
8. Sensitivity analysis
    - Uncertainties - impacts, valuation, of impacts, discount rate

CBA is not solely within the realm of economists – it needs strong input from scientists!
Don't let an economist do a food safety CBA on their own- YOU NEED TO BE INVOLVED

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Assessing Preferences for Food Safety

Methods

Many food attributes (not just food safety) have no market value

Cannot observe how demand changes as quality/quantity changes

Non-market valuation:

1. Revealed preference
2. Stated preference

Mostly stated preferences used to evaluate food safety

Revealed Preference

Weak complementarity: infer non-market value from a market in a well recognized commodity influenced by the non-market good.

- Housing market affected by noise, polluted air, visual aspects
- Labour market and occupational risks

Revealed preference methods: hedonic pricing, value of a statistical life, travel cost method

Hedonic Price Method

- Price of a good measured as a bundle of attributes
  - Price of house= f(number of bedrooms, square footage, noise levels, local amenities …)
  - Price of cherry tomatoes = f(packaging, origin, ripeness, shelf life…)
- Hedonic (or implicit) price function as a regression equation (choice of functional form)

$$P = a_0 G^{a_1} O^{a_2} R^{a_3}$$
$$ln(P) = a_0 + a_1 G + a_2 O + a_3 R$$

Where $G = packaging\ choice, O = origin, R = ripeness$

- a's measure change in P due to change in attribute

Hedonic Price Method

- E.g.) Hedonic price of cherry tomato ripeness

$$\frac{\partial ln(P)}{\partial R} = a_3 \frac{P}{R} \rightarrow positive$$

$a_3 \frac{P}{R}$ is the '<u>marginal market price</u>' of tomato ripeness.

Hedonic Price Method

Chinese consumer demand for food safety attributes in milk products

- Hazard Analysis Critical Control Point (HACCP) → quality management system used by Chinese producers to export their products
- Price premium of HACCP certification labels
- Prices and attributes of 403 milk products in supermarkets (milk, yogurt)
- Other attributes → packaging size, packaging type, protein content, shelf life, production region, supermarket name.

Wang, Zhigang, Yanna Mao, and Fred Gale. "Chinese consumer demand for food safety attributes in milk products." Food policy 33, no. 1 (2008): 27-36.
https://doi.org/10.1016/j.foodpol.2007.05.006

Hedonic Price Method

Chinese consumer demand for food safety attributes in milk products

HACCP certification has a 0.54 RMB per litre price premium

- Additional day of shelf life → 0.025 RMB per litre (additional 21 days equivalent to HACCP)
- Additional gram of protein per 100 ml → 1.08 RMB
- Premiums for Mengniu brand products similar to HACCP
- Premiums for Guangming, Wahaha, Lebaishi brand products more than 3 times the HACCP premium.

Cannot be sure the measure is comprehensive (not really a WTP measure)

- Are consumers aware of health effects of contaminated food products?

Only includes people who have bought the product

Wang, Zhigang, Yanna Mao, and Fred Gale. "Chinese consumer demand for food safety attributes in milk products." Food policy 33, no. 1 (2008): 27-36. https://doi.org/10.1016/j.foodpol.2007.05.006

Coffee Break and Questions

Stated Preference Methods

- Stated preference (SP) methods use carefully structured questionnaires to elicit individuals' preferences for a given change in food attributes.
- SP methods have been applied widely
- The only methods that can estimate non-use values which can be a significant component of overall value
- The main options in this approach are: contingent valuation and choice modelling.

The purpose of studying economics is not to acquire a set of ready-made answers to economic questions, but to learn how to avoid being deceived by economists

Joan Robinson

Contingent Valuation (CVM)

It is called “contingent valuation” because the valuation is contingent on a hypothetical scenario put to respondents

- Create the hypothetical market within interview questions. Market comprises:
    - a statement of the proposed change; and
    - an institutional mechanism through which the proposed change is to be provided/avoided and financed.
- Challenge: to make the market as realistic as possible.

Willingness To Pay (WTP) question

Contingent Valuation (CVM)

Format of WTP Question

- **Open Ended**:
  - ➢ "How much are you willing to pay for public good A?"

- **Bidding Game**:
  - 1) "Are you willing to pay X for public good A?"
  - 2a) If Yes to (1), "Are you willing to pay Y for public good A?" (Y>X)
  - 3a) If Yes (2a), "Are you willing to pay Z for public good A?" (Z>Y).
  - 4a) if Yes to (3a) …
  - If No to (Na), WTP questions stop.
  - 2b) If No to (1), "Are you willing to pay T for public good A?" (T<X)
  - …

- **Payment Cards**:
  - ➢ choose a WTP point estimate from a list of values

Contingent Valuation (CVM)

Questionnaire Design - Payment Vehicle

Must have a realistic institutional context - usually an appropriate **payment** (or **bid**) **vehicle** (**instrument**).

The payment vehicle is the mechanism through which the WTP/WTA values are to be raised/distributed.

Key considerations when selecting a payment vehicle are:

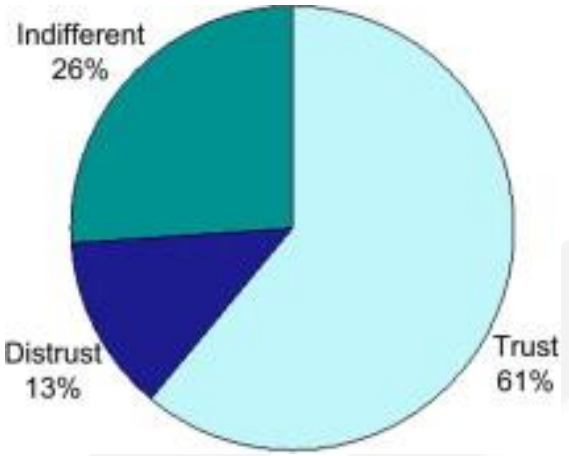
- **familiarity** – does the respondent understand the payment vehicle?
- **credibility** – does the payment vehicle represent a realistic situation?
- **empathy** – is the respondent favourably or unfavourably disposed towards the recipient of the funds?
- **feasibility** – is the recipient of the funds capable of delivering the improvement?
- **universality** – would all the respondents be affected by the payment vehicle?

Contingent Valuation (CVM)

Chinese consumer demand for food safety attributes in milk products

- Interviewed 590 shoppers about HACCP certification in Beijing
  - ➢ Have you heard of HACCP? How long have you been aware of HACCP? Do you trust HACCP?

- WTP → (1) Presented with price of non-certified HACCP certified product, then (2) asked what price they would pay for the same product with HACCP certification
  - Select from a series of prices with increments
  - Asked about products of 4 brands
  - Respondents not familiar with HACCP were provided information first



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Premium (RMB)	After receiving information Brand (package size, price)			
	Yili, 227 ml, RMB 1.30 (%)	Mengniu, 227 ml, RMB 1.65 (%)	Sanyuan, 250 ml, RMB 1.90 (%)	Sanlu, 227 ml, RMB 1.30 (%)
0	5.5	7.0	5.5	6.3
.05	31.1	34.5	19.9	37.2
.10	25.4	20.0	32.2	25.4
.15	5.4	15.7	6.4	5.0
.20	19.9	6.6	24.0	13.6
.25	1.1	4.1	1.1	2.1
.30	3.2	2.0	2	2.7
.35	1.8	4.7	1.8	1.6
.40	1.1	1.4	1.4	0.9
.45	0.5	0.5	1.8	0.2
.50	2.3	0.7	0	3.0
.55	0.9	0.9	1.8	0.0
.60	1.8	1.8	2.1	2.0
Weighted average (RMB)	.14	.13	.15	.13

Consumers willing to pay higher premium after HACCP information

Hedonic Price Model → HACCP certification has a 0.54 RMB per litre price premium

CVM → HACCP certification has comparable price premium (0.62, 0.57, 0.6, 0.57)

This doesn't always happen!

Wang, Zhigang, Yanna Mao, and Fred Gale. "Chinese consumer demand for food safety attributes in milk products." Food policy 33, no. 1 (2008): 27-36. https://doi.org/10.1016/j.foodpol.2007.05.006

Choice Experiments (CE)

Characteristics theory of value

- Any good can be described as a bundle of characteristics
  - Beef – shelf life, origin, organic, fat content …
  - Tomatoes – packaging, ripeness, origin …
- But difficult to completely describe attributes
  - Intangible, hard to measure, not observable …

- Provides method to determine public WTP for different facets or attributes of a composite food product
- Acknowledges that WTP may differ for the different attributes as well as for the provision of different levels of the same attribute
- Uses choice cards that provide participants with choice sets of different attribute levels.

Choice Experiments (CE)

Vaccinated against E.coli 73% Lean Conventional Grain-fed $3.49/lb	Fed Direct-fed microbials 73% Lean Organic Grain-fed $4.49/lb	No treatment 85% Lean Conventional Grass-fed $3.49/lb	I will not purchase
CHECK ONE → ☐	☐	☐	☐

Attributes → Health treatment, fat content, organic, feed, price

Choice Experiments (CE)

Alternative A	Alternative B	Alternative C
		Neither
I choose __	I choose __	I choose __

Attributes → food standard assurance, growth hormone free, promotional claim, country of origin

Choice Experiments (CE)

How does CE produce a valuation?

1. Convert the preferences (marginal contributions to utility) associated with each level of each attribute into a monetary equivalent ("**part worth**")
    - E.g. Dollar value of an additional measure of ripeness in tomatoes
2. Sum the "part worths" of a particular option to estimate WTP for that option
3. Aggregate from sample to appropriate population

Choice Experiments (CE)

Estimating "Part Worths"

- Respondents will choose the option on each card that delivers highest utility
- Perceived utility of each option = sum of separate contributions due to presence of attributes and levels

Utility of Option A $\rightarrow \sum\left[U(P_{L0}) + U\left(A^i_{L1}\right) + U\left(A^i_{L2}\right) + \cdots U(A^n_{LN})\right]$

Utility of Option B $\rightarrow \sum\left[U(P_{L3}) + U\left(A^i_{L3}\right) + U\left(A^i_{L1}\right) + \cdots U(A^n_{LN})\right]$

Stated Preference Methods

Estimating "Part Worths"

- Utility contribution from attributes can be positive (e.g. organic, grass fed) or negative (e.g. payment, use of growth hormones)

$$V(A) = a_o Organic_A + a_h Hormones_A + a_g Grass_A + \beta Payment_A$$
$$V(B) = a_o Organic_B + a_h Hormones_B + a_g Grass_B + \beta Payment_B$$
$$V(C) = a_o Organic_C + a_h Hormones_C + a_g Grass_C + \beta Payment_C$$

All parameters estimated by maximum likelihood methods.

Stated Preference Methods

Estimating "Part Worths"

- Parameters provide linkages between the levels of attributes present in the options

Parameters are first derivative with respect to appropriate variable

$$a_o = \frac{\partial V}{\partial Organic}$$

$$a_h = \frac{\partial V}{\partial Hormones}$$

$$\vdots$$

$$\beta = \frac{\partial V}{\partial Payment}$$

Stated Preference Methods

Estimating "Part Worths"

- Parameters tell us how perceived (or predicted) utility increases as the level attributes change
- But β is telling us the (dis)utility of a payment – how much utility decreases as payments increase

V ↑ as Organic, Grass Fed ↑

$$a_o = \frac{\partial V}{\partial Organic}$$

$$a_g = \frac{\partial V}{\partial Grass}$$

V ↓ as Hormones and payment ↑

$$a_h = \frac{\partial V}{\partial Hormones}$$

$$\beta = \frac{\partial V}{\partial Payment}$$

Stated Preference Methods

Estimating “Part Worths”

Relative size of a_o, a_g, a_h compared to β shows strength of influence of organic, grass fed, and hormone attributes exert over observed choice behaviour compared to the influence of a unit change in payment.

$$\frac{\partial V/\partial Organic}{\partial V/\partial Payment} = \frac{a_o}{\beta} \rightarrow \text{"£ value of organic"}$$

Stated Preference Methods

Labelling of Unhealthy Components of Food in Northern Ireland

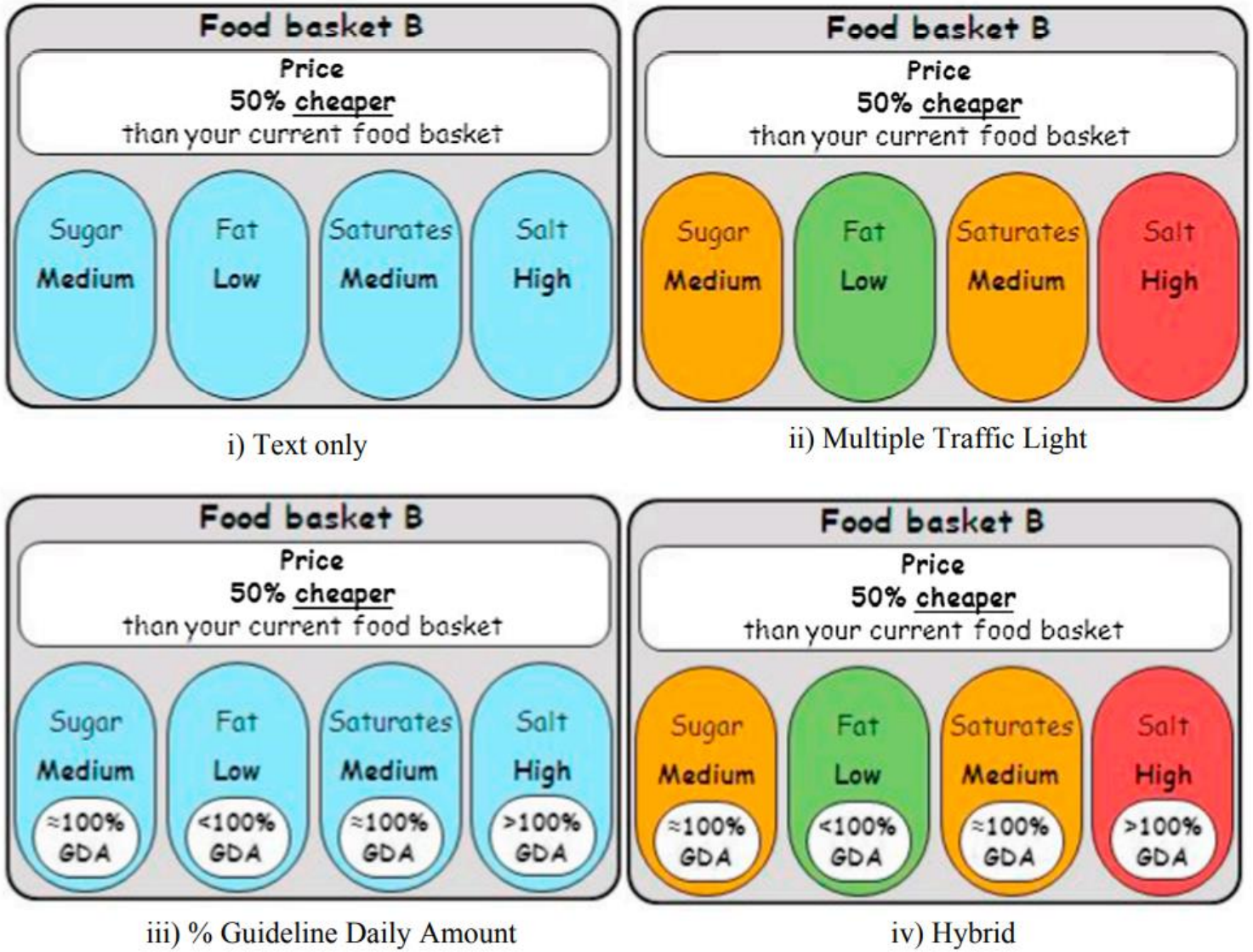
What is the influence of Front of Pack food labelling (FoPL) on consumer's choice of weekly food baskets?

- Survey of 797 people in Northern Ireland in 2011

Attributes and levels.

Attributes	Levels
Sugar	High, Medium, Low
Fat	High, Medium, Low
Saturated	High, Medium, Low
Salt	High, Medium, Low
Price	+50%, +20%, 0, −20%, −50%

Thiene, Mara, Riccardo Scarpa, Alberto Longo, and William George Hutchinson. "Types of front of pack food labels: Do obese consumers care? Evidence from Northern Ireland." Food Policy 80 (2018): 84-102. https://doi.org/10.1016/j.foodpol.2018.09.004



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Stated Preference Methods

Labelling of Unhealthy Components of Food in Northern Ireland

- Consumers show preference for their existing shopping practices (SQ)
- Price effect is negative, as expected.
- Negative preferences towards high levels of unhealthy attributes (“high”)
- Positive preferences for high levels of healthy attributes (“low”)

What about willingness-to-pay for healthier food options?

- Depends on what “class” a respondent belongs to
- Authors identified four classes: (1) healthy all-rounders, (2) high-fat lovers, (3) selectively focused (i.e., only care about a few attributes), (4) moderately interested

Thiene, Mara, Riccardo Scarpa, Alberto Longo, and William George Hutchinson. "Types of front of pack food labels: Do obese consumers care? Evidence from Northern Ireland." Food Policy 80 (2018): 84-102. https://doi.org/10.1016/j.foodpol.2018.09.004

Stated Preference Methods

Willingness to Pay estimates (marginal).

Attributes	Class1	Class2	Class3	Class4
sug_Low	46.5	30.7	−10.6	−1.8
sug_High	−74.1	26.0	−126.2	−1.8
fat_Low	35.7	4.2	−2.9	−0.9
fat_High	−88.2	9.8	−183.8	−2.4
stfat_Low	38.6	−17.8	32.9	−1.9
stfat_High	−83.7	−28.5	−172.6	−1.4
slt_Low	46.0	−33.5	52.3	−0.4
slt_High	−56.9	−15.2	−181.3	−1.8

Market Segmentation?

(1) healthy all-rounders, (2) high-fat lovers, (3) selectively focused (i.e., only care about a few attributes), (4) moderately interested

Thiene, Mara, Riccardo Scarpa, Alberto Longo, and William George Hutchinson. "Types of front of pack food labels: Do obese consumers care? Evidence from Northern Ireland." Food Policy 80 (2018): 84-102. https://doi.org/10.1016/j.foodpol.2018.09.004

Stated Preference Methods

Preferences for Food Safety Attributes, Fuji Apple in China

What is the WTP for selected food safety attributes of Fuji apple products in China?

- 2092 people across Beijing, Shanghai, Guangzhou, Xi'an, Jinan, and Harbin

Fuji apple attributes:

1. Traceability: (a) no traceability, (b) traceability in production, (c) traceability in production and processing, (d) traceability in production, processing, and distribution
2. Certification type: (a) no certification, (b) government, (c) domestic third-party, (d) international third-party
3. Region of origin: (a) none, (b) Shandong, (c) Xinjiang, (d) Shaanxi
4. Price: (a) 6 yuan, (b) 8 yuan, (c) 10 yuan, (d) 12 yuan

Liu, Ruifeng, Zhifeng Gao, Heather Arielle Snell, and Hengyun Ma. "Food safety concerns and consumer preferences for food safety attributes: Evidence from China." Food Control 112 (2020): 107157. https://doi.org/10.1016/j.foodcont.2020.107157

Option A	Option B	Option C
Traceability information that includes production, processing and distribution parts of the value chain	Traceability information that includes production	Neither A or B
International third-party certification	No certification	
Shaanxi	Xinjiang	
Price： 12 yuan per 500 g	Price： 8 yuan per 500 g	
◎	◎	◎
I choose…		

Liu, Ruifeng, Zhifeng Gao, Heather Arielle Snell, and Hengyun Ma. "Food safety concerns and consumer preferences for food safety attributes: Evidence from China." Food Control 112 (2020): 107157. https://doi.org/10.1016/j.foodcont.2020.107157

Stated Preference Methods

Preferences for Food Safety Attributes, Fuji Apple in China

Three distinct groups:

1. “certification oriented” (65.9 %)
   - positively influenced by Fuji apple's traceability information, certification type, and origin
2. “price and origin-oriented” (19.1%)
   - Still care about food safety, but care more about price and origin comparatively.
3. “not interested” (15.0%)
   - Consumers in this class derive positive utility from choosing no alternative option.

Overall, Chinese consumers place the highest value on government certification.

Chinese consumers place the least value on traceability that includes only the production part of the process.

Liu, Ruifeng, Zhifeng Gao, Heather Arielle Snell, and Hengyun Ma. "Food safety concerns and consumer preferences for food safety attributes: Evidence from China." Food Control 112 (2020): 107157. https://doi.org/10.1016/j.foodcont.2020.107157

WTP Estimates

Variable	Class1 (Certification -oriented)	Class 2 (Price and origin-oriented)	Class 3 (Not interested)
Lotrace	5.86	0.35	2.70
	[4.71, 7.02]	[0.07, 0.63]	[0.66, 4.74]
Mitrace	9.40	0.30	4.96
	[7.70, 11.09]	[0.00, 0.60]	[2.42, 7.50]
Hitrace	11.69	0.54	7.69
	[9.68, 13.69]	[0.22, 0.87]	[4.51, 10.87]
Govcert	16.02	0.88	10.20
	[13.37, 18.88]	[0.53, 1.23]	[6.23, 14.18]
Dothccert	12.97	0.73	6.70
	[10.78,15.17]	[0.43, 1.03]	[3.73, 9.66]
Inthcert	14.78	1.04	7.49
	[12.29,17.27]	[0.75, 1.34]	[4.37, 10.61]
Xinjiang	12.13	1.49	9.36
	[10.04, 14.22]	[1.15, 1.82]	[5.32, 13.41]
Shandong	12.57	1.39	10.95
	[10.43, 14.71]	[1.06, 1.72]	[6.45, 15.46]
Shaanxi	11.52	2.03	8.83
	[9.57, 13.48]	[1.66, 2.40]	[4.99, 12.66]

Liu, Ruifeng, Zhifeng Gao, Heather Arielle Snell, and Hengyun Ma. "Food safety concerns and consumer preferences for food safety attributes: Evidence from China." Food Control 112 (2020): 107157. https://doi.org/10.1016/j.foodcont.2020.107157

Coffee Break

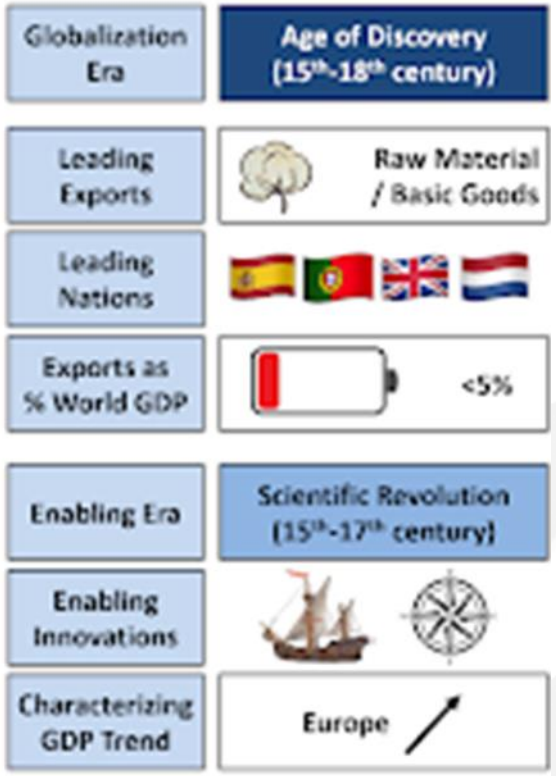
Global Trade and Food: Biosecurity and Ecosystem Risk

Globalization

Globalization: the process by which businesses or other organizations develop international influence or start operating on an international scale.

"is the process of world shrinkage, of distances getting shorter, things moving closer. It pertains to the increasing ease with which somebody on one side of the world can interact, to mutual benefit, with somebody on the other side of the world."

- Thomas Larsson, *The Race to the Top: The Real Story of Globalization*



- Not a recent phenomena…

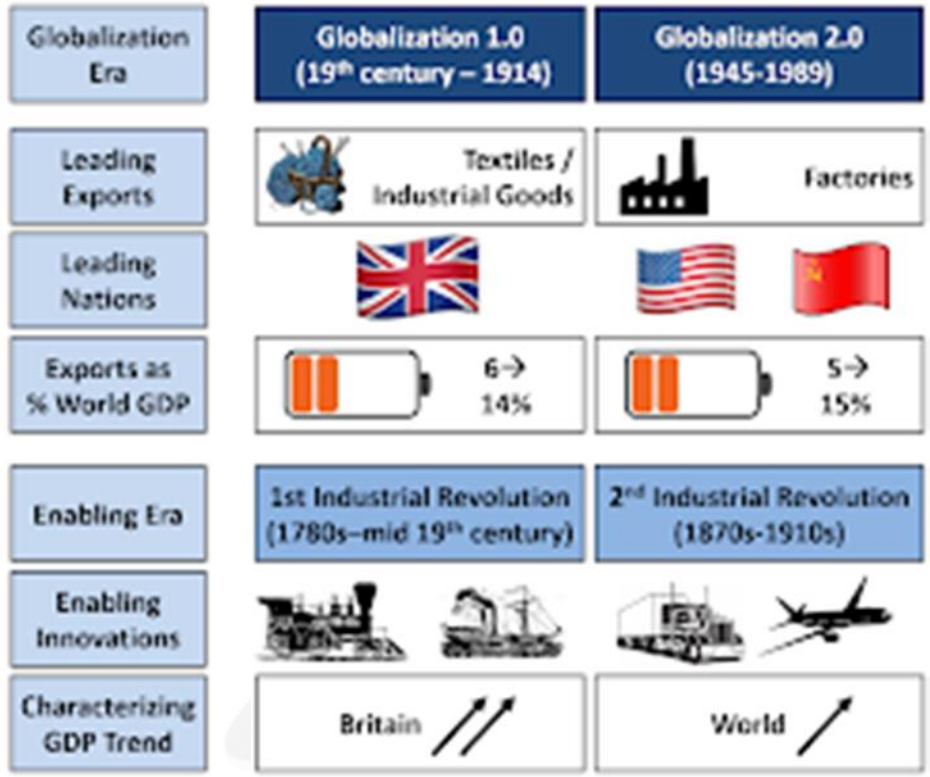
Globalization

Globalization 1.0 → Pre-WW1

- Historic drop in trade costs: steam and other forms of mechanical power
- Little government intervention or support (Bank of England, Navy)
- "free-for-all" system

Globalization 2.0 → Post-WW2

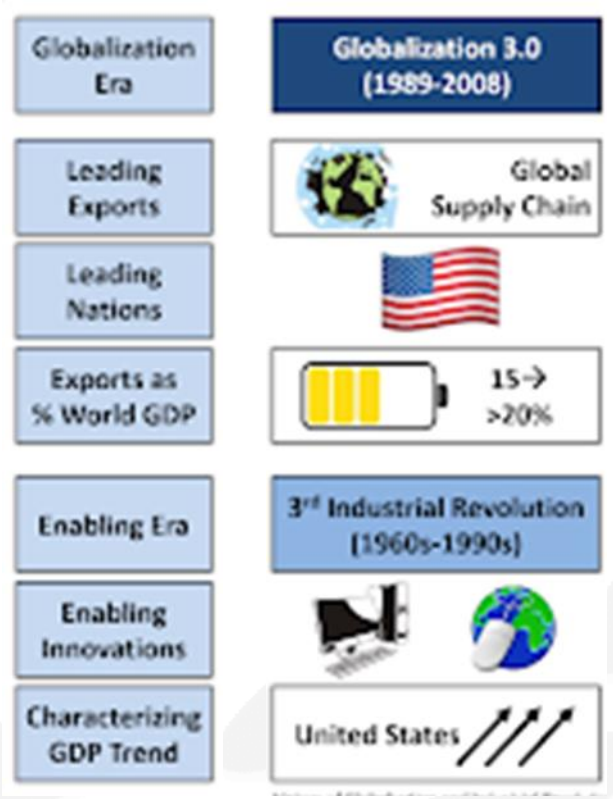
- The fall of European empires
- Markets still free, but government now had a larger role in economic justice
- UN, IMF, World Bank, GATT/WTO, Food and Agricultural Organisation and International Labour Organisation.



Globalization

Globalization 3.0 → 1990 – 2008

- Richard Baldwin: **New Globalization**, Arvind Subramanian: **Hyperglobalization**, Gary Gereffi: **global value chain revolution**, Alan Blinder: **Offshoring**
- Factories crossing boarders; the hunt for cheap labour
- *Benefits*: lower labour costs, increase specialization, lower agency costs
- *Critique*: disrupts the lives of workers who struggle to compete with high technology and low wages



Nike

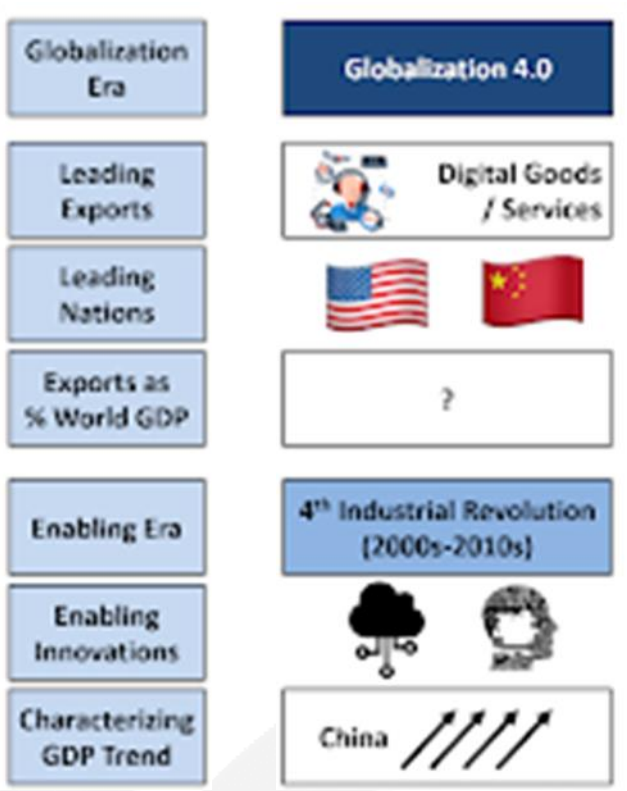
2003 → Global workforce of 660,00 but only 23,000 directly employed staff!

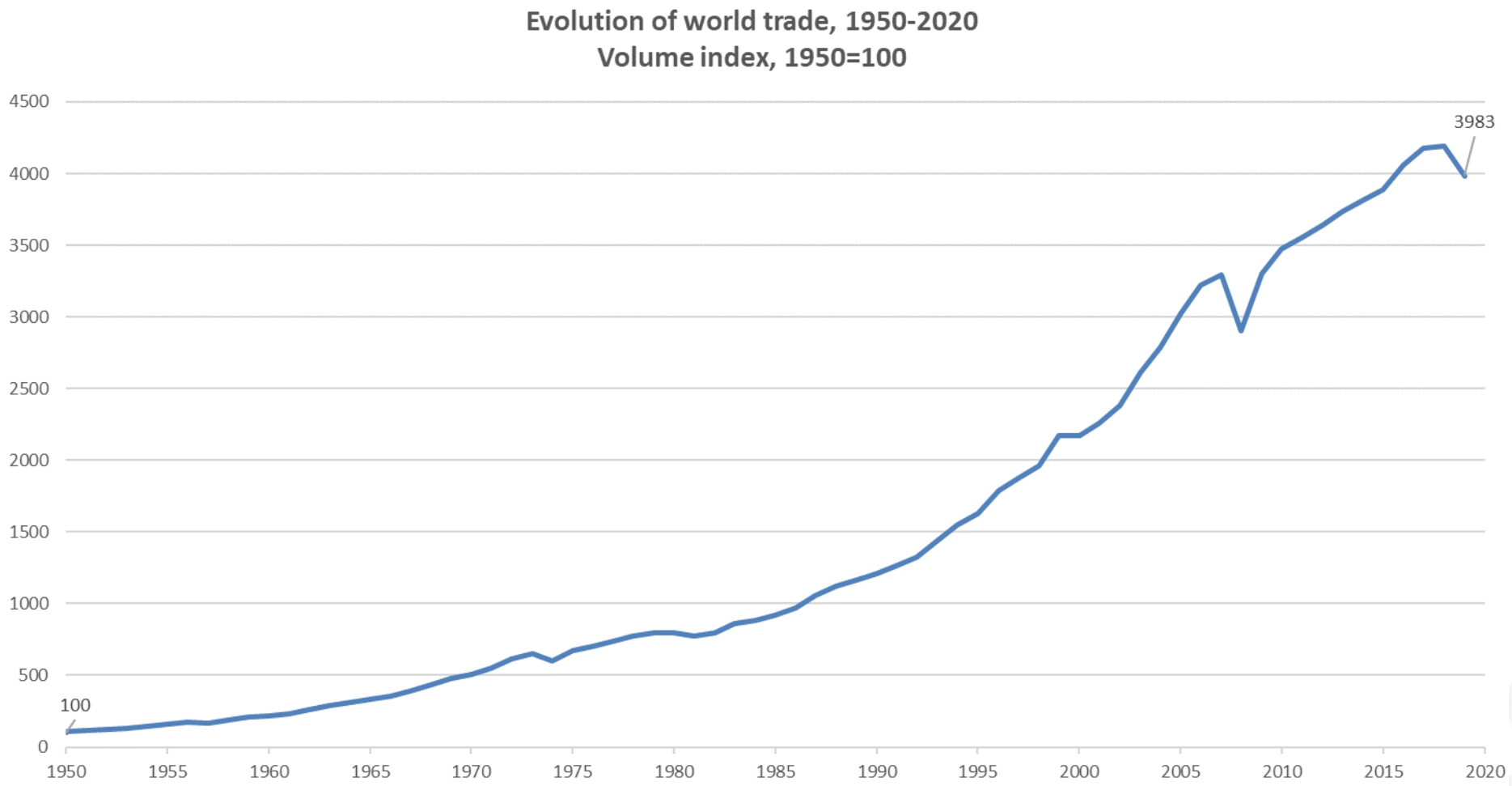
Globalization

- Globalization 4.0 → Now!
  - Services driven, not goods driven
  - Face-to-face service used to be necessary; is it still today?
  - Digital technology removing barriers to wage arbitrage in the service sector

E.g. Could companies pay workers less for working from home?

https://www.bbc.co.uk/news/business-58171716





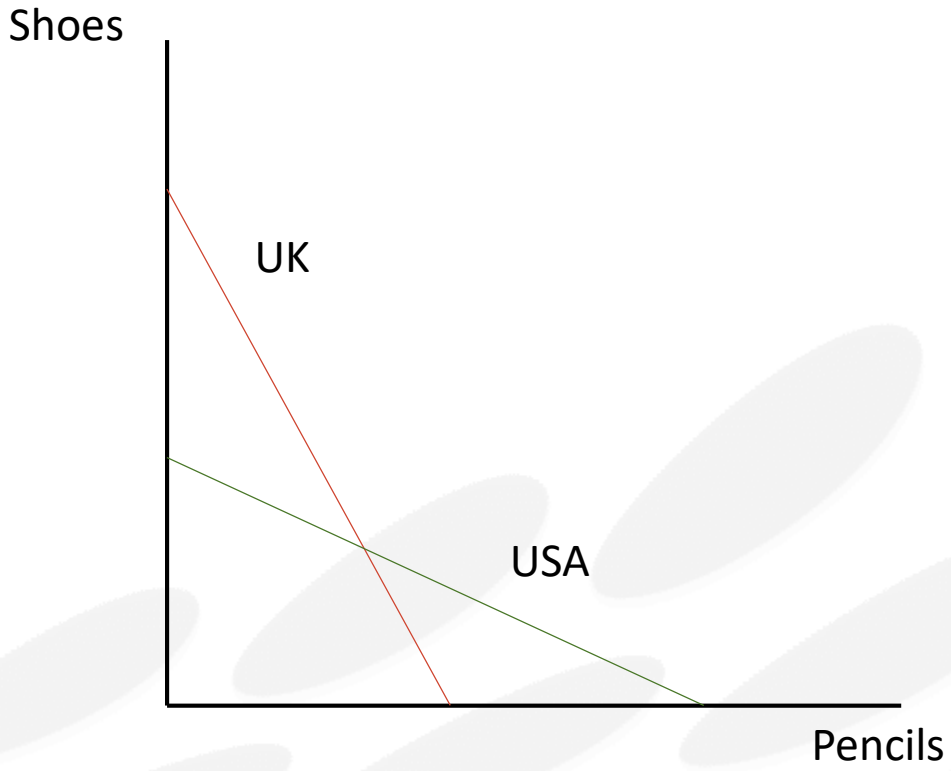
https://www.wto.org/english/res_e/statis_e/trade_evolution_e/evolution_trade_wto_e.htm

Why do Countries Trade?

Adam Smith: Absolute Advantage

- Trade only occurs when there are absolute cost differences between countries.
- UK has an absolute advantage in producing pencils; USA shoes

"It is the maxim of every prudent master of a family, never to attempt to make at home what it will cost him more to make than to buy" – Adam Smith

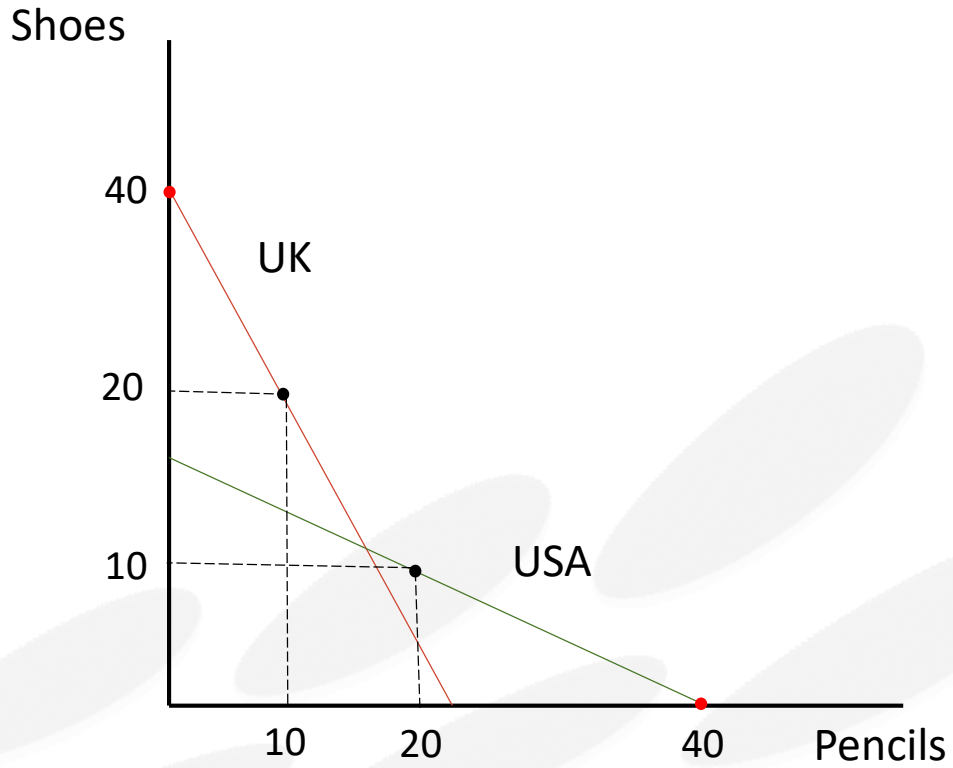


Why do Countries Trade?

Adam Smith: Absolute Advantage

- Before trade → UK produces 20 shoes, 10 pencils; USA produces 10 shoes, 20 pencils.
- After trade → UK produces 40 shoes, 0 pencils; USA produces 0 shoes, 40 pencils
- Both countries gain 10 units of output!

Labour Requirements				
Country	*Labour*	*Shoes*	*Pencils*	*Exchange Ratio*
UK	1	20	10	1 Shoes = 0.5 Pencils
USA	1	10	20	1 Shoes = 2 Pencils



Why do Countries Trade?

David Ricardo: Comparative Advantage

- Two countries (UK and USA) can produce two goods (shoes and pencils).
- USA → produces shoes and pencils more efficiently than the UK; shoes more efficient **relative** to pencils
    - ➢ Why? Technological differences
- Should the UK be fearful? No.
- UK should export pencils to the USA in exchange for shoes. Should not produce shoes itself.
- USA is better off to specialize in shoes, and import pencils from the UK
- Both countries will be better off!

Why do Countries Trade?

Situation 1:

USA → 12 shoes and 18 pencils = 30 total

UK → 3 shoes and 15 pencils = 18 total

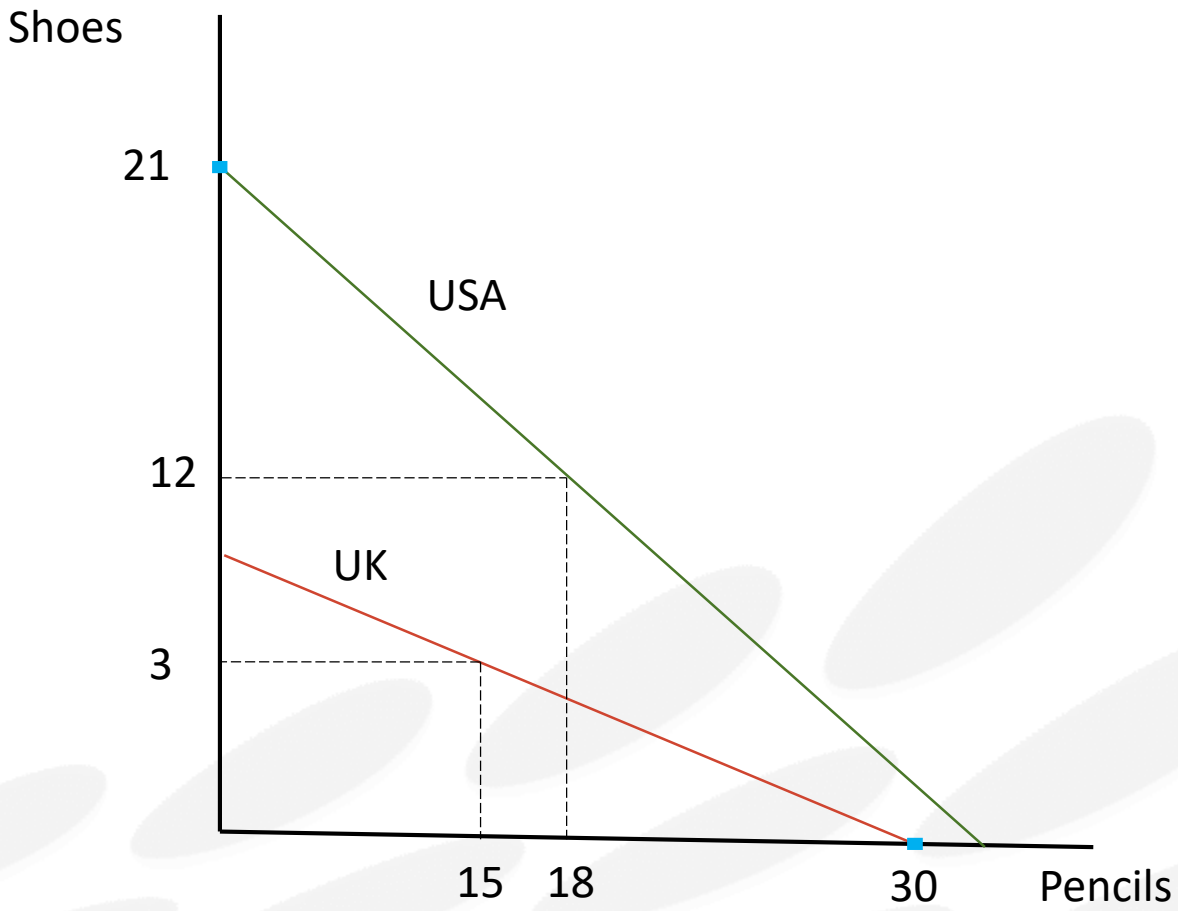
TOTAL = 48

Situation 2:

USA → 21 shoes and no pencils = 21 total

UK → No shoes and 30 pencils = 30 total

TOTAL = 51



Why do Countries Trade?

David Ricardo: Comparative Advantage

In reality?

- What about transportation costs? Externalities? Food safety?
- Do we really see countries specialize in just one good?
- What about food security? Shouldn't there be some minimum amount of domestic production?
- Assumes capital (labour, machines) is not mobile.

Why do Countries Trade?

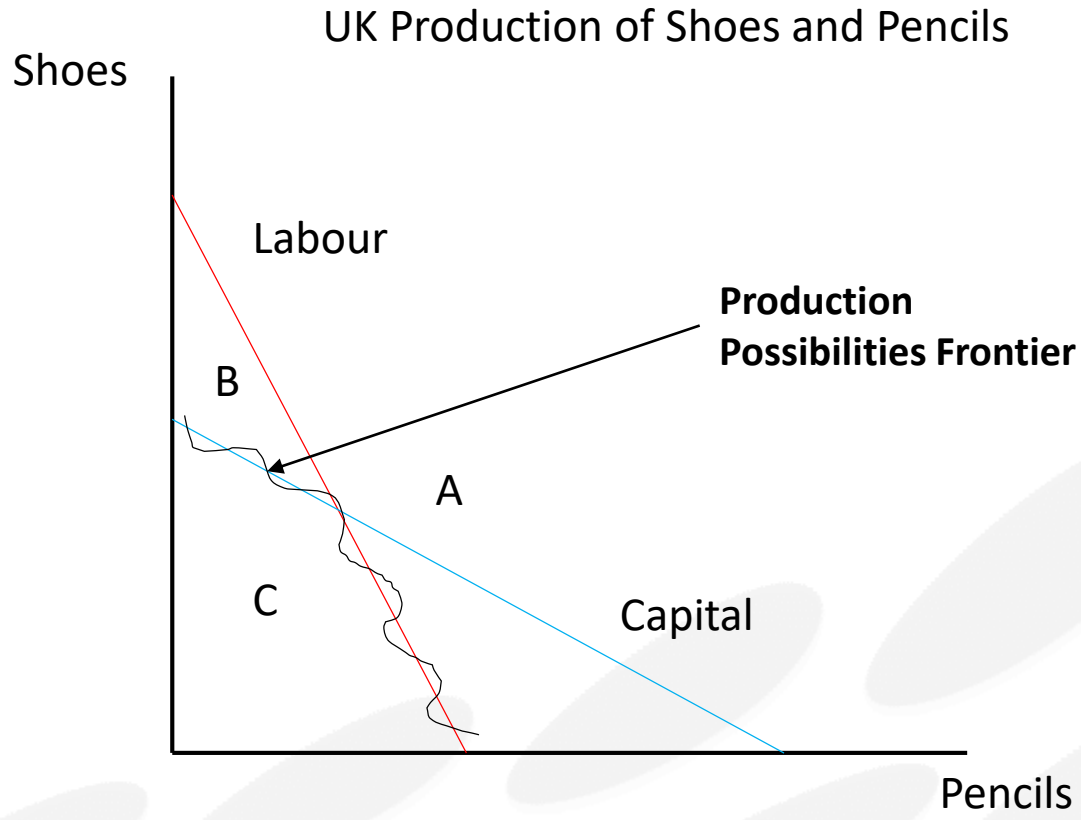
Heckscher-Ohlin-Samuelson (HOS)

- Includes more factors of production than absolute and comparative advantage (labour AND capital).
- Both inputs are mobile across sectors.
- Production techniques are identical between countries.
- Identical consumer preferences, and perfect competition.
- Why do countries trade? **Difference in factor endowments**

Why do Countries Trade?

Heckscher-Ohlin-Samuelson (HOS)

- Can we produce at A?
  - No
- Can we produce at B?
  - No
- Can we produce at C?
  - Yes

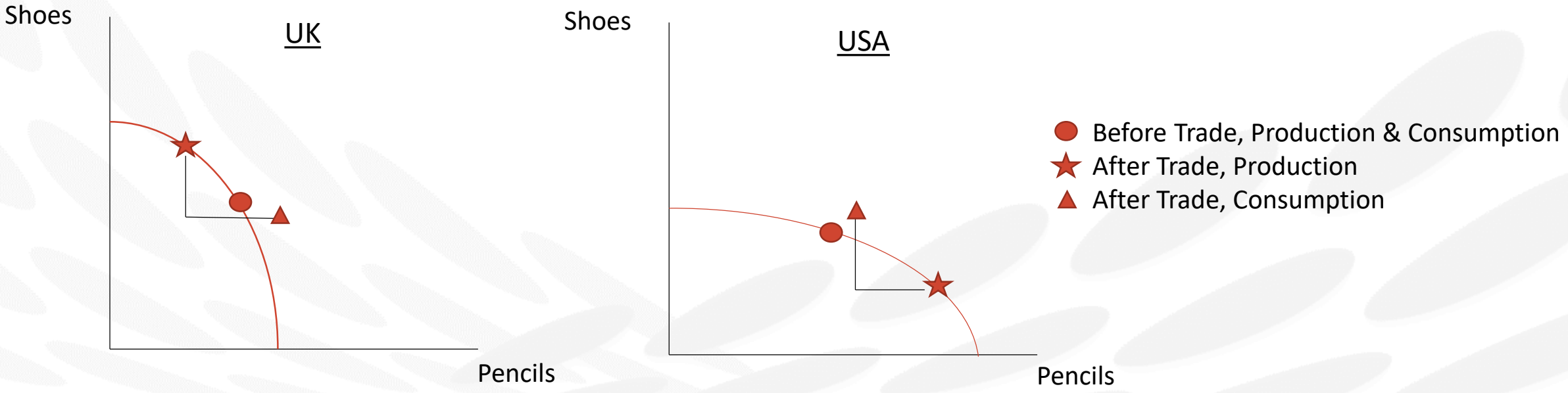


Production possibilities frontier (PPF): amounts of two goods that can be produced given finite resources

Why do Countries Trade?

Heckscher-Ohlin-Samuelson (HOS)

- Export the good which makes the most intensive use of it's abundant factor of production.
- Both countries can reach consumption levels outside of their PPF by trading.



Why do Countries Trade?

Heckscher-Ohlin-Samuelson (HOS)

- Contrary evidence? Leontief (1953) → US imports more capital intensive goods than they export; "Leontief paradox"
- Studies at the time found trade occurred between countries with the same factor endowments
- Large amounts of intra-industry trade between industrial countries.

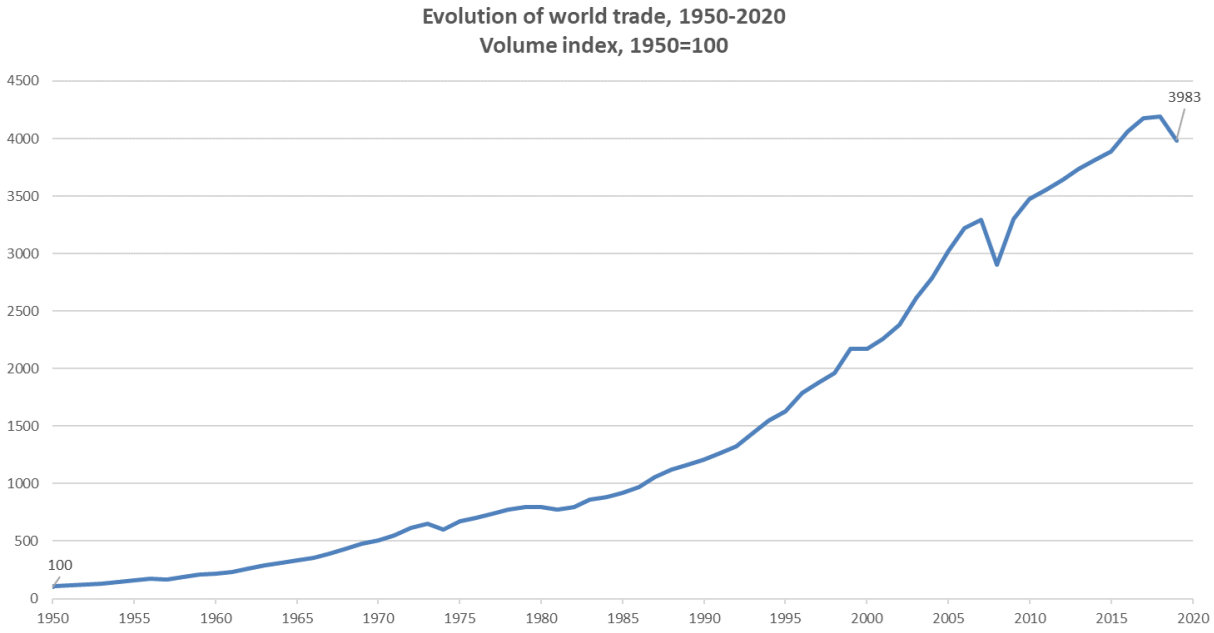
We need something better…

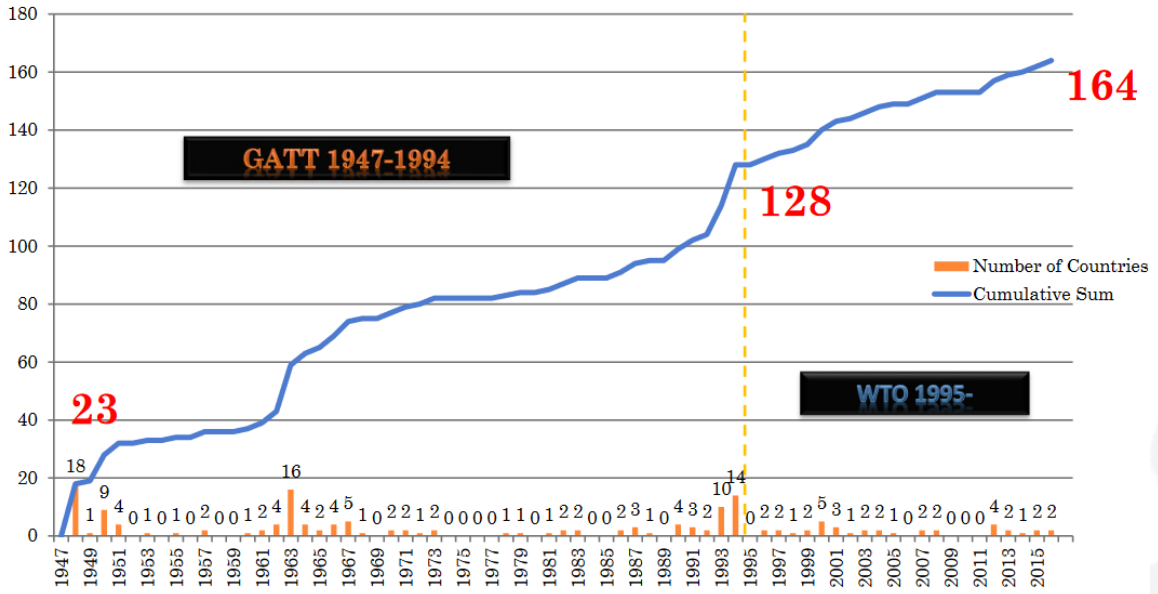
Why do Countries Trade?

Modern Trade Theories

- Technology Gap Theory (Posner, 1961)
  - Countries who introduce new products to the market enjoy a competitive advantage and monopoly power
- Product Life-Cycle Theory (Vernon, 1961)
  - Production of a product gradually moves away from where it was made after it has been adopted and used in the world markets (E.g. Xerox photocopiers in USA → Japan)
- Gravity Theory of Trade (Tinbergen, 1962)
  - Based on Newton's Law of Gravity. Trade more likely to happen between two countries of similar size and proximity.
- Armington Theory of Trade (Armington, 1969)
  - Goods are different based on country of origin. Consumers like to consume some of each (E.g. grapes from China vs. Italy)

Global Trade: GATT and the WTO





https://www.wto.org/english/thewto_e/acc_e/day_1_an_overview_of_the_wto_accession_process_dimitar_bratanov.pdf

164 members as of 2021; 25 observer countries

Global Trade: GATT and the WTO

A Brief History

- Post-WWII → the need for a free trade mechanism kicks up a notch
- General Agreement on Tariffs and Trade (1948); initially as a trade agreement between participating countries
- Major change in 1995 (eighth round of GATT negotiations)– Agreement between members to set up a formal umbrella organization → The WTO
- Improved version of the General Agreement of Tariffs and Trade (GATT)
  - GATT primary and manufactured goods only; WTO includes services and intellectual property
  - GATT advisory; WTO authority, compliance, mandates

"… trade and economic endeavour should be conducted with a view to raise the standard of living… in accordance with the objectives of sustainable development, seeking both to protect and preserve the environment…"

- WTO → maximize social welfare

Global Trade: GATT and the WTO

Rules of WTO

- Non-discrimination
- Reciprocity
- Binding and enforceable commitments
- Safety provision within 'least-restrictive' trade to protect, for example, the environment, human, animal, or plant health.

Trade disputes and adherence to the rules → clear sense, interpretation, and context

Extensive dispute settlement process

Article 13 – "Right to Seek Information"

Global Trade: GATT and the WTO

Global trade a risk to food safety and food security

Trade Disputes Related to Food

- US-Netherlands and EU – Tuna-Dolphin II, 1994
- Australia vs. Canada – Measures affecting importation of salmon, 1995
- Us vs. India, Pakistan, Malaysia and Thailand – Shrimp and Shrimp products, 1998

Trade and Food: Biosecurity Risk

Australia vs. New Zealand – Measures Affecting the Importation of Apples from New Zealand, 2007

- 16 Australian phytosanitary measures; fire blight, European canker, apple leaf curling midge
- New Zealand → Australian import restrictions of apples violated the, "least trade restrictiveness" policy of the WTO
- Australia ignored important factors
  - ➢ border inspections, production processes, climactic conditions, diseases and pests in New Zealand
- Lack of data in debate and deliberations; 'technical and economic feasibility' of alternatives to import ban.

Trade and Food: Biosecurity Risk

Australia vs. New Zealand – Measures Affecting the Importation of Apples from New Zealand, 2007

Outcome? In general, ruling in favor of New Zealand

- Measures from Australia to control the 3 pests violated several WTO Articles
- Australia to adopt WTO-complaint meassures
- But, New Zealand unable to prove prohibition on discrimination or disguised restriction

Trade and Food: Biosecurity Risk

Australia vs. New Zealand – Measures Affecting the Importation of Apples from New Zealand, 2007

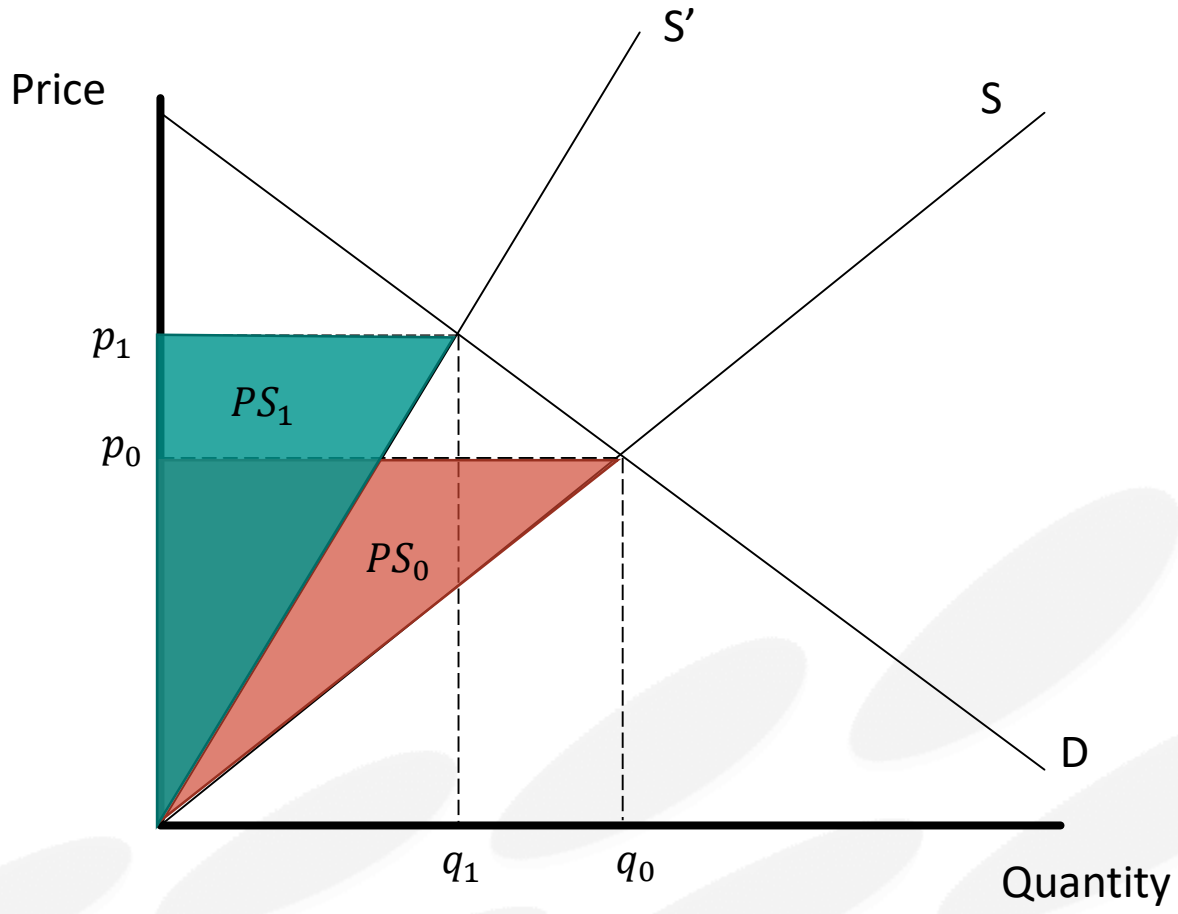
Consumer surplus: the difference between the price a consumer is prepared to pay and the actual price paid.

Producer surplus: difference between the market price received by the seller and the price they would have been prepared to supply at.

Trade and Food: Biosecurity Risk

Should Australia Import Apples from New Zealand?

- No imports; produces q_0 at p_0
- Chance of exotic pest or disease (α) is low
- Exotic pest or disease; supply shock from S to S'
- Lower quantity produced q_1, higher price p_1
- Government has to pay money to control/eradicate the pest → C



<u>Expected Impact from No Trade</u>

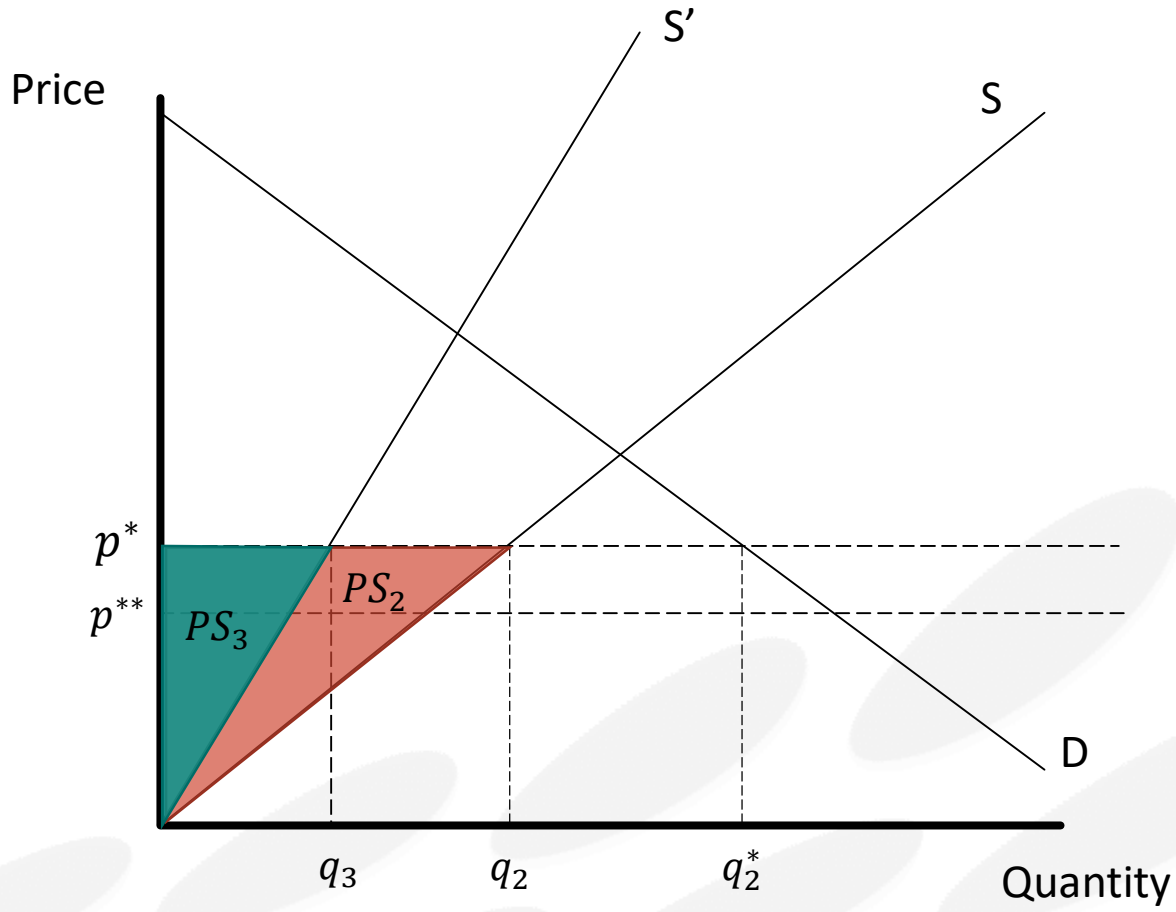
→ Difference between producer surplus, PLUS control/eradication costs

$$EI_{NT} = \alpha \times (PS_0 - PS_1 + C)$$

Trade and Food: Biosecurity Risk

Should Australia Import Apples from New Zealand?

- World price p^{**} greater than domestic price p_0
- New domestic market price (p^*) equals world price plus a mark-up
- Trade deficit: import $q_2^* - q_2$
  - Increase trade risk: α^*
- Exotic pest or disease; supply shock from S to S'
- Lower quantity produced q_3



Expected Impact from Trade

→ Difference between producer surplus, PLUS control/eradication costs

$$EI_T = \alpha^* \times (PS_2 - PS_3 + C)$$

Trade and Food: Biosecurity Risk

Should Australia Import Apples from New Zealand?

Pros from trade?

- Quantity available to consumers q_2^* at the lower price, p^*

Cons from Trade?

- Producers face lower prices $p^* < p_0$

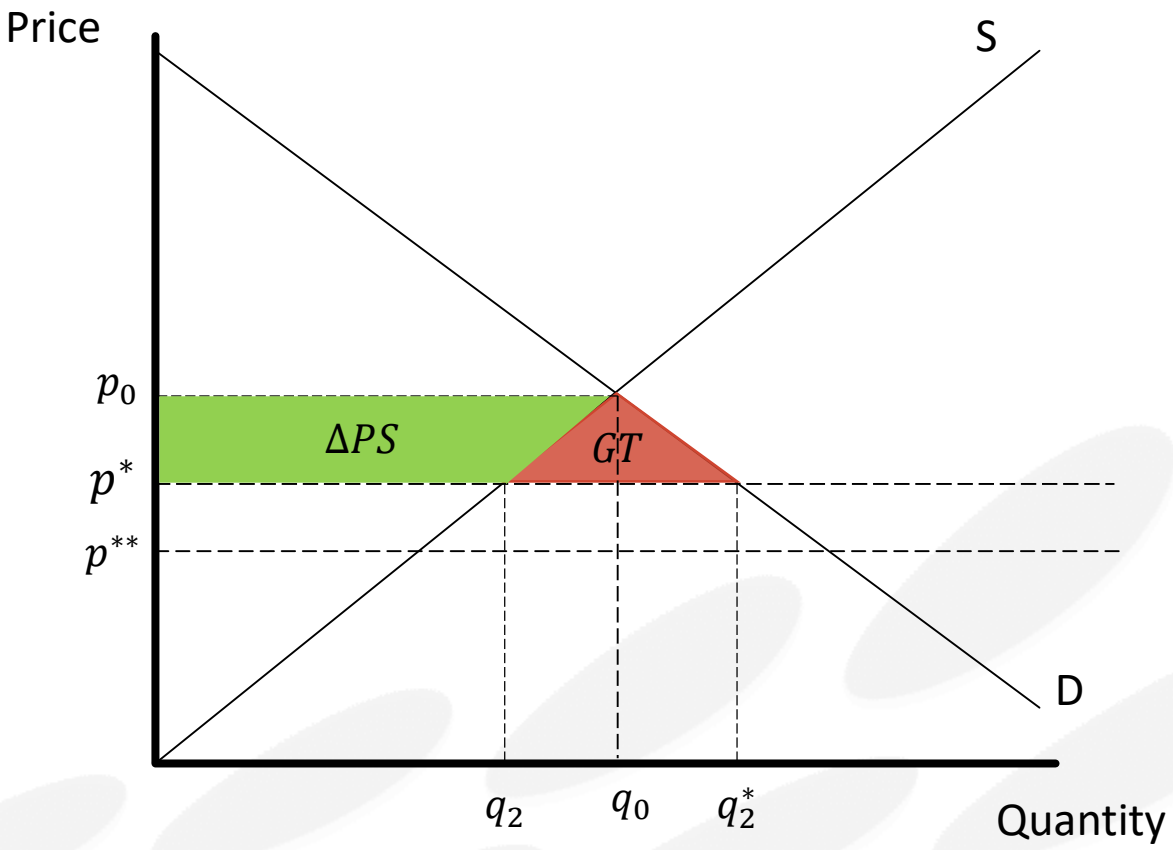
Gains from Trade

$$GT = \Delta CS - \Delta PS$$

Net Gains from trade determine if the country should trade

Equals gains from trade, minus expected impact from biosecurity risk

$$NG = GT - EI^*$$



Trade and Food: Biosecurity Risk

Australia vs. New Zealand – Measures Affecting the Importation of Apples from New Zealand, 2007

Simulation of fire blight in Australia over 30 years

Are shifts to the supply curve static? Most likely not.

- Area of infection grows over time
- Density of infestation in a given area grows over time
- The number of infected sites grows over time

Fire blight continues to spread unless intercepted; maximum interception area before naturalization

Trade and Food: Biosecurity Risk

Australia vs. New Zealand – Measures Affecting the Importation of Apples from New Zealand, 2007

The gains from trade resulting from apple imports from New Zealand

	Mean	Standard Deviation
Change in Consumer Surplus (ΔCS)	$46,343,300	$1,573,340
Change in Producer Surplus (ΔPS)	-$30,731,670	$400,150
Gains from Trade	$15,611,530	$1,604,560

Trade and Food: Biosecurity Risk

Australia vs. New Zealand – Measures Affecting the Importation of Apples from New Zealand, 2007

Expected damage per year from fire blight incursions

	Mean	Standard Deviation
Expected Impact Under No Trade (EI_{NT})	$17,282,810	$14,242,790
Expected Impact Under Trade (EI_T)	**$40,803,290**	$9,813,510
Change in Expected Impact (EI^*)	$23,783,540	$15,058,590

Assumptions → Spread and damage of fire blight over time,

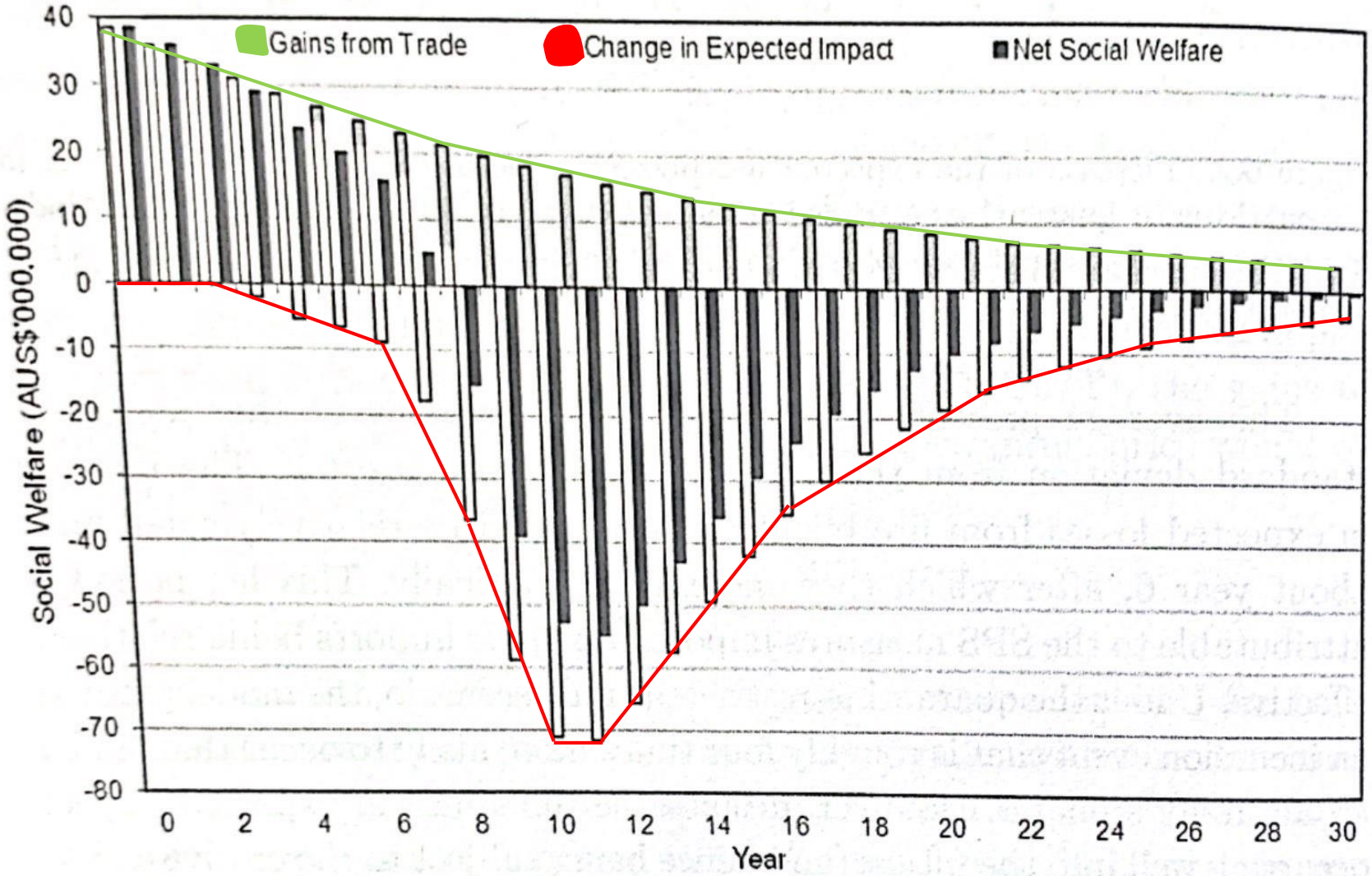


Figure 6.3: Change in social welfare over time resulting from New Zealand apple imports to Australia

Trade and Food: Biosecurity Risk

Australia vs. New Zealand – Measures Affecting the Importation of Apples from New Zealand, 2007

Cumulative net change in social welfare from Australia importing apples from New Zealand

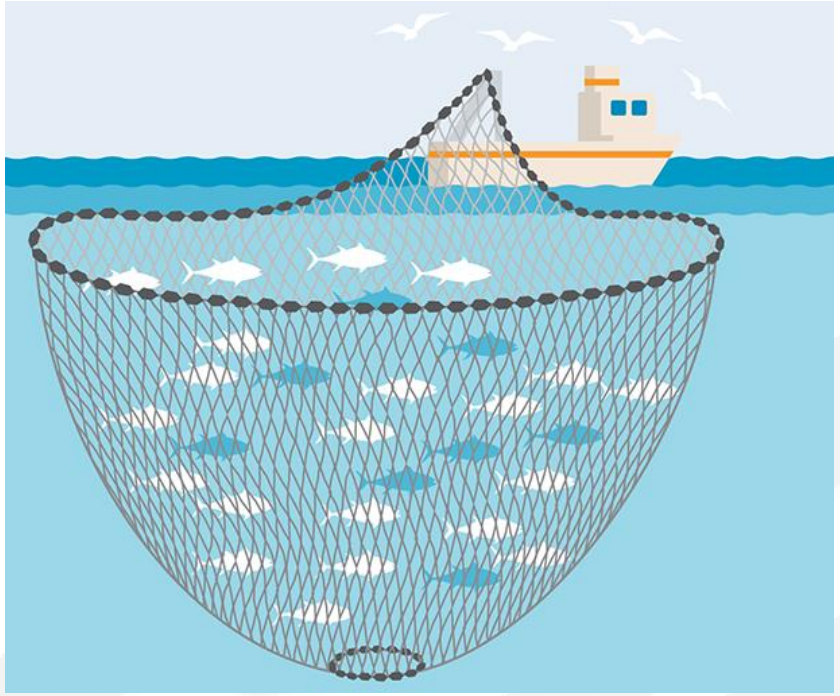
Year	Gains from Trade – Australia ($ million)	Damage from Fire Blight ($ million)	Net Change in Social Welfare ($ million)
10	301.3	207.1	94.2
20	424.0	624.0	-200.0
30	480.9	713.5	-232.6

- Is trade beneficial? Depends on the time frame being considered by policymakers
  - 10 years? **Yes**; 30 Years? **No**

Trade and Food: Ecosystem Risk

USA-Mexico, Tuna-Dolphin, 1991

- Purse-seine nets causes larger marine life to be trapped (rays, sea turtles, sharks, etc.)
  - 1959-1972: 4.9 million dolphins
- US Congress pass Marine Mammal Protection Act in 1972
  - Countries looking to export tuna to US must prove they meet same protection standards as US fishers.
- USA import embargo on Mexican yellowfin tuna
- Mexico → USA treatment of foreign and domestic fishing violated WTO rules



Trade and Food: Ecosystem Risk

USA-Mexico, Tuna-Dolphin, 1991

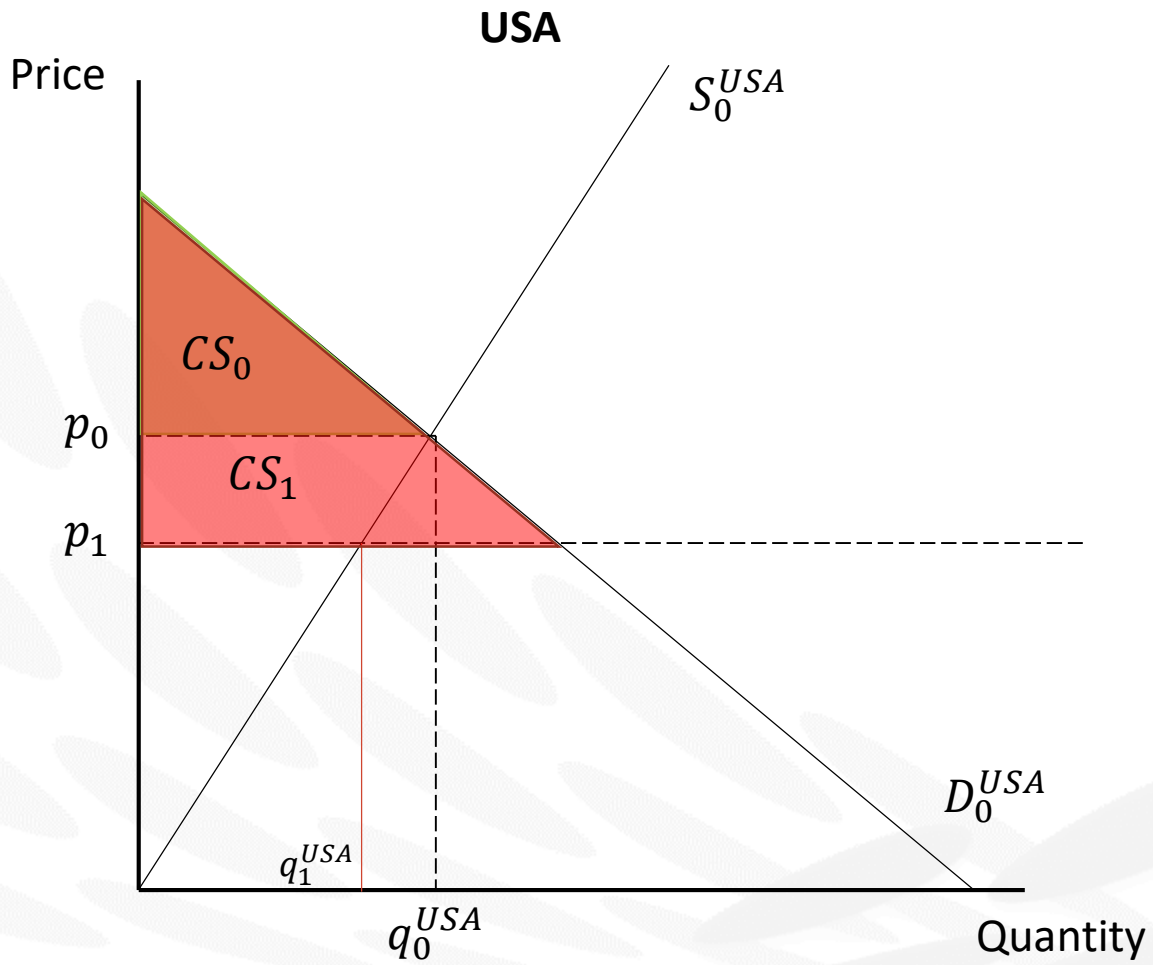
Questions Raised

- Can the US control assets outside of its territorial control?
- Is tuna caught with purse-seine nets in Mexico a **different product** than tuna caught differently in the USA?

Outcome? GATT ruled against the USA.

1. Process by which tuna is caught does not make it a different product
2. USA not allowed to claim its protecting the environment outside its borders.
3. Other means to protect dolphins without trade restrictions.

Trade and Food: Ecosystem Risk



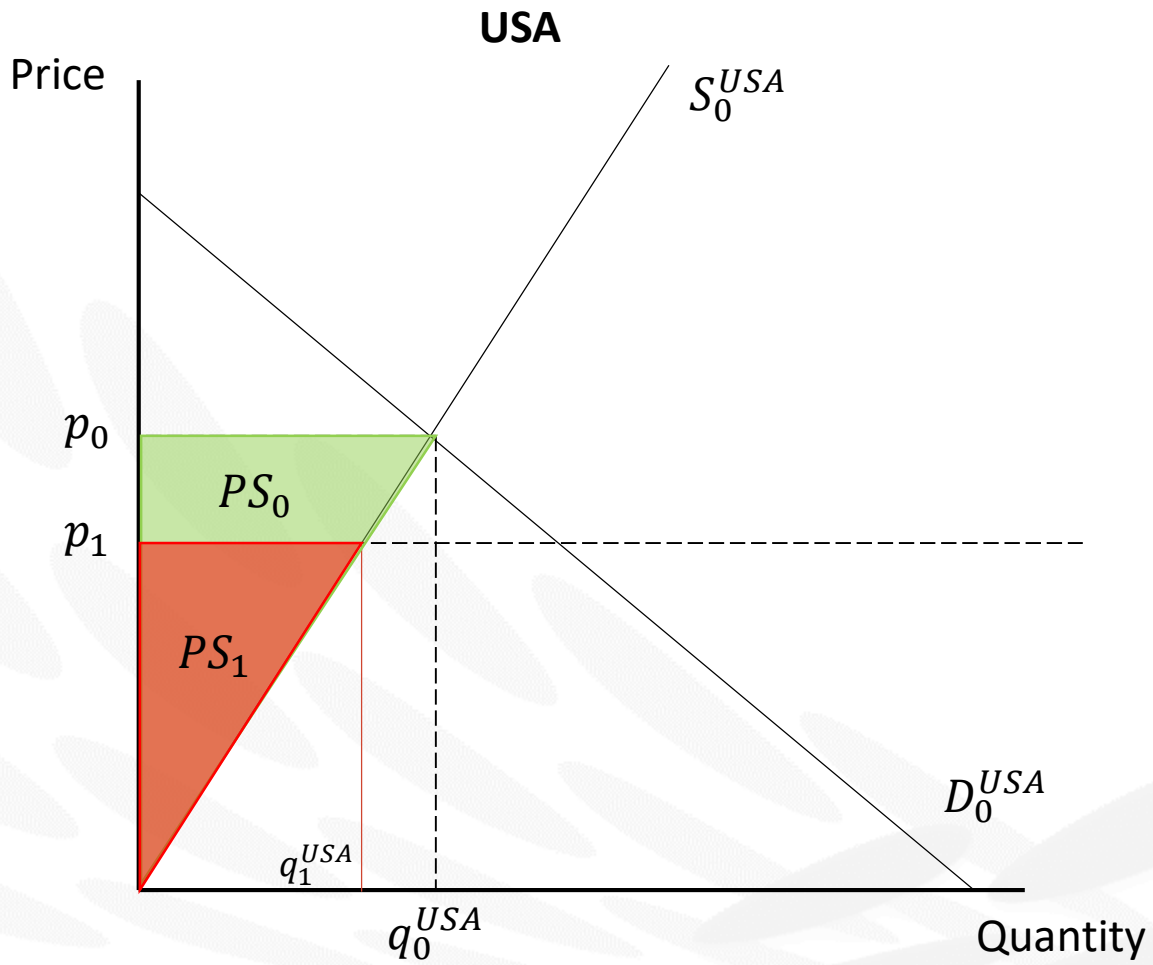
USA Consumer

- No trade → p_0, q_0^{USA}
- Trade → p_1, q_1^{USA}

Trade increase consumer surplus

$$\Delta CS = CS_1 - CS_0$$

Trade and Food: Ecosystem Risk



USA Producer

- Trade decreases producer surplus

$$\Delta PS = PS_1 - PS_0$$

Gains from Trade in USA:

$$GT_{USA} = \Delta CS + \Delta PS$$

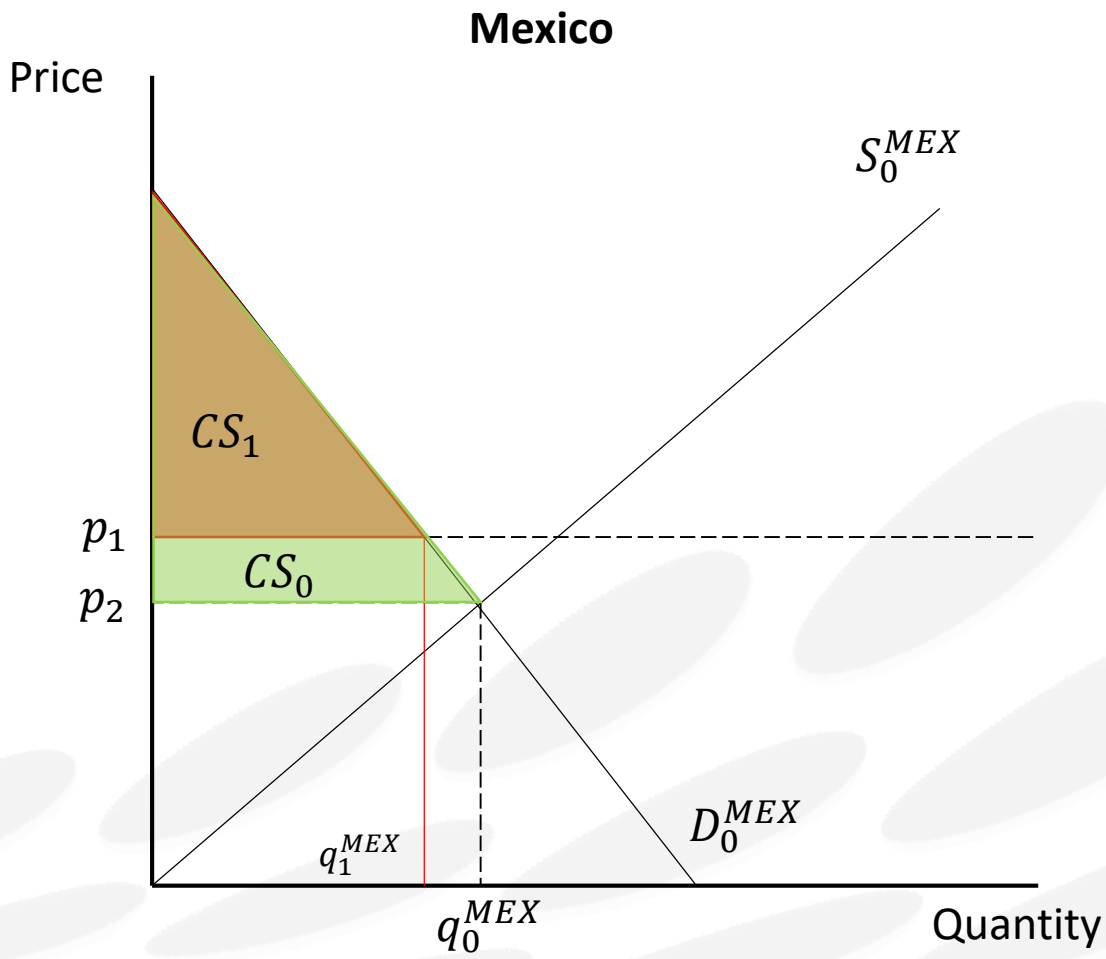
Trade and Food: Ecosystem Risk

Mexico Consumer

- No trade → p_2, q_0^{MEX}
- Trade → p_1, q_1^{MEX}

Trade decreases consumer surplus in Mexico

$$\Delta CS = CS_1 - CS_0$$



Trade and Food: Ecosystem Risk

Mexico Producer

- Trade increase producer surplus in Mexico

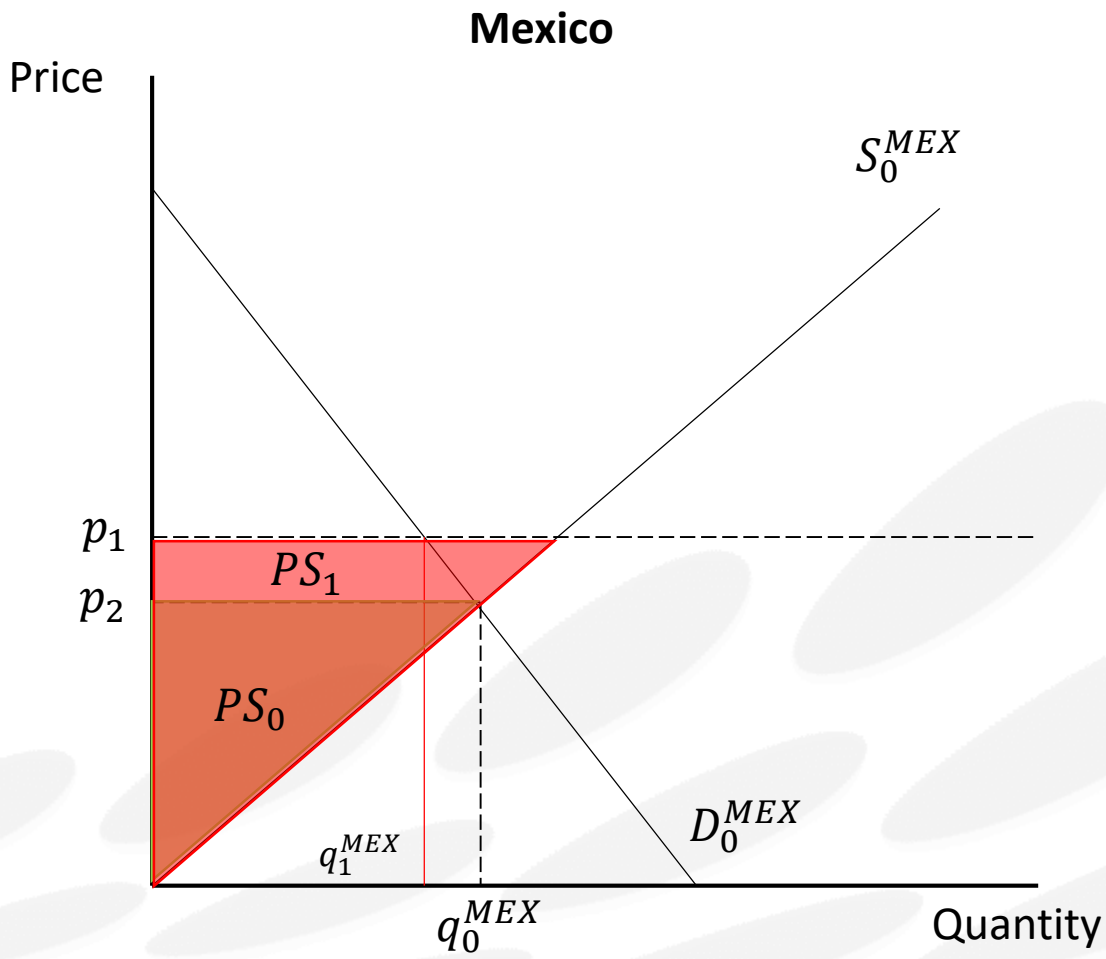
$$\Delta PS = PS_1 - PS_0$$

Gains from Trade in Mexico

$$GT_{MEX} = \Delta CS + \Delta PS$$

Multilateral gains from Trade:

$$GT_M = GT_{USA} + GT_{MEX}$$



Trade and Food: Ecosystem Risk

With no trade, Mexico produces q_0^{MEX} at p_2.

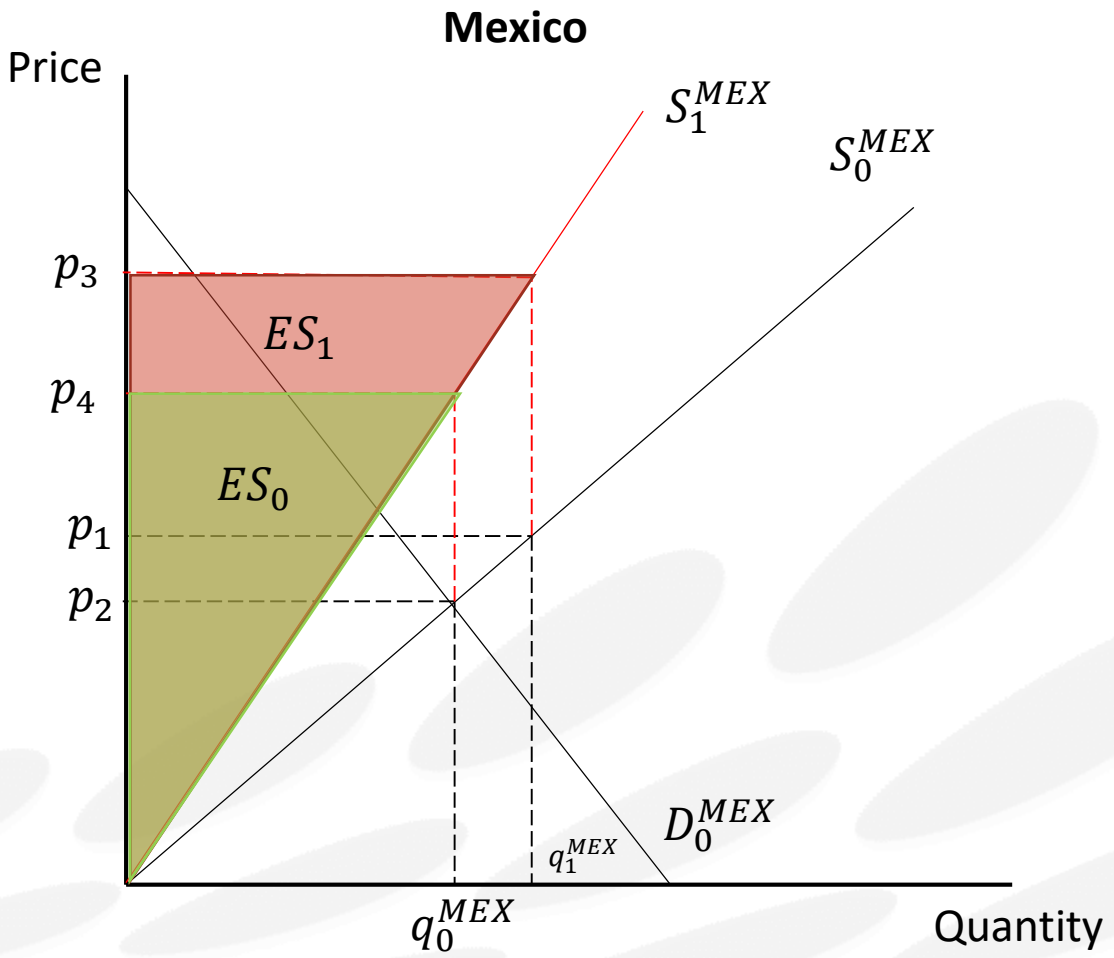
- If the ecosystem service risk is included in the price, the price jumps to p_4.

With trade, quantity produced increases to q_1^{MEX} at price p_1.

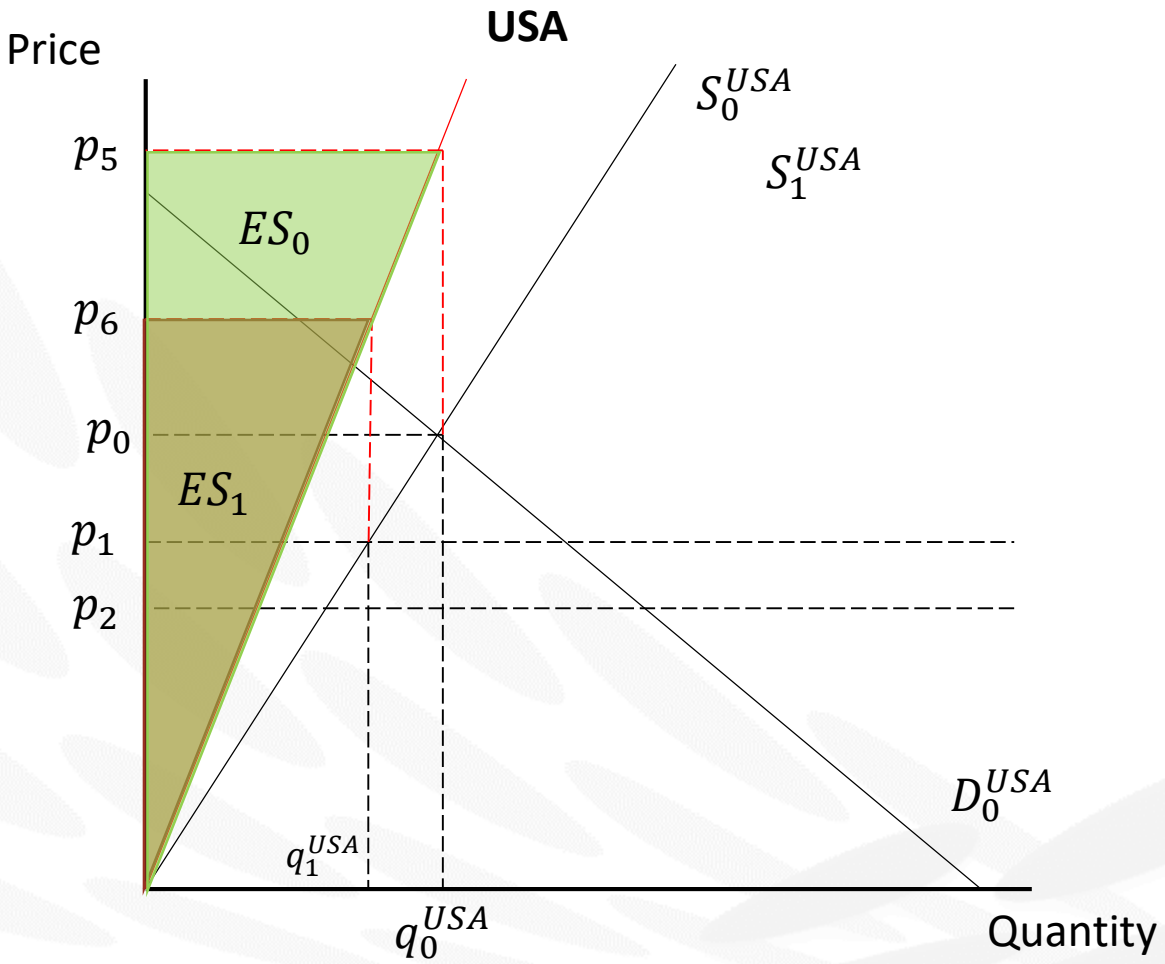
- If the ecosystem service risk is included in the price, the price jumps to p_3.

Loss to ecosystem services in Mexico:

$$\Delta ES_{MEX} = ES_1 - ES_0$$



Trade and Food: Ecosystem Risk



With no trade, USA produces q_0^{USA} at p_0.

- If the ecosystem service risk is included in the price, the price jumps to p_5.

With trade, quantity produced increases to q_1^{USA} at price p_1.

- If the ecosystem service risk is included in the price, the price jumps to p_6.

Loss to ecosystem services in USA:

$$\Delta ES_{USA} = ES_1 - ES_0$$

Multilateral change in ecosystem services:

$$ES_M = \Delta ES_{MEX} + \Delta ES_{USA}$$

Trade and Food: Ecosystem Risk

USA-Mexico, Tuna-Dolphin, 1991

Emphasis on the impact of production processes on ecosystem services (dolphins, other marine wildlife)

- Step 1: Welfare benefits from trade
- Step 2: Ecosystem services benefits

Should USA and Mexico trade? → Only if the **net welfare from trade** is positive

$$W = GT_M + ES_M$$

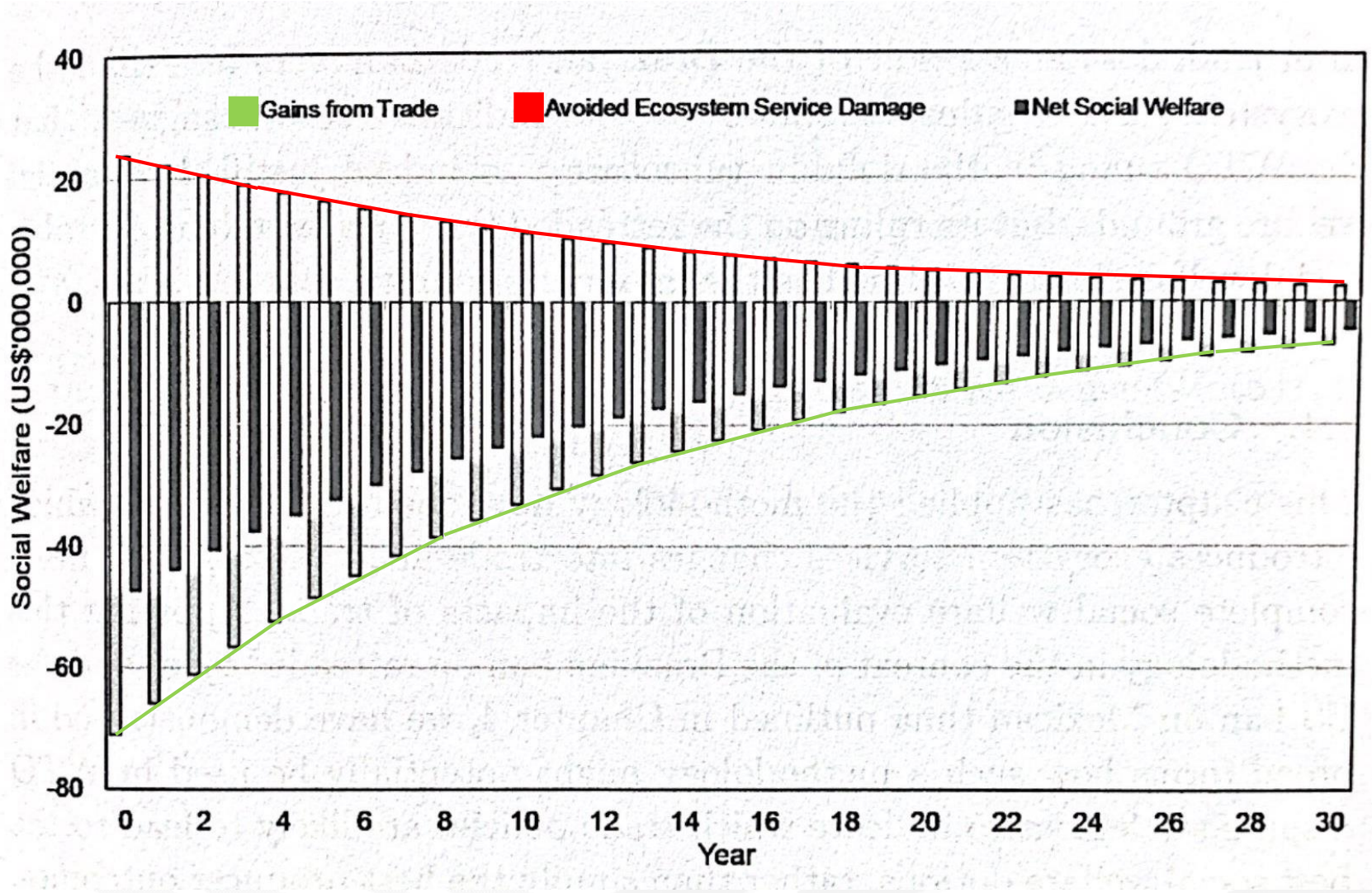


Figure 8.2: Change in social welfare over time resulting from an embargo on Mexican tuna imported to the US.

Trade and Food: Ecosystem Risk

USA-Mexico, Tuna-Dolphin, 1991

Table 8.6: Cumulative net change in social welfare from US embargo on Mexican tuna

Year	Gains from Trade – USA ($ million)	Damage to Ecosystem ($ million)	Net Change in Social Welfare ($ million)
10	-548.3	183.7	-364.6
20	-698.2	234.0	-464.3
30	-871.7	292.1	-579.6

Trade and Food: Ecosystem Risk

USA-Mexico, Tuna-Dolphin, 1991

- Losses from no trade heavily outweigh avoided ecosystem services damage
- The decision by the WTO to remove the embargo seems to have been beneficial
- Undervalue of ecosystem services? It's a tricky business.

Summary

1. Introduction to Economics for Food Scientists
    A. History of Economics
    B. Economics Themes and Supply and Demand
    C. Market Failure and the Role of Government

2. Challenges in the Economic Assessment of Food Safety Incidents
    A. Economic Assessment of Food Safety
    B. Assessing Preferences for Food Safety
    C. Global Trade and Food: Biosecurity and Ecosystem Risk

Final Questions?

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Glyn Jones, E: glyn.d.jones@fera.co.uk