To Beef, or Not To Beef: Trade, Meat, and the Environment

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1 Online Appendix

1.1 Data treatment

This section gives details on how to combine the production emissions from Poore and Nemecek (2018) with the supermarket data from the European retailer. Life cycle assessments (LCA) are a common method to analyze the environmental impact of a product. Typically, environmental scientists measure the emissions related to every part of a production process of a single product. As there exist many methodologies for LCAs, independent studies are typically not comparable. Poore and Nemecek (2018) combine data from 38,700 individual farms in a methodologically consistent manner and provide a worldwide overview of production emissions. I do not observe whether a beef product stems from a dairy herd or a standard beef herd, so I use the standard beef herd emissions for all beef products. Meat from a dairy herd is rare, as most beef products originate from beef herds. Additionally, the consumption data contains veal products for which I do not observe emissions separately. Since calves are a by-product of milk production, I use the emissions from beef from the dairy herds for veal products. Finally, I include crustaceans in the fish category.

1.2 Intuition example

This section gives a numerical example for the intuition of the own- and cross-price elasticities when several prices change. Here, we consider a simplified version of the model with a logit specification for two goods.

	p_j	p_l	s_j	s_l
1	10.0	10.0	0.00665	0.00665
2	8.0	10.0	0.01787	0.00657
3	8.0	3.0	0.01475	0.17973
4	9.9	3.0	0.00576	0.18138

Table 1: Dummy Model Example

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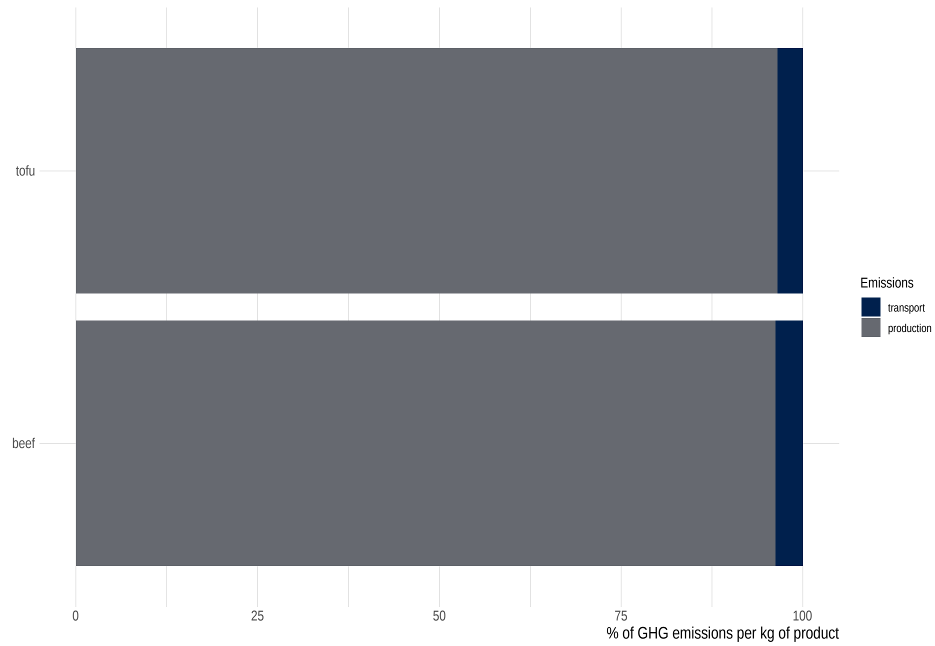

Figure 1: Total GHG emissions of imported beef and imported tofu

Table 1 illustrates several scenarios with α=-0.5. In row 1, products j and l have the same price and thus the same market shares. Decreasing the price of product j in row 2 yields an increase in the market share of product j, and a decrease in the market share of product l. This is the expected result form the own- and cross-price elasticities. In rows 3 and 4, I decrease the price of both goods compared to row 1. Product l experiences a much larger decrease than product j in both scenarios. In row 4, the market shares of both products increase through what I call the own-price effect. Note that s_j increases less than in row 2, because now also the price of product l decreased. This leads to a cross-price effect from the effect of the cross-price elasticity on the market share. In row 4, the price of product j only decreases a little, while the price of l decreases a lot. As a result, the market share of l increases, while the market share of good j *decreases*.

For both products, we have an own- and a cross-price effect that go in opposite directions. In row 4, product j had a small decrease in the price, and thus we would expect an increase in the market share from the own-price effect. However, product l had a large price decrease, from which we expect an increase in the market share of product l. The cross-price effect dominated over the own-price effect for product j, and thus its market share decreases.

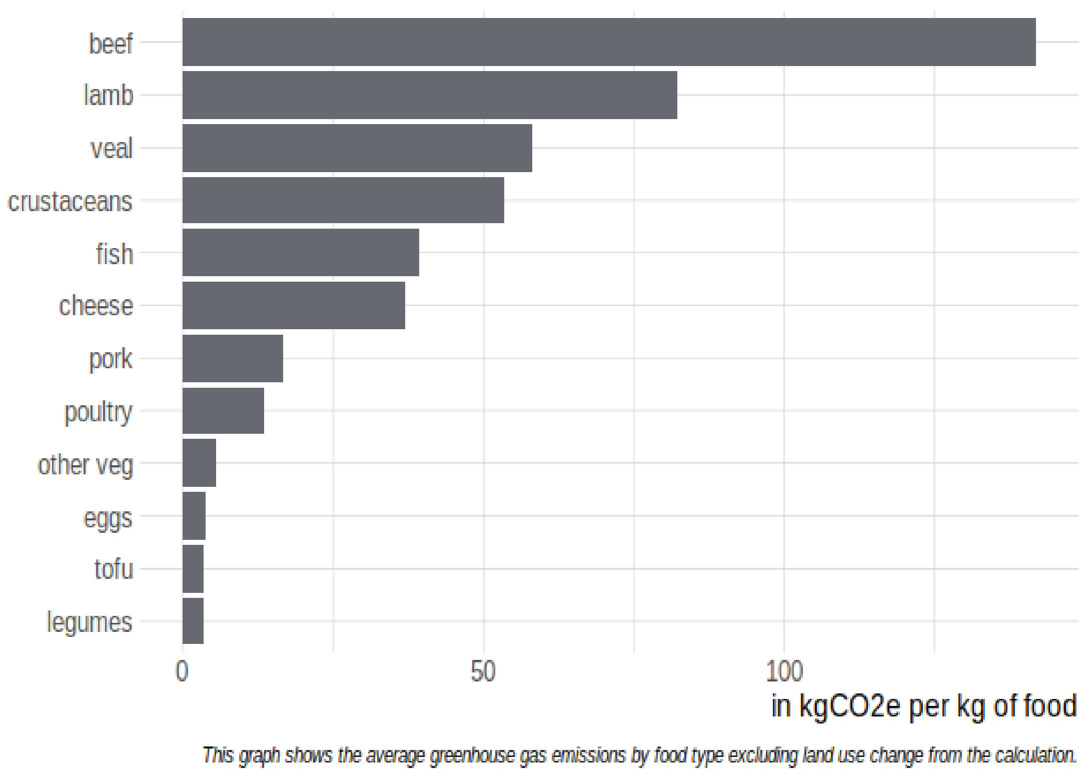

Figure 2: Average GHG emissions of different food types excluding land use change

1.3 Additional regression tables

Table 2: Nested Logit IV

	Relative Market Share
	NL IV
Sales 1	2.133*** (0.066)
Sales 2	−1.999*** (0.074)
Sales 3	0.674*** (0.021)
European Retailer Brandname	3.152* (1.654)
Chicken Brandname	4.069** (1.653)
Sausage Brandname	6.811*** (1.660)
Other Brandname	2.634 (1.658)
No Brandname	2.896* (1.655)
Cheese Brandname	2.384 (1.740)
Meat Substitute Brandname	1.776 (1.661)
Label Organic	−0.132*** (0.024)
Label Local	0.394*** (0.023)
Label Fish	−0.560*** (0.022)
Label Animal Welfare	0.164*** (0.046)
Label Allergy	8.948*** (0.693)
Label Grassfed	−0.060 (0.149)
Label Vegan	−0.828*** (0.077)
Label Vegetarian	0.238*** (0.079)
Price	−0.016*** (0.001)
Within Group MS	0.621*** (0.014)
Observations	39,262

Note: *p<0.1; **p<0.05; ***p<0.01
Includes quarter, year, region, continent, and food type fixed effects, labels, and brands. This table shows a regression of the relative market share on prices, the within group market share, and other product characteristics.

Table 3: Nested Logit IV Barcode Level

	Relative Market Share			
	NL	NL IV	NL	NL IV
	(1)	(2)	(3)	(4)
Price	−0.001*** (0.00001)	−0.013*** (0.0002)	−0.001*** (0.00005)	−0.176*** (0.003)
Within Group MS	0.985*** (0.0001)	0.386*** (0.007)	0.977*** (0.0001)	0.403*** (0.020)
Sales 1	0.177*** (0.002)	2.589*** (0.028)		
Sales 2	−0.038*** (0.001)	−0.879*** (0.010)		
Sales 3	0.006*** (0.001)	−0.177*** (0.003)		
European Retailer Brand	0.015*** (0.002)	0.318*** (0.009)		
Chicken Brand	0.007*** (0.002)	0.177*** (0.010)		
Sausage Brand	0.013*** (0.002)	−0.204*** (0.010)		
Other Brand	0.020*** (0.002)	−0.271*** (0.009)		
No Brand	0.011*** (0.002)	−0.428*** (0.010)		
Cheese Brand	0.002 (0.002)	−0.052*** (0.009)		
Meat Substitute Brand	0.009*** (0.003)	0.128*** (0.012)		
Label Organic	−0.007*** (0.001)	0.134*** (0.003)		
Label Local	0.009*** (0.0004)	0.236*** (0.003)		
Label Fish	−0.037*** (0.001)	0.134*** (0.004)		
Label Animal Welfare	0.012*** (0.001)	0.153*** (0.005)		
Label Allergy	−0.010*** (0.002)	0.221*** (0.007)		
Label Grassfed	0.023*** (0.002)	−0.135*** (0.007)		
Label Vegan	−0.015*** (0.002)	−0.110*** (0.008)		
Label Vegetarian	−0.021*** (0.003)	0.038*** (0.010)		
Product FE	No	No	Yes	Yes
IV	None	Both	None	Both
Observations	2,597,846	2,597,846	2,597,846	2,597,846

Note: *p<0.1; **p<0.05; ***p<0.01
Includes quarter, year, region, continent, and food type fixed effects, labels, and brands. This table shows a regression of the relative market share on prices, the within group market share, and other product characteristics.

Table 4: Nested Logit Regression IV with Emissions

	Relative Market Share	
	NL	NL IV
	(1)	(2)
Sales 1	2.133***	2.231***
	(0.066)	(0.066)
Sales 2	−1.999***	−1.840***
	(0.074)	(0.067)
Sales 3	0.674***	0.406***
	(0.021)	(0.013)
Label Organic	−0.132***	0.465***
	(0.024)	(0.031)
Label Local	0.394***	−0.033*
	(0.023)	(0.017)
Imported		−0.742***
		(0.028)
Emissions		−0.006***
		(0.0002)
Price	−0.016***	−0.015***
	(0.001)	(0.001)
Within Group MS	0.621***	0.692***
	(0.014)	(0.011)
Observations	39,262	39,262

Note: *p<0.1; **p<0.05; ***p<0.01
Includes quarter, year, region, and food type fixed effects, labels, and brands.
This table shows a regression of the relative market share on prices, the within group market share, and other product characteristics.
The first column includes continent fixed effects.
The second column includes an imported dummy, and the greenhouse gas emissions related to each product.

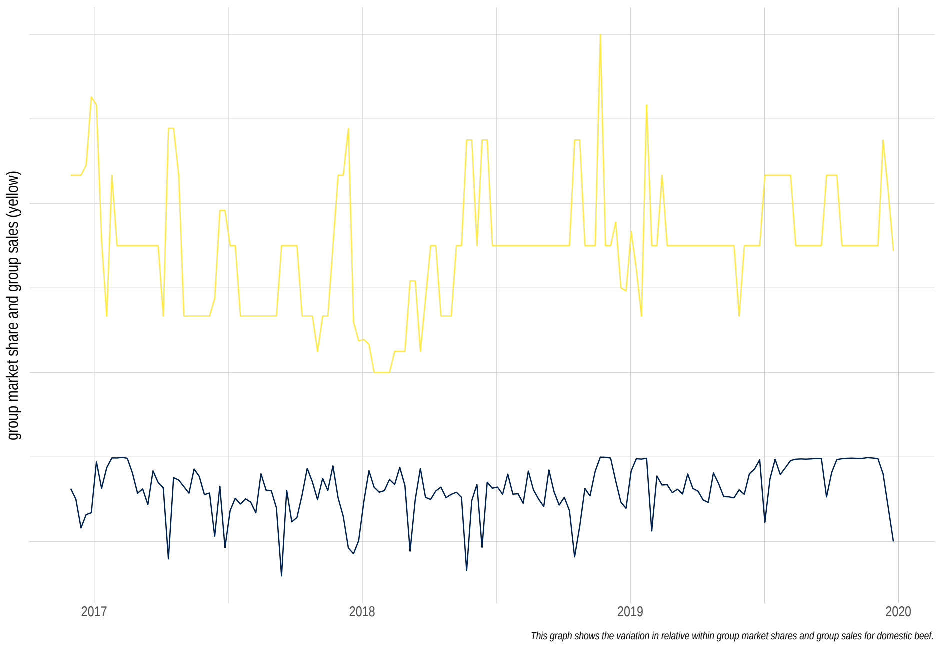

Figure 3: Variation of within group market share

1.4 Elasticity formulas

The nested logit formula for calculating the own-price elasticity is given by:

$$\frac{\alpha p_{jrw}}{1-\sigma}(1-\sigma s_{j|g,rw}-(1-\sigma)s_{jrw}),$$

where α is the price coefficient, σ is the coefficient on the within group market share , p_{jrw} is the price of good j in market n, s_{jrw} is the market share of good j in market n, and $s_{j|g,rw}$ is the within group market share of product j in group g in market rw. Similarly, the cross-price elasticity for products in the same nest is given by

$$\frac{\alpha p_{krw}}{1-\sigma}(s_{k|g,rw}-(1-\sigma)s_{krw})$$

and the cross-price elasticity for products in different nests is the same as the simple logit cross-price elasticity:

$$-\alpha p_{krw} s_{krw}$$

Table 5: Buy Local Demand Only Counterfactual

	Quantity (in mt.)			Emissions (in 1,000 mtCO2e)		
Type	Before	After	Δ%	Before	After	Δ%
Beef	2,392	2,316	-3.19	272,361	262,809	-3.51
Cheese	9,283	9,068	-2.32	450,617	444,794	-1.29
Eggs	3,301	3,087	-6.47	19,251	17,206	-10.62
Fish	1,079	925	-14.22	40,692	35,685	-12.3
Lamb	364	288	-21.03	35,319	29,598	-16.2
Legumes	662	607	-8.37	1,898	1,723	-9.2
Pork	4,140	4,162	0.53	77,230	77,660	0.56
Poultry	4,376	4,367	-0.19	45,855	44,390	-3.2
Tofu	313	288	-7.9	1,233	1,098	-10.97
Veal	82	82	0.47	5,458	5,461	0.05
Outside Good	137,123	137,925	0.58	893,054	898,273	0.58
Total	163,115	163,115	0	1,842,968	1,818,697	-1.32

Note.— This table shows a buy local counterfactual which is calculated using only the demand side. This implies that the price of domestic products is not allowed to change as a response to the disappearance of the imported products from the choice set. The values are for an average year per 1 mio. consumers. The 'before' column refers to the status quo, the 'after' column to the counterfactual values.

1.5 Additional counterfactuals

Table 5 shows a buy local scenario where only the demand side is used, without the supply side. This means that the quantities are predicted by the demand equation, and the domestic prices are not allowed to react to the exclusion of the imported products from the choice set.

Table 6 shows a vegetarian scenario where only the demand side is used, without the supply side. This means that the quantities are predicted by the demand equation, and the prices of the vegetarian products are not allowed to react to the exclusion of the meat products from the choice set. The reason for this similar increase in the consumption of the vegetarian food types lies in the nesting structure of the demand model. As food types are nests, the cross-price elasticities across different food types will be the same. Therefore, the model predicts the same increase in the consumption of each food type.

Poore, J., Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. Science 360, 987–992.

Table 6: Vegetarian Demand Only Counterfactual

	Quantity (in mt.)			Emissions (in 1,000 mtCO2e)		
Type	Before	After	Δ%	Before	After	Δ%
Beef	2,392	0	-100	272,361	0	-100
Cheese	9,283	10,062	8.39	450,617	488,416	8.39
Eggs	3,301	3,578	8.4	19,251	20,870	8.41
Fish	1,079	0	-100	40,692	0	-100
Lamb	364	0	-100	35,319	0	-100
Legumes	662	718	8.38	1,898	2,057	8.37
Pork	4,140	0	-100	77,230	0	-100
Poultry	4,376	0	-100	45,855	0	-100
Tofu	313	339	8.32	1,233	1,336	8.31
Veal	82	0	-100	5,458	0	-100
Outside Good	137,123	148,419	8.24	893,054	966,618	8.24
Total	163,115	163,115	0	1,842,968	1,479,296	-19.73

Note.— This table shows a vegetarian counterfactual which is calculated using only the demand side. This implies that the price of domestic products is not allowed to change as a response to the disappearance of the imported products from the choice set. The values are for an average year per 1 mio. consumers. The 'before' column refers to the status quo, the 'after' column to the counterfactual values.