Göttingen Campus

Trade, price and quality effects of agrifood standards

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6th African Conference of Agricultural Economists
Abuja, Nigeria
September 25, 2019

Motivation

- How standards affect bilateral trade flows is topical in the agricultural trade literature.
  - They are fast becoming important alternative trade policy tools
  - 1456 product lines were subject to at least one NTM in 1997, increasing to 2852 by 2015.
  - Tariffs for agricultural products decreased from 17.9% to 10.51%
  - Related studies increased from 14 in 2000 to 140 in 2017 (Santeramo and Lamonaca, 2019)

- However, the standards-trade effect remains ambiguous
  - Shifts both supply and demand curves
  - Different political economy implications

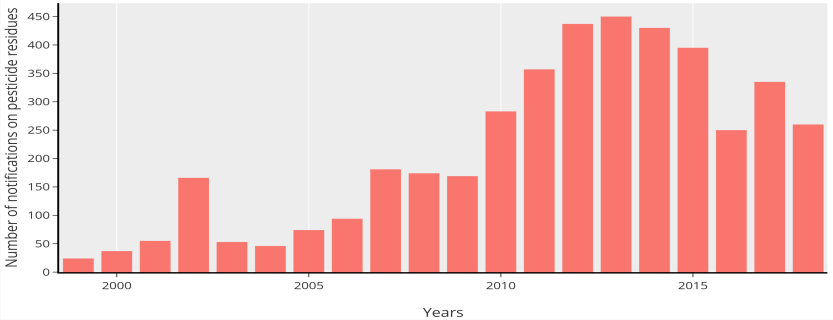
This paper

- A fundamental gap in this literature is the exclusive focus on the direct trade effects of NTMs
  - Other welfare effects? (see, e.g., Asfaw et al., 2010; Sellare and Qaim, 2019, Fiankor et al., 2019)
- Little attention is paid to how standards affect quality of agrifood exports
  - Part of the empirical challenge has been how to measure standards and quality
- Growing interest — focus on firm/regional level and country-specific standards (Curzi et al., 2017; Disdier et al., 2018; Raimondi et al., 2019; Movchan et al., 2019)
- We focus on regulatory heterogeneity (i.e., different country-specific standards for the same product)
  - We use data on **Maximum residue limits** and estimate quality ffollowing Khandelwal et al. (2013)

Maximum Residue Limits

- Highest level of residue that is legally tolerated in/on food/feed when chemicals are applied
  - Mandatory regulations that condition market access

Figure 1: EU border notifications relating to pesticide residues (1999-2018)



Source: EU RASFF data, own graph

Comparison of maximum residue limits on selected products

Table 1: Comparison of maximum residue limits on selected products in 2014

Chemical	Fruit	Countries						
		EU	USA	Canada	Japan	Vietnam	China	Codex
Carbaryl	Citrus	0.01	10	10	1	7	_	15
Methidathion	Citrus	0.02	5	2	5	5	2	5
Captan	Apple	3	25	5	5	25	15	15
Fenbutatin-Oxide	Apple	2	15	3	5	5	5	5
Acetamiprid	Apple	0.80	1	1	2	_	0.80	0.80
Bifenthrin	Tea	5	30	_	30	_	_	30
Endosulfan	Tea	30	24	_	30	30	_	10
Fenpropathrin	Tea	2	2	2	25	_	5	2
Chlorothalonil	Cranberries	0.67	5	2	5	_	_	5

Source: Homologa dataset

Notes: — implies that there are no residue limits set by that country on the given product-pesticide pair. MRLs are measured in ppm.

Maximum Residue Limits

- Data source: Agrobase-Logigram Homologa database.
  - Collects monthly changes in allowable pesticides for 61 countries.
  - We identify 145 unique products at the HS6 digit
- Bilateral product varying index over time

$$MRL_{ijkt} = \left(\frac{1}{N_k}\right) \sum_{p \epsilon N_k} \exp\left(\frac{MRL_{ikt} - MRL_{jkt}}{MRL_{ikt}}\right) \tag{1}$$

Identification strategy

We estimate the following baseline equation changing X_{ijkt} depending on the research question

$$\ln X_{ijkt} = \psi_{ikt} + \lambda_{jkt} + \theta_{ij} + \beta_1 MRL_{ijkt} + \beta_2 \ln(1 + Tariff_{ijkt}) + \epsilon_{ijkt} \quad (2)$$

- i = exporter, j = importer, k = product, t = time, ψ_{ikt}, λ_{jkt}, and θ_{ij} are fixed effects
- Eqn (2) is estimated using OLS (with ϵ_{ijkt} clustered at the ijk level)
- Identification of β_1 is achieved from changes in bilateral MRL differences over time

Methodological issues in estimating β_1

- Endogeneity of the standards–trade relationship: 3-way FEs (Baier et al., 2014)

Standards and trade margins a la Feenstra and Kee (2004)

1. **Extensive margin:** weighted count of exporter *i*'s categories (HS2 digit) exported to *j* in year *t*, relative to the average number of categories that *j* imports from all countries over the whole period

$$EM_{ijh2,t} = \frac{\sum_{h6 \epsilon R_{ijt}^{h2}} \bar{V}_{jW,h6}^{h2}}{\sum_{h6 \epsilon R_{jW}^{h2}} \bar{V}_{jW,h6}^{h2}} \tag{3}$$

2. **Intensive Margin:** measures *i*'s overall market share within the set of categories it exports to *j* in *t*

$$IM_{ijh2,t} = \frac{\sum_{h6 \epsilon R_{ijt}^{h2}} V_{ijh6t}^{h2}}{\sum_{h6 \epsilon R_{ijt}^{h2}} \bar{V}_{jW,h6}^{h2}} \tag{4}$$

3. Taking logs and using some algebra, Hummels and Klenow (2005) show that

$$\ln X_{ijkt} = \ln EM_{ijkt} + \ln IM_{ijkt} + \ln X_{jkt} \tag{5}$$

4. Value of trade conditional on exporting, i.e., $\ln(X_{ijkt})$

Unit values, quality, and quality-adjusted price

5. Unit values$_{ijkt}$ = $Values_{ijkt}/Quantities_{ijkt} \implies$ proxies product prices

6. We measure unobserved "product quality" using trade data (Khandelwal et al., 2013)
   - Intuition: conditional on prices, higher market shares imply higher quality
   - We model the demand for product k in period t as follows: CES utility functions for quality estimation

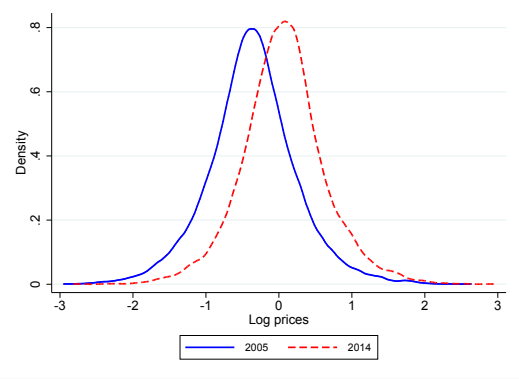
$$\ln x_{ijkt} + \sigma_{jk} \ln p_{ijkt} = \alpha_k + \alpha_{jt} + e_{ijkt} \tag{6}$$

$$\text{Quality} = \ln \hat{q}_{ijkt} \equiv \hat{e_{ijkt}}/\sigma_{jk} - 1 \tag{7}$$

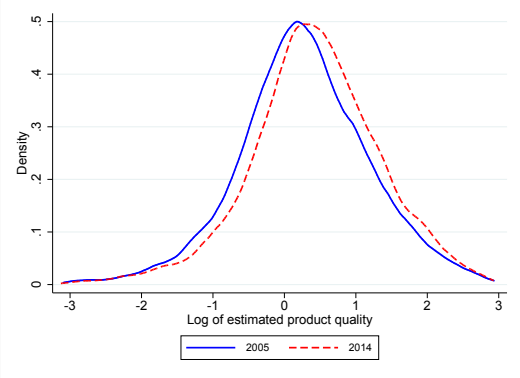
7. Quality adjusted prices $= \ln \hat{p}_{ijkt} = \ln p_{ijkt} - \ln \hat{q}_{ijkt}$

Relationship between estimated quality and unit values (export prices)

Figure 2: Distribution of unit values and estimated product quality of imports in 2005 and 2014



(a) Log of prices (unit values)



(b) Log of estimated product quality

The effect of MRLs on trade

Table 2: The effect of bilateral differences in standards on trade

	EM_{ijkt}	IM_{ijkt}	$EM_{ijkt} \times IM_{ijkt}$	X_{ijkt}
	(1)	(2)	(3)	(4)
MRL_{ijkt}	-0.070***	-0.066**	-0.136***	-0.082***
	(0.022)	(0.033)	(0.036)	(0.023)
Log (1 + $Tariff_{ijkt}$)	-0.021***	-0.075***	-0.095***	-0.259***
	(0.007)	(0.012)	(0.013)	(0.014)
Importer-Product-Time FE	Yes	Yes	Yes	Yes
Exporter-Product-Time FE	Yes	Yes	Yes	Yes
Importer-Exporter FE	Yes	Yes	Yes	Yes
Observations	100,143	100,143	100,143	615,483
R^2	0.775	0.579	0.729	0.687

Notes: Robust country-pair-product clustered standard errors in parentheses. ***, **, * denote significance at 1%, 5% and 10% respectively. The trade margins in columns (3) and (4) are defined using the Feenstra and Kee (2004) measures. All models are estimated using OLS.

The effect of MRLs on price and quality

Table 3: The effect of bilateral differences in standards on unit values and quality

	Unit values	Quality	Quality-adjusted price
	(1)	(2)	(3)
MRL_{ijkt}	0.027***	0.002	0.026**
	(0.008)	(0.013)	(0.012)
Log (1 + $Tariff_{ijkt}$)	0.035***	-0.078***	0.113***
	(0.005)	(0.008)	(0.008)
Importer-Product-Time FE	Yes	Yes	Yes
Exporter-Product-Time FE	Yes	Yes	Yes
Importer-Exporter FE	Yes	Yes	Yes
Observations	399,526	399,526	399,526
R^2	0.774	0.436	0.687

Notes: Robust country-pair-product clustered standard errors in parentheses. ***, **, * denote significance at 1%, 5% and 10% respectively.

Main Take Aways

- Regulatory heterogeneity in terms of MRLs
  - decreases trade flows and available product varieties
  - increase prices and quality-adjusted prices of imports
  - has no statistically significant effect on estimated product quality
- We observe disruptions to trade with no benefits to consumers
- Food safety risks are borderless and the consequences are easily transmitted across countries
  - Shocking that approaches to tackle them are still national in scope
  - We recommend a move toward mutual recognition, standards harmonisation, and strengthening of the Codex so that they can set standards that are acceptable to all trading partners

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Thank You!!

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Summary statistics

Table 4: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
MRL_{ijkt}^{HS2}	1.171	0.810	0	2.718	100,729
MRL_{ijkt}	1.123	0.813	0	2.718	631,227
Extensive margin (EM_{ijkt})	0.008	0.030	0	0.559	100,729
Intensive margin (IM_{ijkt})	0.720	1.654	0	70.320	100,729
Trade value (mln USD)	3.048	70.053	0	19144.001	631,227
Tariffs (log)	0.718	1.228	0	6.686	631,227
Price (log)	-5.744	1.125	-8.643	-2.487	399,526
Quality (log)	0.041	1.154	-3.135	2.934	399,526
Quality adjusted price (log)	-5.785	1.436	-11.487	0.480	399,526

PPML estimates of the trade margins

Table 5: The effect of bilateral differences in MRLs on trade: no bilateral fixed effects

	EM_{ijkt}	IM_{ijkt}	$EM_{ijkt} \times IM_{ijkt}$	X_{ijkt}
	(1)	(2)	(3)	(4)
Colony_{ij}	0.275***	0.193***	0.467***	0.216***
	(0.044)	(0.073)	(0.089)	(0.031)
Language_{ij}	0.165***	0.238***	0.403***	0.363***
	(0.039)	(0.063)	(0.076)	(0.028)
Contiguity_{ij}	0.053	0.598***	0.652***	0.999***
	(0.046)	(0.067)	(0.086)	(0.027)
$\text{Log (1 + Tariff}_{ijkt}\text{)}$	-0.704***	-0.925***	-1.628***	-1.037***
	(0.015)	(0.023)	(0.028)	(0.012)
MRL_{ijkt}	-0.127***	-0.047	-0.174***	-0.195***
	(0.024)	(0.037)	(0.041)	(0.024)
$\text{Log (1 + Tariff}_{ijkt}\text{)}$	-0.073***	-0.108***	-0.181***	-0.404***
	(0.009)	(0.014)	(0.016)	(0.014)
Observations	100,279	100,279	100,279	615,616
R^2	0.706	0.472	0.626	0.637

Notes: Robust country-pair-product clustered standard errors in parentheses. ***, **, * denote significance at 1%, 5% and 10% respectively. Importer-product-time and exporter-product-time fixed effects included in all regressions. Intercepts included but not reported.

Alternative definitions of the extensive and intensive margins

Table 6: The effect of bilateral differences in MRLs on the probability of trade, market exit, and trade values

	$\Pr(X_{ijkt}) > 0$	$Exit_{ijkt}$	$Tradevalue_{ijkt}$
	(1)	(2)	(3)
MRL_{ijkt}	-0.003***	0.044***	-0.120***
	(0.001)	(0.001)	(0.028)
Log (1 + $Tariff_{ijkt}$)	0.008***	0.026***	-0.111***
	(0.000)	(0.000)	(0.012)
Observations	3,628,820	3,265,938	2,682,478
Estimator	LPM	LPM	PPML

Notes: Robust country-pair-product clustered standard errors in parentheses. ***, **, * denote significance at 1%, 5% and 10% respectively. Importer-product-time, exporter-product-time, and importer-exporter fixed effects included in all regressions. Intercepts included but not reported. The dependent variables in Columns (1) and (2) are dummies defined for the probability of trading and exit respectively and are estimated using a linear probability model.

More on quality

- Consider a CES utility function, which expresses the preference of consumers for a variety ν in country j (we assume that consumer preferences incorporate quality, $\lambda(\nu)$):

$$U = \left[\int_{\nu \epsilon V} [\lambda(\nu) q(\nu)]^{\frac{\sigma-1}{\sigma}} \, d\nu \right]^{\frac{\sigma}{(\sigma-1)}} \tag{8}$$

- Maximising (8) subject to a budget constraint, gives the demand of consumers in country j for product k coming from country i as depending on the price and quality of the product, prices of substitute products and on the income of the consumer, yielding:

$$q_{ijkt} = \lambda_{ijkt}^{\sigma-1} p_{ijkt}^{-\sigma} P_{jt}^{\sigma-1} Y_{jt} \tag{9}$$

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Short and long quality ladder

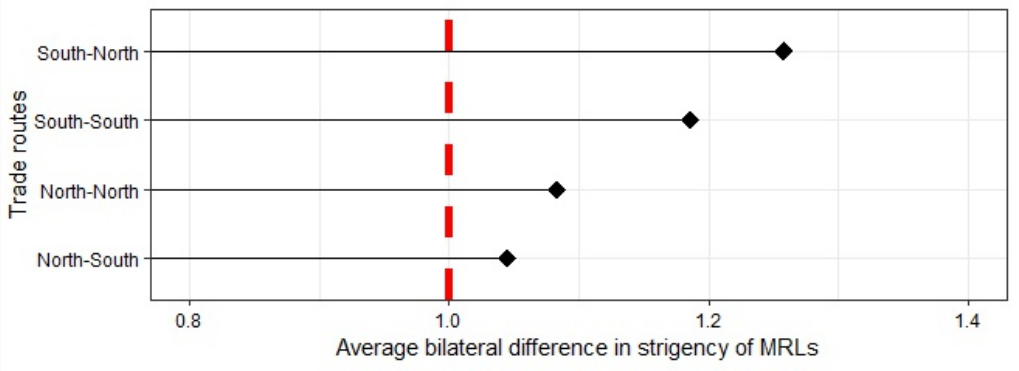
Table 7: The effect of bilateral differences in MRLs on unit values and quality: quality ladder

	Short quality ladder			Long quality ladder		
	Price (1)	Quality (2)	QA price (3)	Price (4)	Quality (5)	QA price (6)
MRL_{ijkt}	0.027**	-0.008	0.036**	0.025**	0.001	0.025
	(0.011)	(0.019)	(0.018)	(0.011)	(0.017)	(0.016)
Log (1 + $Tariff_{ijkt}$)	0.029***	-0.083***	0.112***	0.040***	-0.077***	0.117***
	(0.006)	(0.012)	(0.012)	(0.007)	(0.012)	(0.012)
Observations	203,554	203,554	203,554	195,837	195,837	195,837
R^2	0.785	0.473	0.694	0.759	0.423	0.682

Notes: The sample is divided according to the level of product differentiation, as indicated by the quality ladder. We compute the quality ladder as the difference between the maximum and the minimum value of estimated quality in a given product category. Products with quality ladder values below the median fall in the category short-quality ladder. Robust country-pair-product clustered standard errors in parentheses. ***, **, * denote significance at 1%, 5% and 10% respectively. Importer-product-time, exporter-product-time, and importer-exporter fixed effects included in all regressions. Intercepts included but not reported. QA price = quality-adjusted price

Are the effects heterogeneous across different trade routes?

Figure 3: Average bilateral difference in MRL stringency by trade route (2005 - 2014)



Source: Authors' own construction

Are the effects heterogeneous across different trade routes?

Table 8: Heterogeneities across different trade routes

	North – North		North – South		South – South		South – North	
	MRL	Tariff	MRL	Tariff	MRL	Tariff	MRL	Tariff
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EM_{ijkt}	0.002	0.001	-0.006	-0.016	-0.023	-0.023	-0.064***	0.009
IM_{ijkt}	-0.030**	-0.036***	-0.018	-0.023	-0.004	-0.007	-0.023	-0.031***
$EM_{ijkt} \times IM_{ijkt}$	-0.021*	-0.027***	-0.018	-0.027*	-0.018	-0.020	-0.058***	-0.018**
$\ln(X_{ijkt})$	-0.024**	-0.117***	-0.019	-0.057***	-0.011	0.009	-0.033***	-0.041***
$Price_{ijkt}$	0.025**	0.032***	0.028	0.004	0.032	-0.062	0.008	0.016
$Quality_{ijkt}$	0.002	-0.112***	0.002	-0.022	0.058	-0.036	-0.027	-0.005
$QA\ Price_{ijkt}$	0.018	0.115***	0.020	0.021	-0.022	-0.020	0.028**	0.016

Notes: Robust country-pair-product clustered standard errors in parentheses. ***, **, * denote significance at 1%, 5% and 10% respectively. Standardized beta coefficients in parenthesis.