Pesticide Regulatory Heterogeneity, Foreign Sourcing, and Global Agricultural Value Chains

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Summary

- ▶ What is the effect of cross-country variations in pesticide regulations on the import decisions of agri-food firms?

- ▶ We combine **pesticide regulations data** with **firm-level import data** on Switzerland

- ▶ **Identification:** Pesticide regulations are exogenous to firm-level import decisions

- ▶ Regulatory heterogeneity decreases imports. Firms pay **higher import prices**

- ▶ GVC-active firms and large firms are more resilient.

Pesticides and agriculture: a love-hate relationship

▶ Pesticide use in modern agriculture

▶ Consequences for the environment, biodiversity and human health

▶ Policy response — review and/or set new standards $\rightarrow$ maximum residue limits (MRL)

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[1]Image source: Pesticide Atlas, DW, WTO

Often there is nothing "standard" about standards across countries

Table: Maximum Residue Limits on selected products in 2018 (Source: Homologa)

Active element	Product	CHE	EU	Japan	USA	Canada	China	Codex
Carbaryl	Mandarins	0.01	0.01	7	10	10		15
Fenbutatin-Oxide	Apple	2	2	5	15	3	5	5
Acetamiprid	Apple	0.8	0.8	2	1	1	0.8	0.8
Azoxystrobin	Tomatoes	3	3	3	0.2	0.2	3	3
Folpet	Avocado	0.02	0.03	30	25	25		

Notes: MRLs are measured in parts-per-million (ppm).

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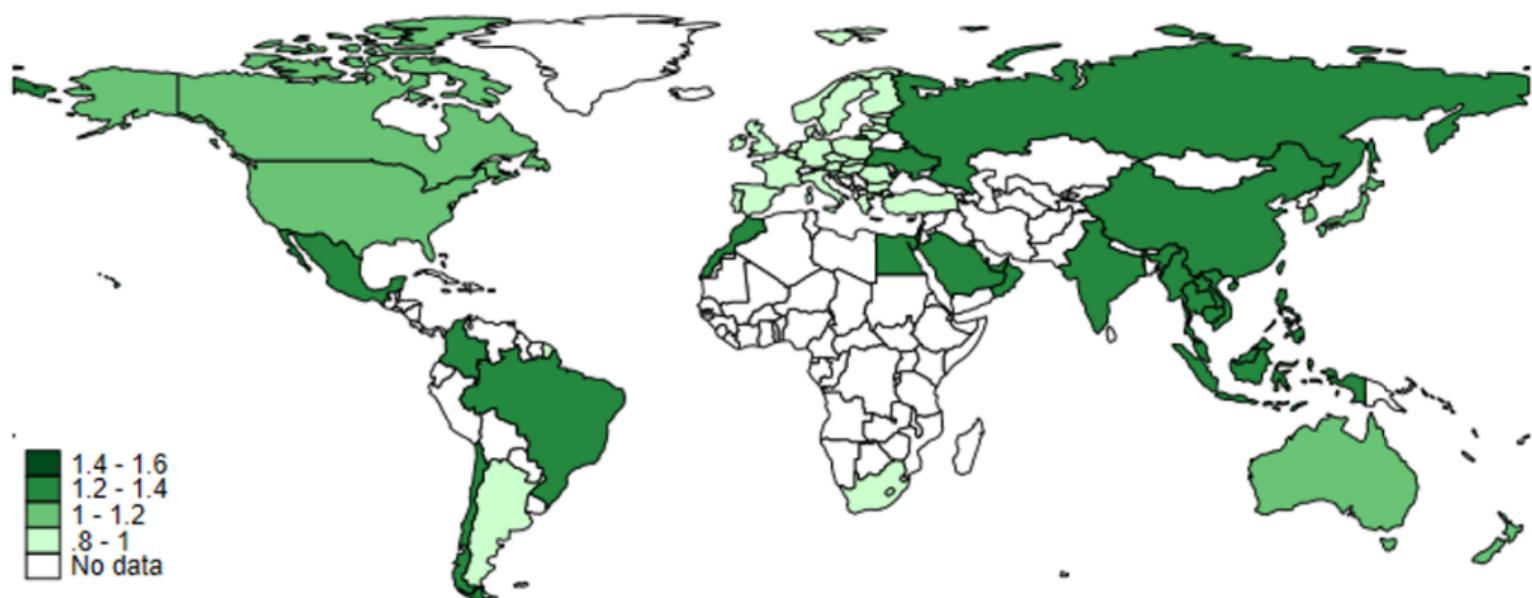
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Setting: exploit unique Swiss firm-level imports and data on MRLs.

A theoretical model of foreign sourcing

▶ Antras and Helpman (2004) provide a framework that models heterogeneous firms' decisions to outsource or insource

▶ Heterogeneous firms trade off higher fixed costs and lower variable costs of sourcing abroad against lower fixed costs and higher variable costs of sourcing at home.

▶ One of the main results of this model is that less productive firms source domestically while their more productive counterparts source inputs from abroad.

Bilateral variation in pesticide regulations (MRL_{odpt})

(2) Data on firm-level imports from Swiss-Impex

Our unit of analysis is the firm

- ▶ Imports by firm-product-origin from 2016 – 2018

- ▶ 10,271 firms

- ▶ 255 products (HS8 digit level)

- ▶ 65 origin countries

Empirical model
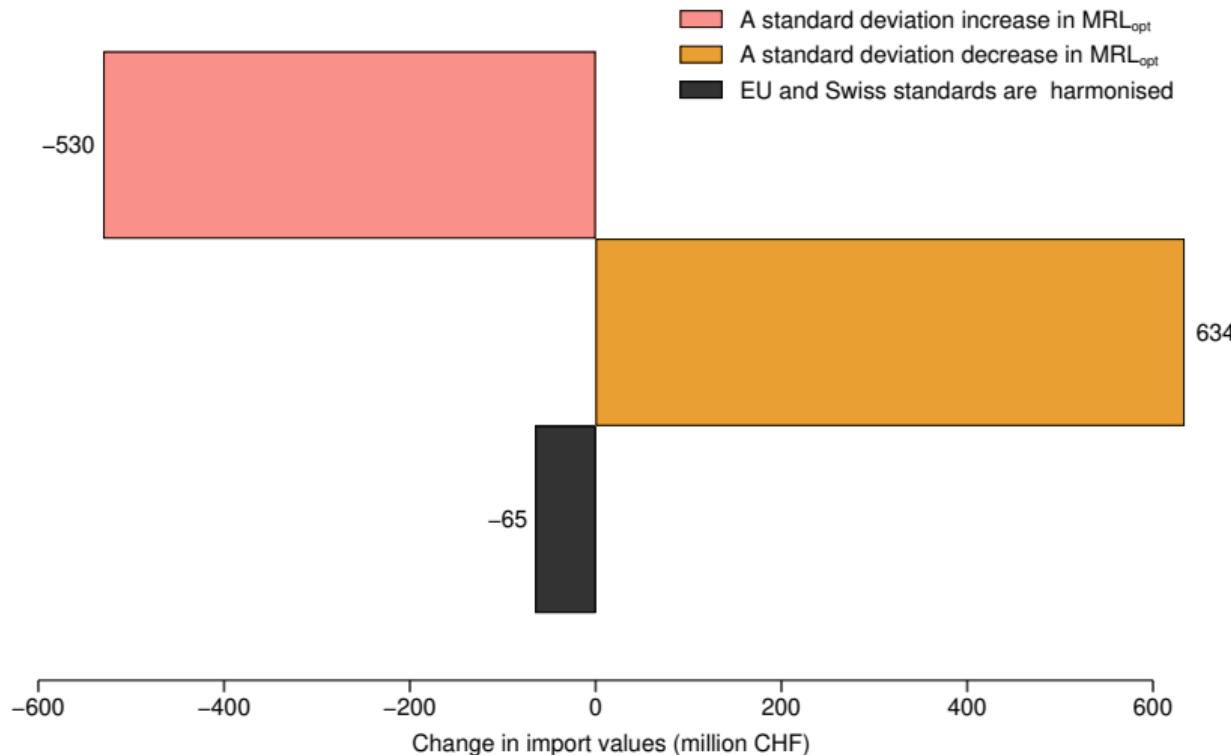
$$\log X_{fopt} = \beta_0 + \boxed{\beta_1 MRL_{opt}} + \beta_2 \log(1 + Tariff_{opt}) + \lambda_{fpo} + \lambda_{ot} + \varepsilon_{fopt} \quad (1)$$

▶ X_{fopt} = Import values in CHF

▶ MRL_{opt} = bilateral difference in MRL stringency between o and d

▶ $Tariff_{opt}$ = MFN tariffs imposed by Switzerland on imports from o

▶ λ_{fpo}, λ_{ot} = firm-product-origin and origin-time fixed effects

▶ Equation (1) is estimated using OLS (with ε_{fopt} clustered at the fpt level)

Results

- ▶ Pesticide regulatory differences decrease imports, less so for productive firms
- ▶ The negative effects are driven entirely by the intensive margin
- ▶ Mechanism: lower import quantities due to increased import prices
- ▶ The effects are more pronounced in higher-quality products
- ▶ Diversified firms are more resilient (multi-product, multi-origin, GVC)

Simulating imports due to hypothetical country-product equivalence

Main takeaways

▶ Differences in pesticide regulations decreases imports.

▶ Trade-off in welfare between prices and pesticide risks

▶ Smaller firms are less resilient $\Rightarrow$ threatens inclusive supply chains

▶ Business diversification helps coping with policy (annd probably) other risks

Thank you for your attention
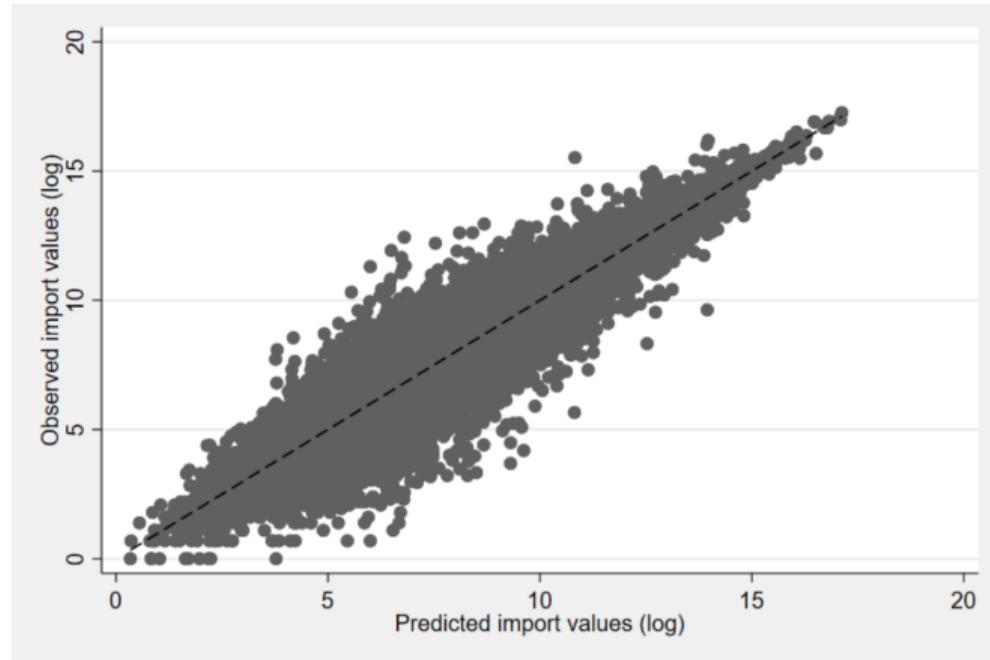
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Antras, P. and Helpman, E. (2004). Global sourcing. *Journal of Political Economy* 112: 552–580.

Fiankor, D.-D. D., Curzi, D. and Olper, A. (2021). Trade, price and quality upgrading effects of agri-food standards. *European Review of Agricultural Economics* 48: 835–877.

Hejazi, M., Grant, J. H. and Peterson, E. (2022). Trade impact of maximum residue limits in fresh fruits and vegetables. *Food Policy* 106: 102203.

Summary statistics

Variable	Mean	SD	Min	Max	*N*
Import value (000 CHF)	69965	520647	1	31340624	50488
Import volumes (tonnes)	53780	1033227	0	159124704	50488
Extensive margin	529	776	1	2503	50488
Intensive margin	1050	48206	0.001	7445081	50488
MRL_{opt}	1.044	0.267	0.795	2.371	50488
$Tariff_{opt}$ (CHF/kg)	40	86	0	1756	50488
GVC	0.443	0.497	0	1	50488

Observed and predicted import values

Alternative measure of firm size

Dependent variable (Log)	Total imports	Extensive margin	Intensive margin
	(1)	(2)	(3)
MRL_{opt}	−1.463***	−0.098**	−1.365***
	(0.254)	(0.048)	(0.249)
MRL_{opt} × Medium-size firm	0.726***	0.006	0.719***
	(0.034)	(0.004)	(0.034)
MRL_{opt} × Large-size firm	1.179***	0.006	1.173***
	(0.065)	(0.008)	(0.065)
Log (1 + $Tariff_{opt}$)	−0.872***	−1.176***	0.304
	(0.205)	(0.135)	(0.209)
Firm-origin-product FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
N	50488	50488	50488
adj. R^2	0.871	0.991	0.889

Notes: The dependent variable in column (1) is the aggregate value of firm f imports from origin o in year t. The extensive margin is the number of active firms importing product p from origin o in year t, and the intensive margin is the average import value per product per firm in year t. p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported. Standard errors are clustered at the firm-product-year level. Intercept included but not reported.

(3) Size matters: multi-product and multi-origin firms are more resilient

Table: Pesticide regulations and firm-level imports: multi-industry and multi-origin firms

Dependent variable (Log)	Total imports		Extensive margin		Intensive margin	
	(1)	(2)	(3)	(4)	(5)	(6)
MRL_{opt}	−0.785***	−0.772***	−0.096**	−0.104**	−0.689***	−0.667***
	(0.251)	(0.249)	(0.049)	(0.048)	(0.248)	(0.246)
MRL_{opt} × Multi-industry firms	0.120***		0.003		0.117***	
	(0.034)		(0.006)		(0.034)	
MRL_{opt} × Multi-origin firms		0.104***		0.011***		0.093***
		(0.030)		(0.004)		(0.029)
Log $(1 + \text{Tariff}_{opt})$	−0.832***	−0.827***	−1.176***	−1.175***	0.344	0.348*
	(0.207)	(0.207)	(0.135)	(0.135)	(0.211)	(0.211)
Firm-origin-product FE	Yes	Yes	Yes	Yes	Yes	Yes
Origin-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	504	50499	50488	50488	50488	50488
adj. R^2	0.868	0.868	0.991	0.991	0.887	0.887

Notes: The dependent variable in column (1) is the aggregate value of firm f imports from origin o in year t. The extensive margin is the number of active firms importing product p from origin o in year t, and the intensive margin is the average import value per product per firm in year t. p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported. Standard errors are clustered at the firm-product-year level. Intercepts included but not reported. Multi-industry firms are firms that import products in more than one four-digit industry over the study period. Multi-origin firms are firms that imported from more than one country over the study period.

Alternate estimator: PPML

$$X_{fopt} = \exp\left[\beta_0 + \beta_1 MRL_{opt} + \beta_2 \ln(1 + Tariff_{opt}) + \lambda_{fpo} + \lambda_{ot}\right] + \varepsilon_{fopt} \qquad (2)$$

Table: Pesticide regulations and firm-level imports: PPML estimator

Dependent variable (Log)	Import value	Import volume
	(1)	(2)
MRL_{opt}	−0.973**	−2.244***
	(0.454)	(0.791)
Log $(1 + Tariff_{opt})$	−0.946***	0.123
	(0.275)	(0.365)
Firm-origin-product FE	Yes	Yes
Origin-Year FE	Yes	Yes
Estimator	PPML	PPML
N	50488	50439

Notes: The dependent variable in column (1) is total Swiss import values in CHF of product p from origin country o in year t. The dependent variable in column (2) is total Swiss import volumes in kilograms of product p from origin country o in year t. p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported.

Ad-valorem tariff equivalents of pesticide regulatory heterogeneity

$$AVE_{MRL} = \left[\exp\left(\frac{\alpha \beta_1}{\sigma} \right) - 1 \right] \times 100 \tag{3}$$

where α measures a unit change in the policy variable.

- If we take the β_1 and $\sigma = \beta_2$ coefficients from column (1) of Table **??**, we can compute the AVEs for different values of α.

- For a one standard-deviation increase in MRL_{opt}, we obtain a tariff rate of 24%.

Measuring regulatory heterogeneity relative to Codex standards

$$MRL_{pt} = \frac{1}{N_{cp}} \left[\sum_{c \in N_p} \exp \left(\frac{MRLCodex_{pt} - MRL_{dpt}}{MRLCodex_{pt}} \right) \right] \tag{4}$$

Table: Pesticide regulations and firm-level imports

Dependent variable (Log)	Total imports	Extensive margin	Intensive margin
	(1)	(2)	(3)
MRL_{pt}	−0.242***	−0.045	−0.197***
	(0.081)	(0.028)	(0.076)
Log $(1 + \text{Tariff}_{opt})$	−0.295***	−0.229***	−0.066***
	(0.015)	(0.005)	(0.014)
Firm-origin FE	Yes	Yes	Yes
Origin-Year FE	Yes	Yes	Yes
N	20435	20435	20435
adj. R^2	0.554	0.387	0.570

Notes: The dependent variable in column (1) is total Swiss import values in CHF of product p from origin country o in year t. The dependent variable in column (2) is total Swiss import volumes in kilograms. of product p from origin country o in year t. p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported.

Alternative set of fixed effects

Table: Pesticide regulations and firm-level imports

| Dependent variable (Log)	Import value		Import volume	
	(1)	(2)	(3)	(4)
MRL_{opt}	−0.276***	−0.321***	−0.364***	−0.492***
	(0.044)	(0.112)	(0.048)	(0.130)
Log $(1 + \text{Tariff}_{opt})$	−1.608*	−3.471**	−1.560*	−2.609**
	(0.876)	(1.386)	(0.940)	(1.174)
Log GDP_{ot}	0.138***	0.121***	0.130***	0.251***
	(0.013)	(0.031)	(0.014)	(0.051)
Log Distance_o	−0.064***	−0.172***	−0.100***	−0.150***
	(0.019)	(0.051)	(0.021)	(0.057)
Border_o	0.565***	0.884***	0.516***	0.446**
	(0.068)	(0.138)	(0.073)	(0.176)
Language_o	−0.368***	−1.006***	−0.440***	−0.687***
	(0.062)	(0.120)	(0.067)	(0.152)
RTA_{ot}	0.176***	0.086	0.308***	0.273*
	(0.048)	(0.115)	(0.051)	(0.149)
Firm-product-year FE	Yes	Yes	Yes	Yes
N	37614	37614	37485	37599
Estimator	OLS	PPML	OLS	PPML
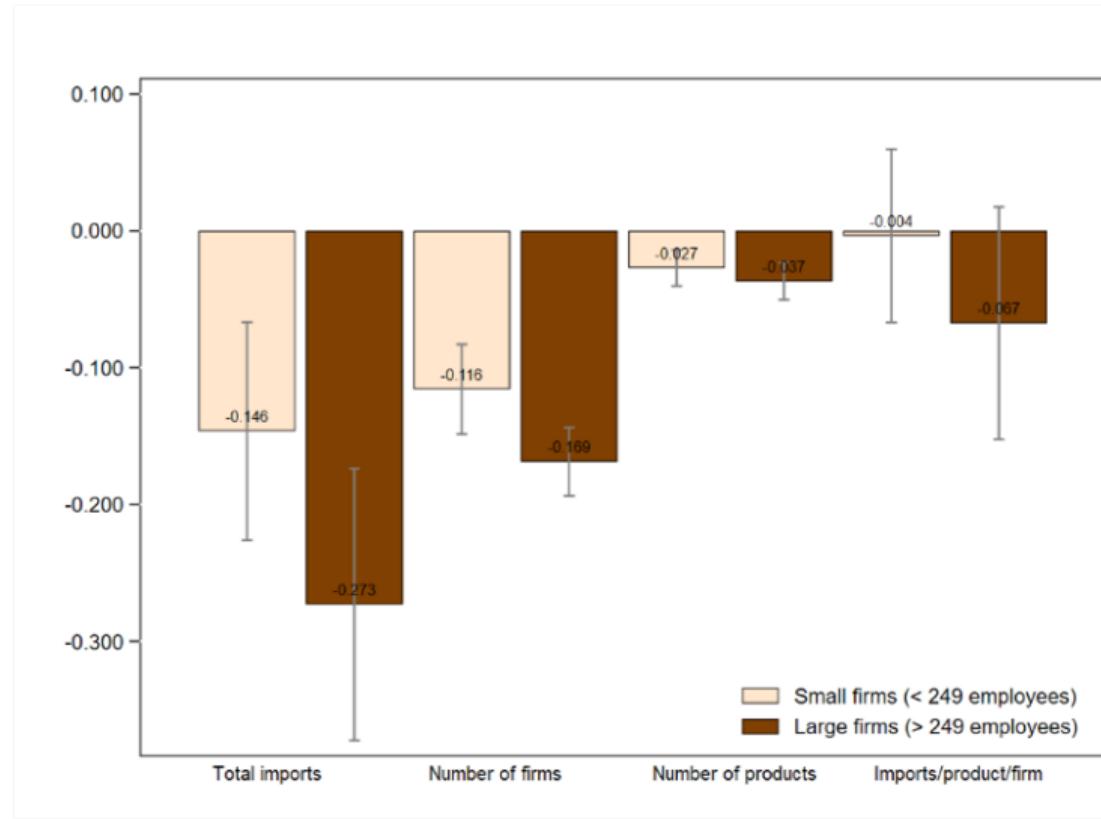
Notes: p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported. Standard errors are clustered at the firm-product-year level. Intercepts included but not reported.

Trade and price effects are more pronounced for higher quality products

Dependent variable	High quality products		Low quality products	
	Import values	Import prices	Import values	Import prices
	(1)	(2)	(3)	(4)
MRL_{opt}	−1.986***	0.239***	−0.202	−0.005
	(0.675)	(0.033)	(0.303)	(0.025)
Log $(1 + \text{Tariff}_{opt})$	−1.747***	−0.047	−2.016***	0.491
	(0.401)	(0.467)	(0.385)	(0.318)
Firm-origin-product FE	Yes	Yes	Yes	Yes
Origin-Year FE	Yes	Yes	Yes	Yes
N	24429	18474	23988	17868
adj. R^2	0.875	0.740	0.869	0.772

Notes: p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Standard errors are clustered at the firm-product-year level. Intercepts included but not reported. The lower number of observations is because the elasticity of substitution used to estimate product quality are not available for all product-origin country pairs. 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 or equal to the median fall in the short-quality ladder category.

… firm size (productivity) is not a guaranteed predictor of resilience

For a common global shock larger more productive firms are more affected (Fiankor et al., 2023; Food Policy)