No Double Standards: Quantifying the Impact of Standard Harmonization on International Trade

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Motivation

Standards are everywhere...

- Health, safety, environmental standards:
  - Safety specifications for children's toys
  - Pesticide levels for agricultural products
  - Mechanical filter specifications for FFP2/N95 face masks

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  - Mechanical filter specifications for FFP2/N95 face masks
- Quality standards:
  - Composition of dental implants, production of organic food, ISO 9000 quality management
- Compatibility standards:
  - Classic examples: electricity plugs, railway gauges, A4/letter paper formats
  - Internet protocols, 4G mobile telecommunications standards, door frames
- Conformity assessment standards:
  - Car safety crash tests, fire resistance of building materials, guidelines for personal data protection
- Technical standards:
  - QWERTY keyboard, archiving systems, statistical reporting, file format used for 3D printing, cybersecurity tools and safeguards

Motivation

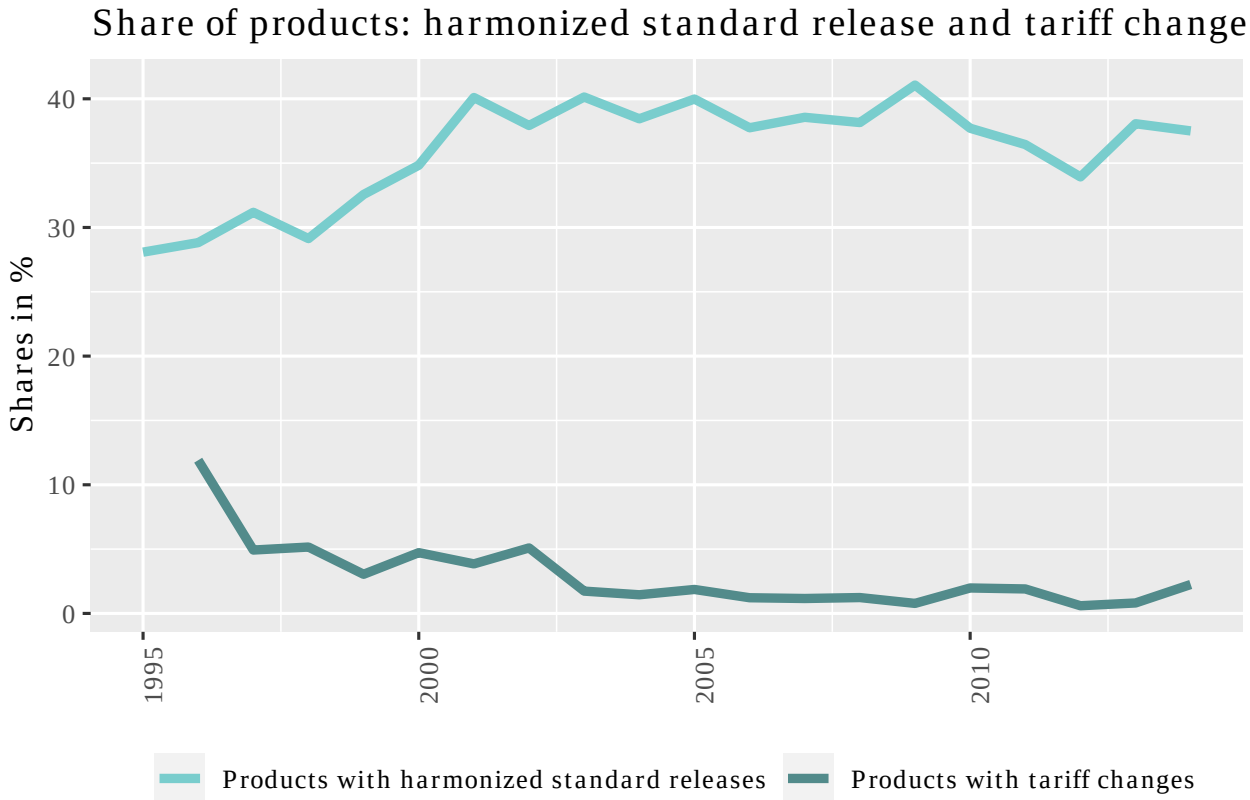
A fresh look at product standards

- Product standards usually qualified as barriers to trade...
- Approach of this paper:
  - Bulk of product standards are **voluntary**.
  - Standard development by **standard-setting organizations (SSOs)**, i.e. industry associations and non-profit standardization bodies.
  - Standardization is **beneficial** for users.
- **Novel mechanism** through which industrialized countries have achieved higher **trade integration**:
  - Compliance with standards is costly.
  - SSOs increasingly release harmonized standards (=equivalent versions in different countries).

  $\rightarrow$ Firms can reap benefits of standardization: higher demand for standardized products $\rightarrow$ higher exports.

Motivation

- Release of harmonized standards is a frequent event.



- **This paper: quantification and economic channels.**

Example

- Producers of electric motors want to certify their products' energy efficiency.
- International Electrotechnical Commission (IEC) releases a harmonized standard on motor efficiency (IEC 60034-2-1)
  - IEC 60043-2-1 unifies test method, test report format, efficiency classification, certification process and labelling.
  - Firms are free to use measurement methods described in IEC 60034-2-1.

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- Does France sell more electric motors to China than to Canada and US?

Findings

- Introduction of a harmonized standard is beneficial to trade flows:
  - On impact: 0.67% increase of **new** trade.
  - Ad valorem equivalent tariff decrease: 0.16 to 1.58 pp.
  - Increase in world trade: 0.27% per year.
  - **Contribution: 2 to 3 times larger than tariff reductions**
- Driven by expansion of sales rather than entry of new products/firms.
- Channels:
  - Heterogeneous firm model with **voluntary** standard adoption.

  $\rightarrow$ Harmonized standard releases allow for cost complementarities that stimulate investment into product attributes that consumers value.

Literature

1. Impact of non-tariff barriers to trade (specifically the effect of the **introduction** of standards) on trade flows:
   - Swann et al. [1996], Maskus et al. [2000], Moenius [2004]
   - Fontagné et al. [2015], Fernandes et al. [2019]
   - Macedoni and Weinberger [2018]
2. Effect of cross-country standard **harmonization** on trade flows:
   - Chen and Mattoo [2008], Disdier et al. [2015]
   - Reyes [2011]
3. **Theoretical** papers:
   - Mei [2017], Parenti and Vannoorenberghe [2019], Maggi and Ossa [2019], Grossman, McCalman and Staiger (2019)

Standards

The standard-setting process

- Standards are released by standard-setting organizations (SSOs).
  - Examples: ISO, IEEE, DIN, ANSI
  - Many SSOs are non-profit, non-governmental organizations.
  - SSOs elaborate standards in working groups and technical committees.

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- SSOs develop **voluntary** consensus standards.
  - Legally binding when incorporated into governmental regulation.
  - Majority of standards remain voluntary.

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- Harmonized standard releases: mainly international standards accredited by national SSOs.
  - 6% due to national SSOs accrediting the standard of another national SSO

Standards

Benefits of using voluntary standards

- Regulatory standards often associated with negative externalities.
- Voluntary standards define product attributes that users value.
- **Interoperability** and positive **network effects** [Katz and Shapiro, 1985, Farrell and Saloner, 1985]
  - Especially relevant for horizontally differentiated products
  - Compatibility standards: economies of scale $\rightarrow$ supply chains and mass production
- **Reduction of information asymmetries** [Leland, 1979]
  - Especially relevant for vertically differentiated products
  - Quality and technical standards: consumers can assess product attributes through certification or labelling
- Consumer demand can be such that standards are *de facto* binding.

Theoretical framework

General set-up

- Modified version of the Melitz [2003] - Chaney [2008] framework
- CES consumption basket:

$$C_{jk} = \left[\sum_{i=1}^{N} \int_{\omega \in \Omega_{ijk}} \left[z_{ijk}(\omega) c_{ijk}(\omega) \right]^{\frac{\sigma_k - 1}{\sigma_k}} d\omega \right]^{\frac{\sigma_k}{\sigma_k - 1}}$$

  z_{ijk}: demand shifter that translates product attributes of the standard

- Standard adoption is voluntary but entails sunk investment costs $a(z_{ijk})$:

Standardizers:	$z_{ijk} = z_{jk} > 1;$	$a(z_{jk}) > 0$
Non-standardizers:	$z_{ijk} = 1;$	$a(z_{jk}) = 0$

- Marginal production costs $z_{ijk}^{t_k}$
- Heterogeneous firm setup with firm-level productivity φ.

Theoretical framework

General set-up

- Demand for variety-specific exports:

$$c_{ijk}(\varphi) = A_{jk} z_{ijk}(\varphi)^{\sigma_k - 1} p_{ijk}(\varphi)^{-\sigma_k}$$

$A_{jk} = P_{jk}^{\sigma_k - 1} X_{jk}$: destination-specific sector demand

- Prices:

$$p_{ijk}(\varphi) = \frac{\sigma_k}{\sigma_k - 1} \frac{\tau_{ijk} z_{ijk}^{t_k}(\varphi)}{\varphi}$$

- Export sales:

$$x_{ijk}(\varphi) = A_{jk} \left(\frac{\sigma_k}{\sigma_k - 1} \frac{\tau_{ijk}}{\varphi} \frac{z_{ijk}^{t_k}(\varphi)}{z_{ijk}(\varphi)} \right)^{1-\sigma_k}$$

- Firm profits:

$$\pi_{ijk}(\varphi) = \frac{x_{ijk}(\varphi)}{\sigma_k} - f_{ijk} - a(z_{ijk}(\varphi))$$

Theoretical framework

Endogenous standard adoption

- Consider a two-country world ($N = 2$).
- Benchmark situation: respective SSO in each country issues a national k-specific product standard.
- Two export cut-offs:

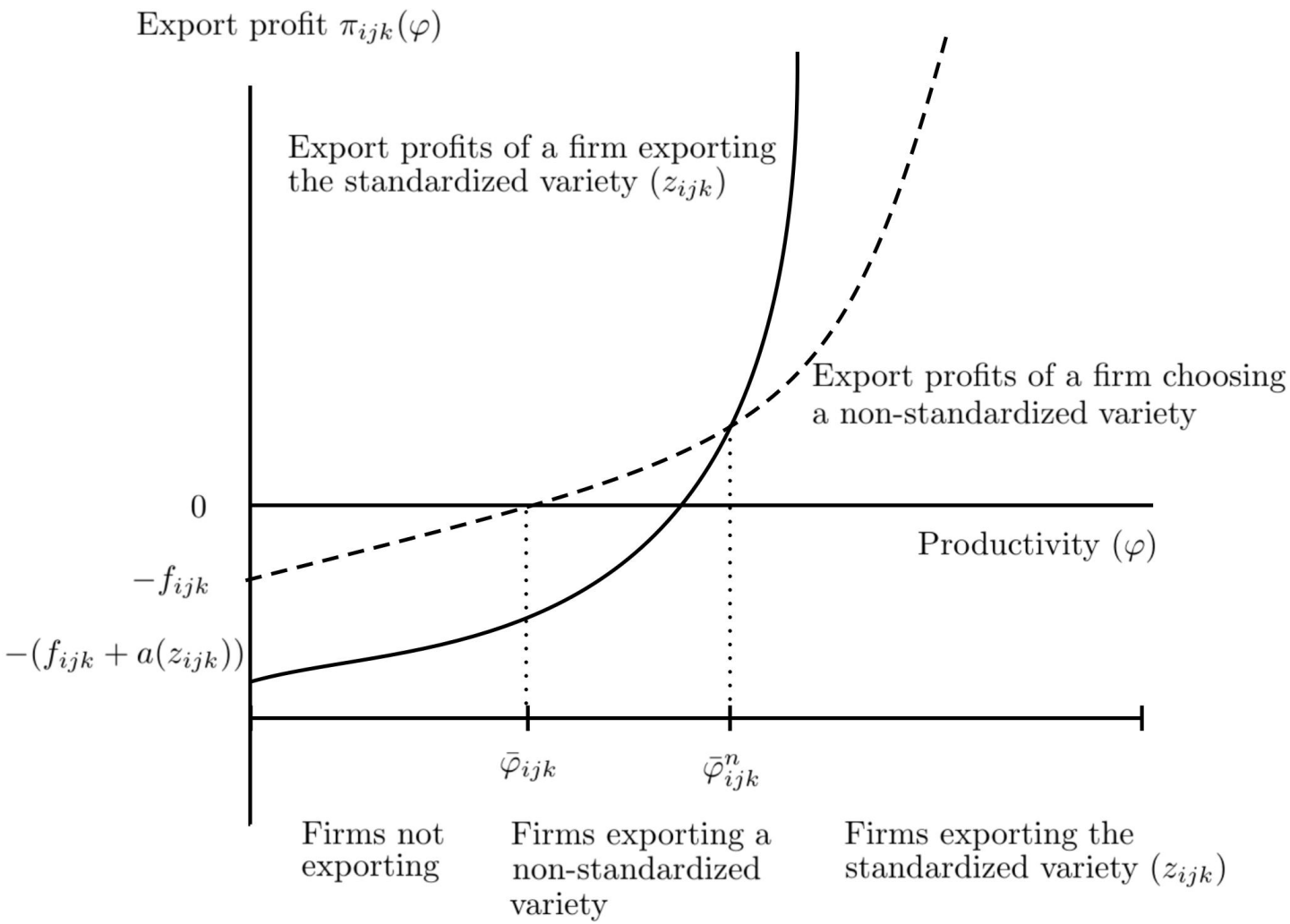
$$\bar{\varphi}_{ijk} = \left(\frac{\sigma_k f_{ijk}}{A_{jk}} \right)^{\frac{1}{\sigma_k - 1}} \frac{\sigma_k}{\sigma_k - 1} \tau_{ijk} \quad \text{(non-standardizers)}$$

$$\bar{\varphi}^n_{ijk} = \left(\frac{\sigma_k a(z_{jk})}{s(z_{jk}) A_{jk}} \right)^{\frac{1}{\sigma_k - 1}} \frac{\sigma_k}{\sigma_k - 1} \tau_{ijk} \quad \text{(standardizers)}$$

$s(z_{jk}) = z_{jk}^{(\sigma_k - 1)(1 - t_k)} - 1$: additional demand for standardized products

Theoretical framework

Two cut-offs



Theoretical framework

Endogenous standard adoption

- Assumption of a Pareto distribution over $[1, \infty]$ with product-specific shape parameter ξ_k.
- Product-specific bilateral trade flows:

$$X_{ijk}^n = \left(\frac{\sigma_k}{\sigma_k - 1} \tau_{ijk} \left(\sigma_k \frac{f_{ijk}}{A_{jk}} \right)^{\frac{1}{\sigma_k - 1}} \right)^{-\xi_k} \Gamma_k f_{ijk} \left(1 + \Delta_{ijk}^n s(z_{jk}) \right)$$

$$\Gamma_k = \frac{\xi_k \sigma_k}{\xi_k - (\sigma_k - 1)}$$

- Share of exporters that produce in accordance with foreign standard:

$$\Delta_{ijk}^n = \left(\frac{s(z_{jk}) f_{ijk}}{a(z_{jk})} \right)^{\frac{\xi_k}{\sigma_k - 1} - 1}.$$

Theoretical framework

Harmonized product standards

- Common harmonized standard z_k that is equivalent in both countries.
- Second cut-off is different:

$$\bar{\varphi}_{ijk}^{h} = \left(\frac{\sigma_k a(z_k)}{s(z_k)\left(A_{ik} + A_{jk}\tau_{ijk}^{1-\sigma_k}\right)} \right)^{\frac{1}{\sigma_k - 1}} \frac{\sigma_k}{\sigma_k - 1}$$

- Bilateral trade flows:

$$X_{ijk}^{h} = \left(\frac{\sigma_k}{\sigma_k - 1} \tau_{ijk} \left(\sigma_k \frac{f_{ijk}}{A_{jk}} \right)^{\frac{1}{\sigma_k - 1}} \right)^{-\xi_k} \Gamma_k f_{ijk} \left(1 + \Delta_{ijk}^{h} s(z_k)\right)$$

- Share of firms that invest into the harmonized standard:

$$\Delta_{ijk}^{h} = \left(\frac{s(z_k) f_{ijk} \left(A_{ik} + A_{jk}\tau_{ijk}^{1-\sigma_k}\right)}{a(z_k) A_{jk} \tau_{ijk}^{1-\sigma_k}} \right)^{\frac{\xi_k}{\sigma_k - 1} - 1}$$

Theoretical framework

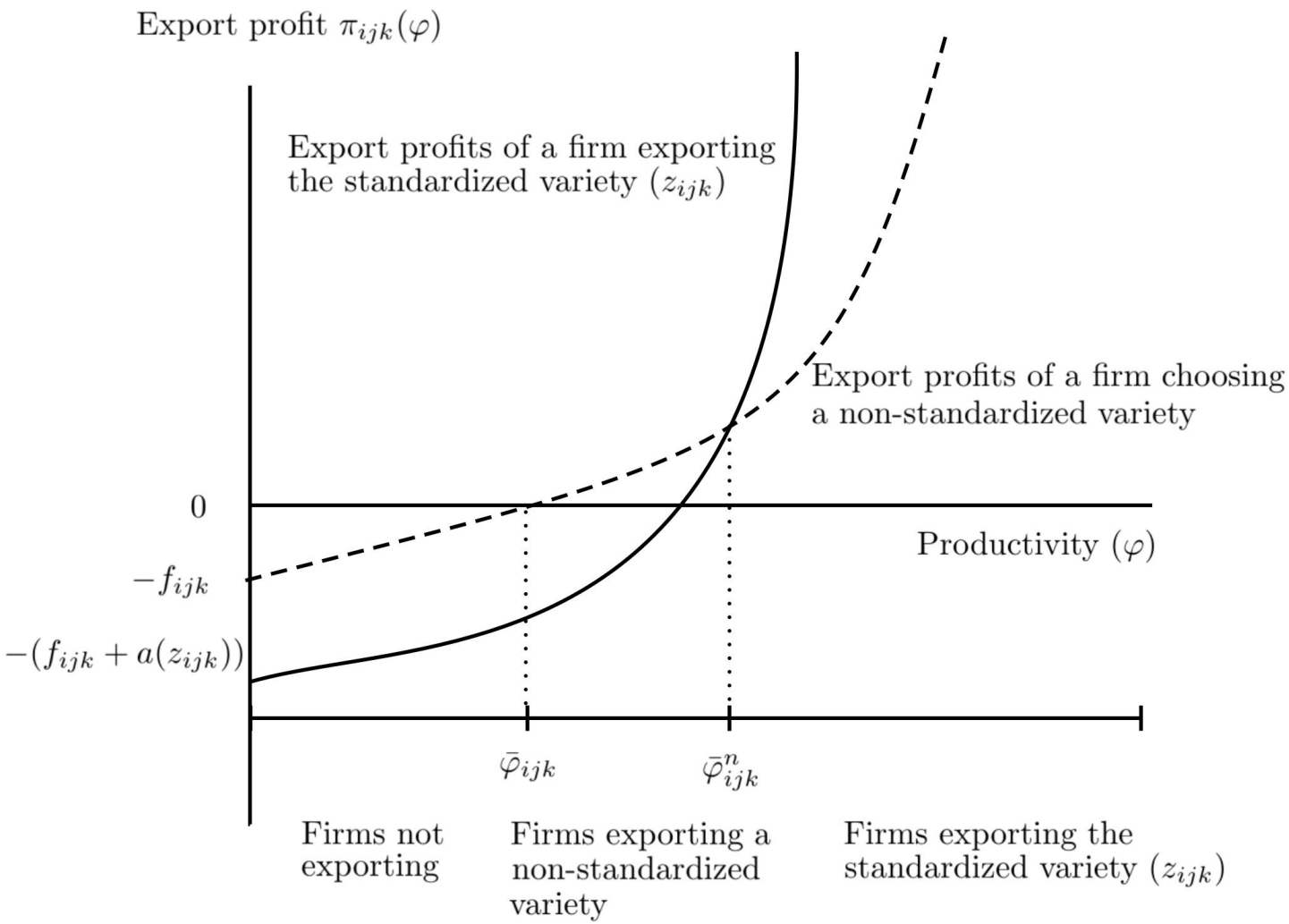
Comparing national and harmonized standards: two effects

- *Cost complementarity effect*: always higher for harmonized standards
  - Harmonized standards allow for complementarities in sunk investment costs.
  - For a similar level of product attribute ($z_k = z_{jk}$), the share of exporters producing the standardized variety is always higher ($\Delta^h_{ijk} > \Delta^n_{ijk}$).
  - Smaller markets profit from harmonized standards to a larger extent.
- *Demand effect*: captures the extent to which consumers value harmonized standards z_k differently from national standards z_{jk}
  - Can be positive or negative.

▸ Analytical expressions

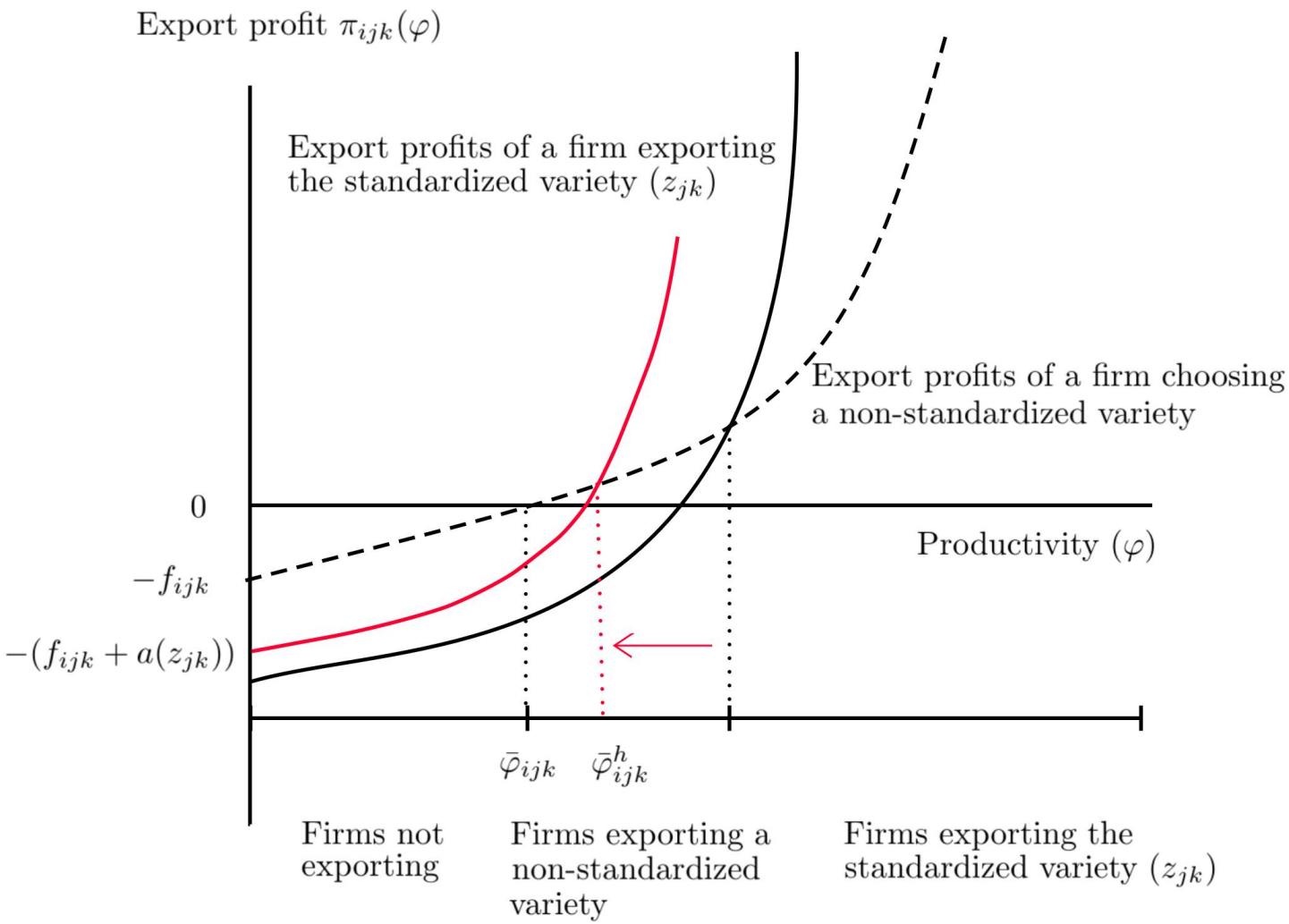
Theoretical framework

Harmonized product standards



Theoretical framework

Harmonized product standards



Data sources

- Standard data from Searle Center (Northwestern University)
  - Based on ICS classification system, use of 5 digit codes (405 classes)
  - ▸ Cleaning ▸ SSO ▸ Industry
- Bilateral product-level trade data from Comtrade (UN)
  - Use 4 digit HS code classification (1260 products).
- Firm-level trade data from French customs
- Sample period: 1995–2014

Linking standards to trade flows

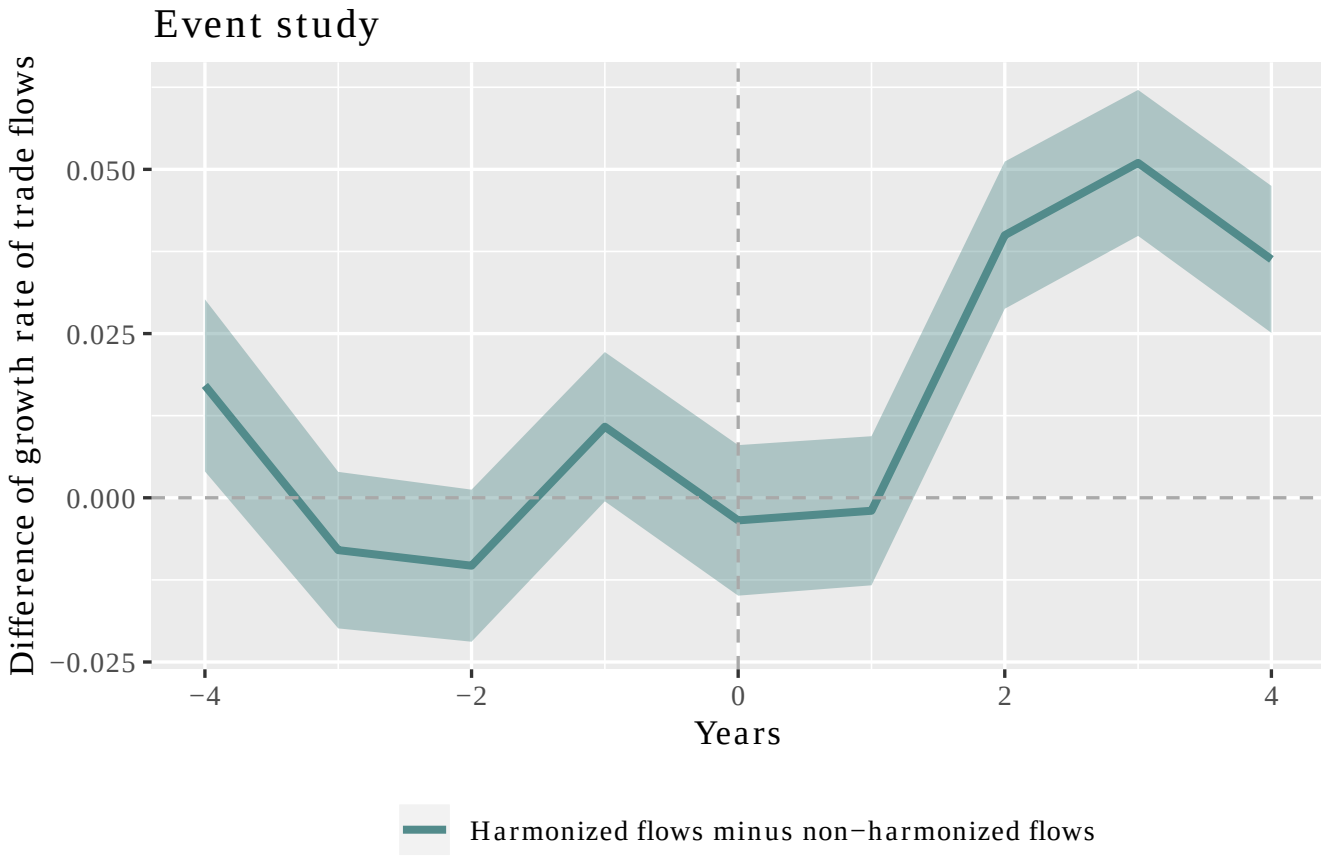
Remedies

1. TBT IMS database from the WTO
   - Technical Barriers to Trade (TBT) and Sanitary and Phytosanitary (SPS) notifications of WTO members
2. Keyword matching algorithm (see companion paper: Han et al. [2019])
   - Keywords respectively from DIN and HS description
   - Unbiased and comprehensive matching
   - Drawback: quality of the match not as good as WTO table

- WTO table as benchmark, keyword matching table as robustness.

Event study: diff-in-diff

- Average growth rates of trade in harmonized vs. non-harmonized products



Econometric specification

Baseline

- Treatment (standard harmonization) vs control group (no harmonization)

$$Y_{ijkt} = \beta h_{ijkt} + f_{ikt} + f_{jkt} + f_{ijk} + f_{ijt} + \varepsilon_{ijkt}$$

  - Treatment h_{ijkt} equals 1 if i and j harmonize standard(s), 0 otherwise
    - h_{ijkt} = stock measure: in cases of multiple harmonization events within ijk triplet, we add 1 for every event.

- Dependent variable Y_{ijkt}: total exports from i to j of product k (HS 4-digit level)

Results

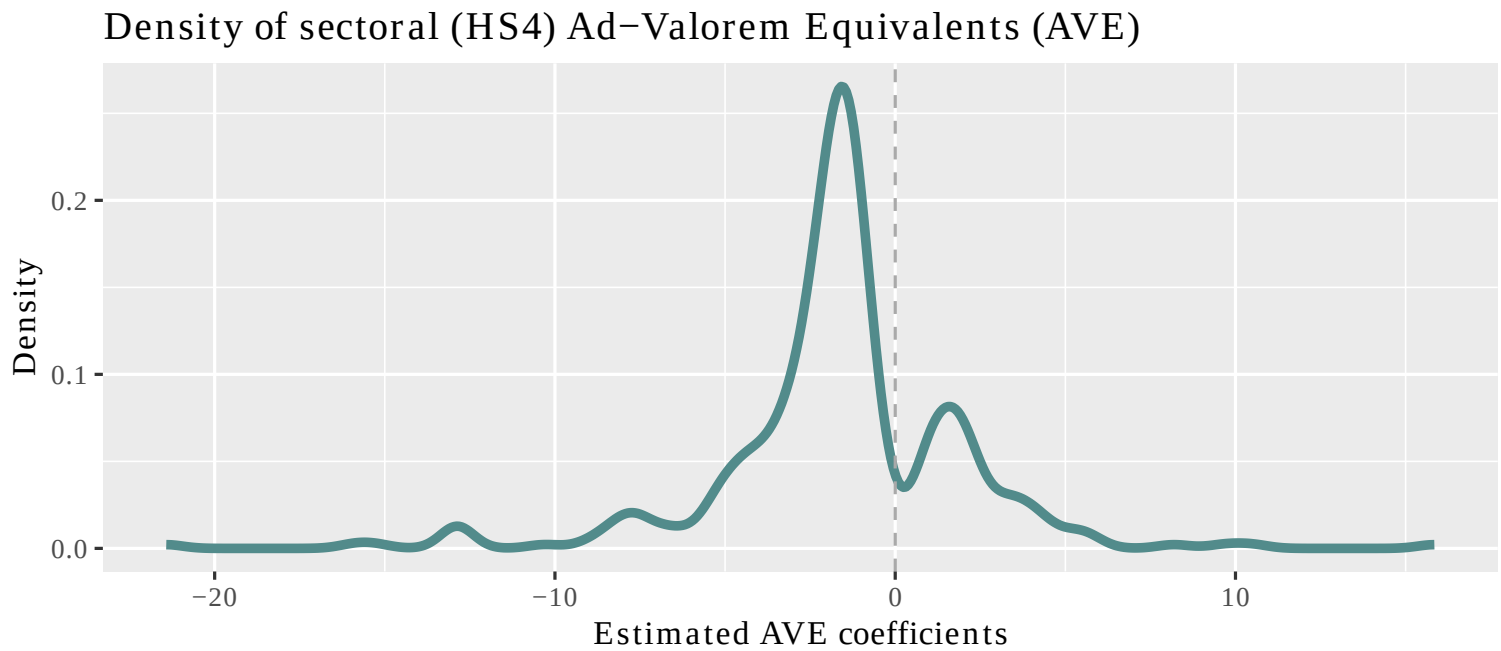
Baseline specification

	(1) Total	(2) Total	(3) Total	(4) Total
Harm.	0.15050***	0.02121***	0.00667***	0.00489***
	[0.000]	[0.000]	[0.000]	[0.008]
Ln(1+tariff)				-1.71290***
				[0.000]
Observations	5920146	5848858	5848855	4692952
R^2	0.22	0.88	0.88	0.89
Adjusted R^2	0.22	0.85	0.85	0.86
Exporter-time FE	yes	no	no	no
Importer-time FE	yes	no	no	no
Exporter-importer FE	yes	no	no	no
Exporter-product-time FE	no	yes	yes	yes
Importer-product-time FE	no	yes	yes	yes
Exporter-importer-product FE	no	yes	yes	yes
Exporter-importer-time FE	no	no	yes	yes

- A harmonization event increases trade flows by 0.67%.

Quantification of effects

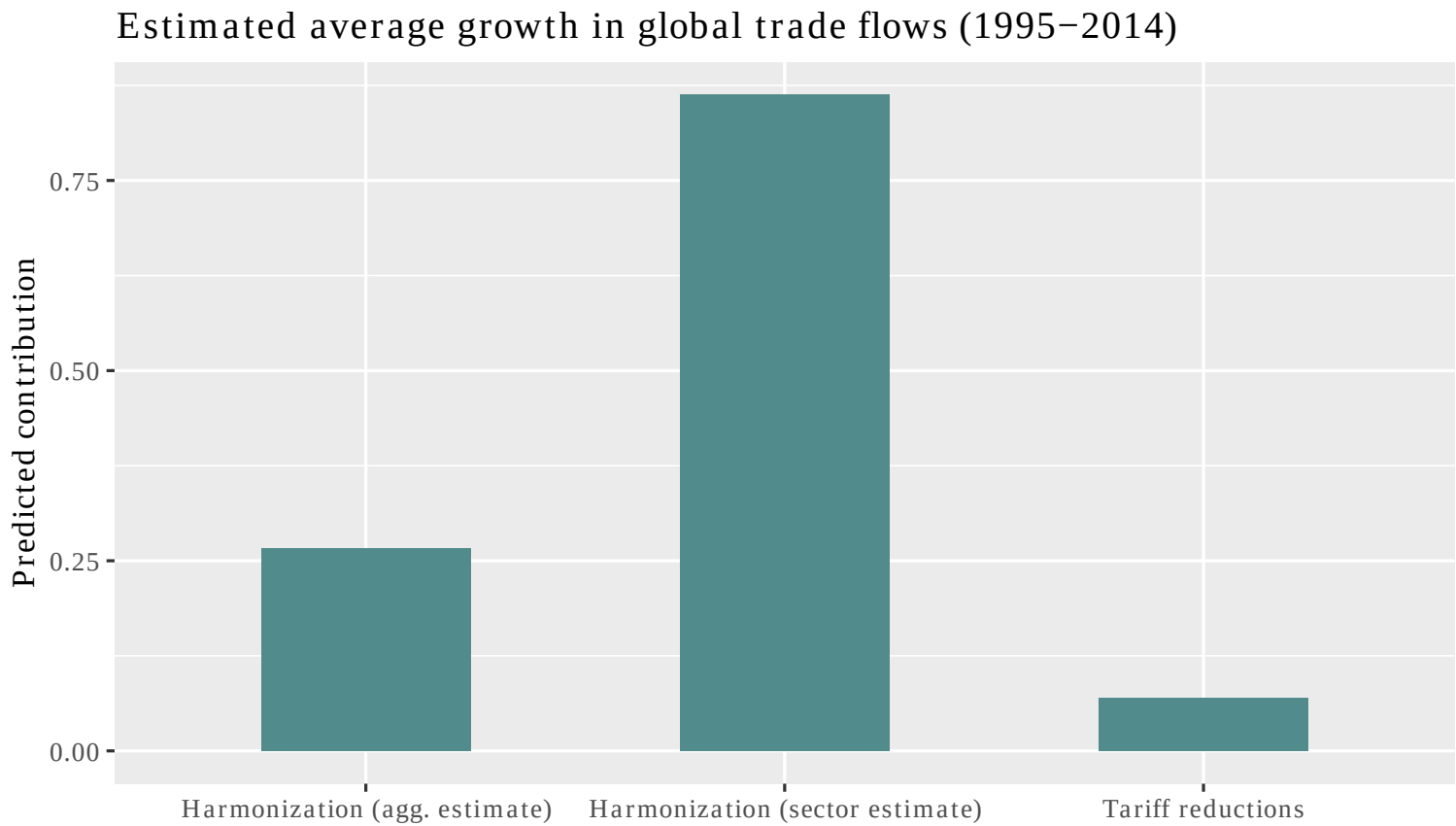
Ad-valorem equivalent (AVE) tariff



- Baseline estimates of 0.16pp to 0.18pp
- Sectoral estimates: mean of 0.87pp (only significant estimates: 1.58pp)

▸ Details on computation

Quantification of effects



- Implied increase of trade growth: 0.27% (aggregate estimate) to 0.79% (sectoral estimates)

→ Contribution to trade growth: up to 12.4%

Endogeneity concerns

- Pre-trends are not significant
  ▸ Pre-trends
- Differenced data: results are not driven by product categories with larger trade flows
  ▸ Differenced data
- Supranational EN standards: large degree of exogeneity
  ▸ EN standards
- IV regressions: standard harmonization events of neighboring countries
  ▸ IV results

Extensive and intensive margin

- Decomposition of French bilateral product-level trade flows into an extensive and intensive margin:

$$\log(X_{ijkt}) = \log(M_{ijkt}) + \log(\bar{x}_{ijkt})$$

	(1) Total	(2) Extensive Margin	(3) Intensive Margin
Harmonization	0.01740***	0.00319	0.01422***
	[0.005]	[0.108]	[0.010]
Product-time FE	yes	yes	yes
Importer-product FE	yes	yes	yes
Importer-time FE	yes	yes	yes
Observations	300457	300457	300457
R^2	0.88	0.97	0.80
Adjusted R^2	0.87	0.96	0.78

- Results driven by higher intensive margin, no effect on extensive margin.

Firm-level evidence

- Regression on the firm-level for export status, total sales, quantities and price of firm f of product n (HS6-level) to destination j:

$$Y_{fjnt} = \beta h_{jnt} + f_{fjn} + f_{fjt} + \varepsilon_{fjnt}$$

	(1) Export status	(2) Sales	(3) Sales	(4) Price	(5) Quantity
Harmonization	0.00084	0.00691***	0.00586***	0.00188*	0.00398**
	[0.185]	[0.000]	[0.002]	[0.080]	[0.044]
Firm-importer-year FE	yes	yes	yes	yes	yes
Firm-importer-product FE	yes	yes	yes	yes	yes
Observations	12634460	5285380	4506939	4506939	4506939
R^2	0.63	0.85	0.86	0.94	0.90
Adjusted R^2	0.55	0.80	0.80	0.91	0.86

- No effect on net entry, sales increase driven by higher prices and quantities.

Firm-level evidence

Firm heterogeneity

- Splitting firm-level data into size quartiles:

	(1) 1st quartile	(2) 2nd quartile	(3) 3rd quartile	(4) 4th quartile
Harmonization	-0.00130	0.00786	0.00176	0.01213**
	[0.846]	[0.272]	[0.773]	[0.035]
Firm-importer-year FE	yes	yes	yes	yes
Firm-importer-product FE	yes	yes	yes	yes
Observations	762640	1233791	1477145	1655427
R^2	0.85	0.85	0.86	0.85
Adjusted R^2	0.73	0.76	0.79	0.81

- Only large (high-productivity) firms benefit from harmonized standards.

Evidence on demand-shifting

- Interaction with dummy for horizontally differentiated goods [Rauch, 1999] and for above-median "quality ladder" index [Khandelwal, 2010]:

	(1) Total	(2) Total	(3) Total
Harmonization	0.00157	0.00167	-0.00043
	[0.488]	[0.405]	[0.850]
Harmonization x Rauch index	0.01692***		0.01399***
	[0.000]		[0.000]
Harmonization x Quality ladder		0.02168***	0.01487***
		[0.000]	[0.001]
Exporter-product-time FE	yes	yes	yes
Importer-product-time FE	yes	yes	yes
Exporter-importer-product FE	yes	yes	yes
Exporter-importer-time FE	yes	yes	yes
Observations	5176560	5848855	5176560
R^2	0.88	0.88	0.88
Adjusted R^2	0.85	0.85	0.85

- Differentiated goods drive results.

Heterogeneous effects on the product-level

- Interaction with destination market size (expected effect: negative), home market size (expected effect: positive) and distance/trade costs (expected effect: positive)

	(1) Total	(2) Total	(3) Total	(4) Total
Harmonization	0.00949***	0.00868***	0.00674***	0.00606***
	[0.000]	[0.000]	[0.000]	[0.000]
Harmonization x Dest. market size	-0.01827***	-0.02108***	-0.10275***	-0.10469***
	[0.000]	[0.000]	[0.000]	[0.000]
Harmonization x Home market size		0.00779**		0.00664*
		[0.033]		[0.069]
Harmonization x log(distance)			0.00390***	0.00388***
			[0.000]	[0.000]
Exporter-product-time FE	yes	yes	yes	yes
Importer-product-time FE	yes	yes	yes	yes
Exporter-importer-product FE	yes	yes	yes	yes
Exporter-importer-time FE	yes	yes	yes	yes
Observations	5848855	5848855	5848855	5848855
R^2	0.88	0.88	0.88	0.88
Adjusted R^2	0.85	0.85	0.85	0.85

Conclusion

- Novel database that tracks national and international product standards.
- Quantification of their impact on international trade: largely outnumbering the effect of tariff reductions.

$\rightarrow$ Uncover an industrial feature that can explain high levels of trade integration among industrialized countries.

Conclusion

- Novel database that tracks national and international product standards.
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→ Uncover an industrial feature that can explain high levels of trade integration among industrialized countries.

- Aggregate, average effect: abstract from standard-specific mechanisms.
- Further research: development and accreditation of standards.
- Optimality of the standard-setting process?
  - Standard-essential patents and market-structure [Schmalensee, 2009, Llanes and Poblete, 2014, Lerner and Tirole, 2015]
  - Effect on innovation/growth when an industry becomes "locked in" a certain technology [David, 1985, Farrell and Saloner, 1985, 1986]

▸ Additional exercises

Appendix

Theoretical framework

Comparing national and harmonized standards: two effects

$$X_{ijk}^h - X_{ijk}^n = \left\{ \underbrace{\left(\lambda^h - \lambda^n\right) s(z_{jk})^{\frac{\xi_k}{\sigma_k - 1}}}_{\text{cost complementarity effect}} + \underbrace{\lambda^h \left(s(z_k)^{\frac{\xi_k}{\sigma_k - 1}} - s(z_{jk})^{\frac{\xi_k}{\sigma_k - 1}} \right)}_{\text{demand effect}} \right\}$$

$$\lambda^h = \left(\frac{f_{ijk}}{a(z_k)} \frac{\left(A_{ik} + A_{jk}\tau_{ijk}^{1-\sigma_k}\right)}{A_{jk}\tau_{ijk}^{1-\sigma_k}} \right)^{\frac{\xi_k}{\sigma_k - 1} - 1}$$

$$\lambda^n = \left(\frac{f_{ijk}}{a(z_{jk})} \right)^{\frac{\xi_k}{\sigma_k - 1} - 1}$$

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Standards

Releases of harmonized standards, by major ICS categories

Field	Number	in %
Agriculture and food technologies	26309	3.3
Construction	80694	10.1
Electronics, information technology and telecommunications	130109	16.3
Engineering technologies	135966	17.0
Generalities, infrastructures and sciences	88337	11.0
Health, safety and environment	89568	11.2
Materials technologies	135906	17.0
Special technologies	28324	3.5
Transport and distribution of goods	84707	10.6
Total	799920	100

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Standards

Procedure to define subset of data

Initial number of standards	1372038
Standards that are not linked to other standards (step 1)	545315
Duplicate accreditations within one country (step 2)	275309
Remaining national standards (step 3)	194160
Remaining standards in database	530645
of which: original bilateral standards	3250
of which: accreditations of bilateral standards	26790
of which: by national SSOs	24658
of which: by international SSOs	2132
of which: original international standards	73344
of which: accreditations of international standards	427261

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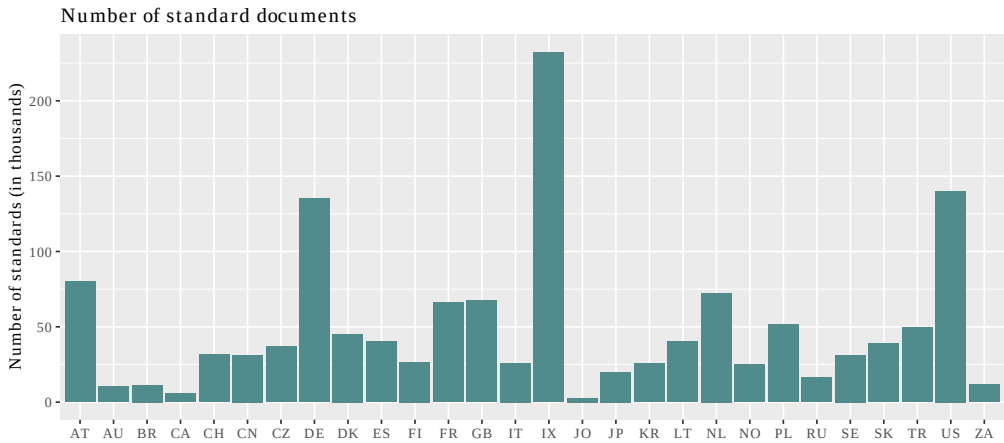
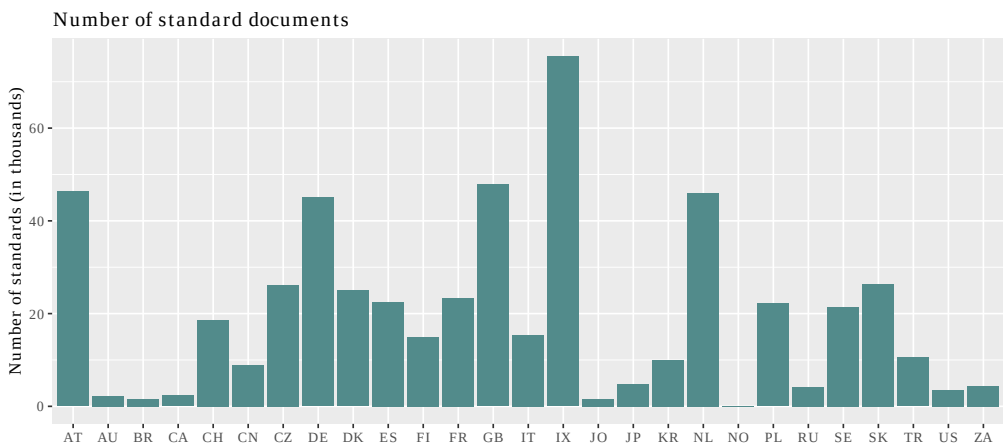
Standards

Country distribution before and after cleaning

(a) Raw data



(b) Relevant subset



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Standards

Top ten international SSOs (release of original standards)

SSO	Number	in %
CEN – European Committee for Standardization	26747	36.5
ISO – International Organization for Standardization	18995	25.9
IEC – International Electrotechnical Commission	13344	18.2
CENELEC – European Comm. for Electrotechnical Standardization	6820	9.3
ETSI – European Telecommunications Standards Institute	4815	6.6
ASD – AeroSpace and Defence Industries Association of Europe	1467	2.0
ITU – International Telecommunication Union	371	0.5
ECMA – European Asso. f. Standardizing Info. and Comm. Systems	140	0.2
ECSS – European Cooperation for Space Standardization	107	0.1
CCSDS – Consultative Committee for Space Data Systems	90	0.1
Other	448	0.6
Total	73344	100

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Quantification of effects

Ad-valorem equivalent (AVE) tariff

- Calculation of AVE tariff following Kee et al. [2009]:

$$AVE = \left(\frac{\exp(\beta) - 1}{\sigma} \right) 100.$$

- Two approaches:
  1. Take baseline estimate of the harmonization dummy in column (4) for β and the estimated coefficient of the average applied tariff rate minus one for σ.
  2. Value 4 from Head and Mayer [2014] for σ and the baseline estimate of the harmonization dummy in column (3) for β.

$\rightarrow$ Aggregate AVE between 0.16pp and 0.18pp.

- Product-specific ad-valorem equivalents (using 4-digit HS import demand elasticity estimates from Soderbery [2018]):

$$\log(X_{ijt}^k) - \sigma_k \log(1 + t_{ijkt}) = \beta_{1,k} h_{ijt}^k + f_{it} + f_{jt} + f_{ij} + \varepsilon_{ijt}.$$

$\rightarrow$ Cross-sector average: 0.87pp (only significant estimates: 1.58pp)

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Endogeneity

Pre-trends: dummies for leads of first harmonization

$$\log(X_{ijkt}) = \beta_h h_{ijkt} + \sum_{n=1}^{4} \beta_n d^{1st}_{ijkt-n} + f_{ikt} + f_{jkt} + f_{ijt} + f_{ijk} + \varepsilon_{ijkt}$$

	(1) Total
Harmonization	0.00791***
	[0.000]
Harmonization (t-1)	-0.00319
	[0.510]
Harmonization (t-2)	-0.00665
	[0.232]
Harmonization (t-3)	-0.00458
	[0.457]
Harmonization (t-4)	0.00061
	[0.926]
Exporter-product-time FE	yes
Importer-product-time FE	yes
Exporter-importer-product FE	yes
Exporter-importer-time FE	yes
Observations	4580633
R^2	0.89
Adjusted R^2	0.85

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Endogeneity

Differenced data

- **Endogeneity** concern: countries harmonize standards of products with large trade flows.
- Address endogeneity by differencing the data:

$$\Delta \log(Y_{ijkt}) = \beta \Delta \ h_{ijkt} + f_{ikt} + f_{jkt} + f_{ijt} + \varepsilon_{ijkt}$$

  - Harmonization dummy equals 1 (h_{ijkt}) if i and j harmonize standard(s) in product class k in year t , 0 otherwise.

- Taking care of medium-rum and potential anticipation effects [Baier et al., 2014]: take differences of several years.

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Endogeneity

Differenced data

	(1) Δ_{t-1} Total	(2) Δ_{t-2} Total	(3) Δ_{t-3} Total	(4) Δ_{t-4} Total	(5) Δ_{t-5} Total
Harmonization	-0.00132	0.00301*	0.00630***	0.00573***	0.00568***
	[0.533]	[0.094]	[0.000]	[0.001]	[0.001]
Exporter-product-time FE	yes	yes	yes	yes	yes
Importer-product-time FE	yes	yes	yes	yes	yes
Exporter-importer-time FE	yes	yes	yes	yes	yes
Exporter-importer-product FE	yes	yes	yes	yes	yes
Observations	5017031	4676493	4370967	4078732	3794623
R^2	0.22	0.25	0.27	0.30	0.32
Adjusted R^2	0.08	0.11	0.13	0.16	0.19

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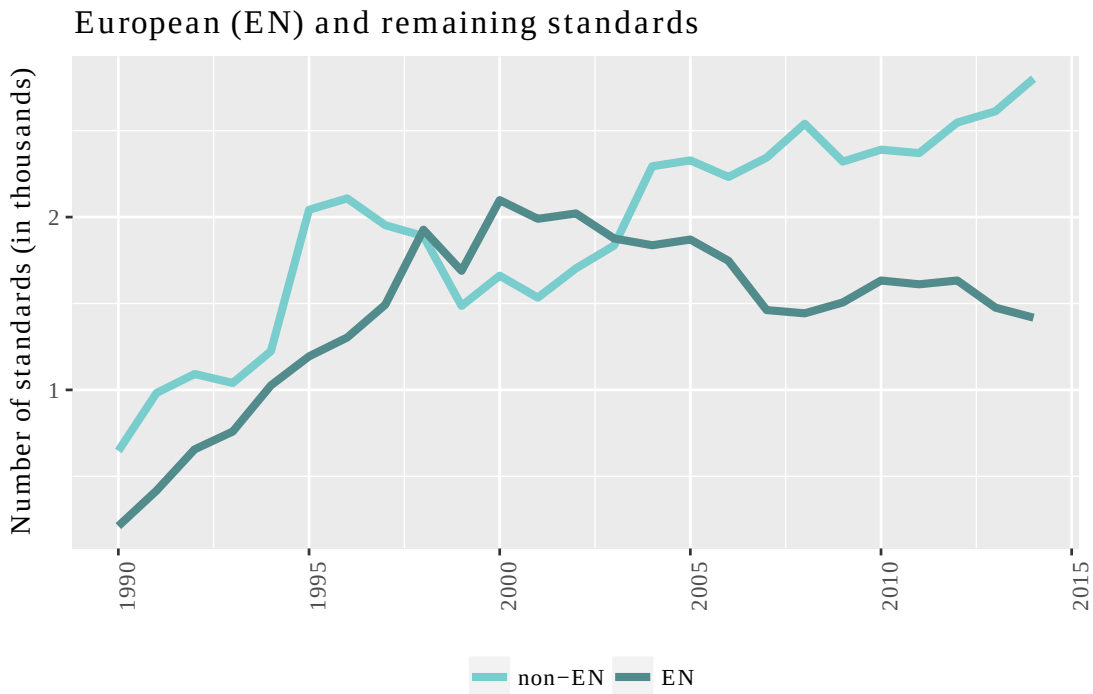
Endogeneity

EN Standards

- Providers of so-called "European Standards":
  - European Committee for Standardisation (CEN)
  - European Committee for Electrotechnical Standardization (CENELEC)
  - European Telecommunications Standards Institute (ETSI)
- Obligation to implement EN standards at national level.



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Endogeneity

EN Standards

	(1) Total
Harmonization	0.00528*** [0.009]
Exporter-product-time FE	yes
Importer-product-time FE	yes
Exporter-importer-product FE	yes
Exporter-importer-time FE	yes
Observations	6194987
R^2	0.88
Adjusted R^2	0.85

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Endogeneity

IV regressions

- IV: Harmonization events of exporting countries' neighbors (similar to Kee and Nicita [2016])

	All countries		Non-EU countries	
	1st stage (1)	2nd stage (2)	1st stage (3)	2nd stage (4)
Harmonization neighbors	0.23846***		0.12188***	
	[0.000]		[0.000]	
Harmonization		0.01861**		0.04344*
		[0.013]		[0.075]
Exporter-product-time FE	yes	yes	yes	yes
Importer-product-time FE	yes	yes	yes	yes
Exporter-importer-product FE	yes	yes	yes	yes
Exporter-importer-time FE	yes	yes	yes	yes
Observations	5848855	5848855	938639	938639
F-statistic	3811		612	

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National standards

- Inclusion of dummy variables for the release of national standards by the importing country.

	(1) Total	(2) Total	(3) Total
National foreign	0.02358***	-0.00099	-0.00164
	[0.000]	[0.445]	[0.210]
Harmonization			0.00759***
			[0.000]
Exporter-product-time FE	no	yes	yes
Importer-product-time FE	no	no	no
Exporter-importer-product FE	yes	yes	yes
Exporter-importer-time FE	yes	yes	yes
Observations	5885597	5861583	5861583
R^2	0.83	0.86	0.86
Adjusted R^2	0.82	0.84	0.84

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Firm-level evidence

Firm heterogeneity and market size / trade costs

- Interaction with destination market size (expected effect: positive) and distance/trade costs (expected effect: negative)

	(1) 1st quartile	(2) 2nd quartile	(3) 3rd quartile	(4) 4th quartile
Harmonization	0.00000	0.00330	0.00158	0.01077*
	[1.000]	[0.607]	[0.805]	[0.070]
Harmonization x Dest. market size	0.00001	0.00003	0.00013***	0.00022***
	[0.675]	[0.395]	[0.001]	[0.003]
Harmonization x log(distance)	-0.00012	0.00005	0.00002	-0.00022**
	[0.549]	[0.732]	[0.872]	[0.040]
Firm-importer-year FE	yes	yes	yes	yes
Firm-importer-product FE	yes	yes	yes	yes
Observations	762640	1233791	1477145	1655427
R^2	0.84	0.85	0.86	0.85
Adjusted R^2	0.73	0.77	0.80	0.81

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Multiple harmonization events

Econometric specification

- Marginal treatment effect depends on number of harmonization events.

$$Y_{ijkt} = \beta h^{1}_{ijkt} + ... + h^{18}_{ijkt} + f_{ikt} + f_{jkt} + f_{ijk} + f_{ijt} + \varepsilon_{ijkt}$$

  - h^{n}_{ijkt} describes the nth harmonization event.

- The specification captures the effect of the nth harmonization event relative to no standard harmonization.

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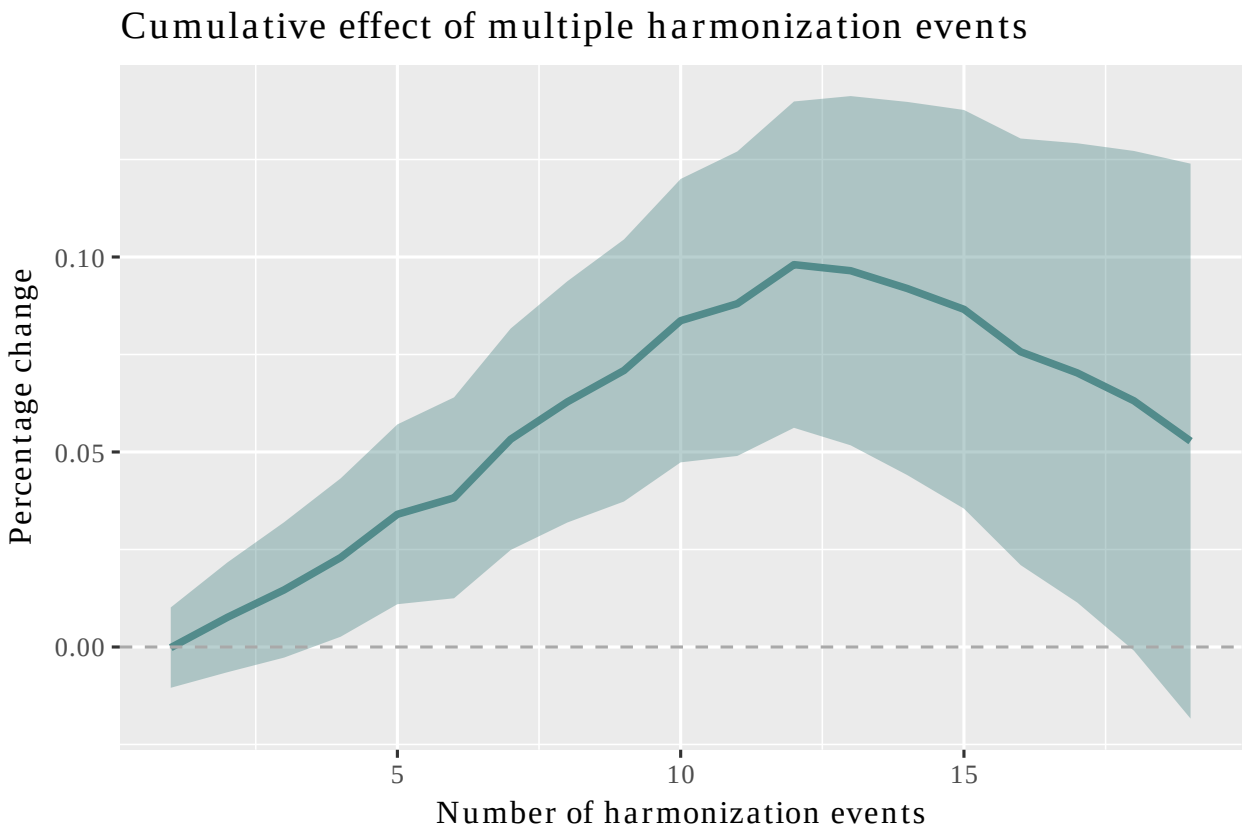
Multiple harmonization events



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Robustness

Concordance via keyword-matching table

	(1) Total	(2) Total	(3) Total
Harm.	0.09946*** [0.000]	0.01841*** [0.000]	0.00406*** [0.000]
Exporter-time FE	yes	no	no
Importer-time FE	yes	no	no
Exporter-importer FE	yes	no	no
Exporter-product-time FE	no	yes	yes
Importer-product-time FE	no	yes	yes
Exporter-importer-time FE	no	yes	yes
Exporter-importer-product FE	no	no	yes
Observations	4306574	4260304	4260286
R^2	0.21	0.88	0.88
Adjusted R^2	0.21	0.85	0.85

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Robustness

PPML estimates

	(1) Total	(2) Total	(3) Total
Harmonization	0.12745*** [0.000]	0.03683*** [0.000]	0.00267* [0.061]
Exporter-time FE	yes	no	no
Importer-time FE	yes	no	no
Exporter-importer FE	yes	no	no
Exporter-product-time FE	no	yes	yes
Importer-product-time FE	no	yes	yes
Exporter-importer-time FE	no	yes	yes
Exporter-importer-product FE	no	no	yes
Observations	10694300	9815057	8622827

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Robustness

WLS estimates

	(1) Total	(2) Total	(3) Total
Harmonization	0.07325*** [0.000]	0.03168*** [0.000]	0.00339** [0.016]
Exporter-time FE	yes	no	no
Importer-time FE	yes	no	no
Exporter-importer FE	yes	no	no
Exporter-product-time FE	no	yes	yes
Importer-product-time FE	no	yes	yes
Exporter-importer-time FE	no	yes	yes
Exporter-importer-product FE	no	no	yes
Observations	5920146	5887935	5848855
R^2	0.44	0.96	0.99
Adjusted R^2	0.44	0.95	0.99

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