Trade, Growth, and Product Innovation

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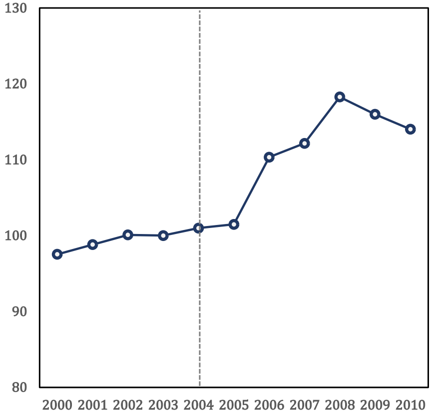
Can economic integration induce product innovation?

- Opposing economic forces:

- **Specialization**
  (part of trade literature)
  $\implies$ $(\downarrow)$ measure of varieties

- **Market size effect**
  (part of growth literature)
  $\implies$ $(\uparrow)$ measure of varieties

- **No framework to reconcile these forces!** That's what I do!



Total Number of Produced Varieties, Average Across New Member States (2004 Enlargement). Index, 2003 = 100. Source: Eurostat Prodcom.

Why Product Innovation?

- While there is a large degree of consensus regarding static gains from trade, there is little consensus on dynamic gains from trade.

  (Arkolakis, Costinot, and Rodríguez-Clare 2012; Melitz and Redding 2021)

- New product margin has large welfare implications. In a simple trade model, adding extensive margin can make welfare costs of a 10% tariff go from 1% to 20%! (Romer 1994)

- Around trade liberalization episodes, the bulk of trade creation comes from the extensive margin. (Kehoe and Ruhl 2013)

Contributions

- New quantitative framework of trade and growth that integrates and the forces of specialization and market access.
- Analytical expression for dynamic gains from trade that decomposes these two forces.
- Existence of a common global BGP in this framework and show how equilibrium growth rates change with market access.
- Documentation of new facts of new product variety production, R&D and trade around the events of EU enlargement.
- Use of plausibly exogenous variation to test dynamic mechanism and show that market access is related to trade-induced product innovation.
- Quantification of the welfare effects estimating that 2004 EU enlargement increased long-run yearly growth rate by 0.16%.

Related Literature

- **Trade and growth** Grossman and Helpman 1989, 1990, 1991; Romer 1990; Rivera-Batiz and Romer 1991a, 1991b; Eaton and Kortum 1999; Acemoglu and Ventura 2002; Baldwin and Robert-Nicoud 2008; Lucas 2009; Alvarez et al. 2013; Perla, Tonetti, and Waugh 2015; Arkolakis 2016; Sampson 2016; Aghion et al. 2018; Buera and Oberfield 2020; Santacreu 2020; Hsieh and Klenow 2022; Trouvain 2022; Kleinman et al. 2023; Sampson 2023.

- **Documentation of the extensive margin to the growth in trade flows and production** Feenstra 1994; Melitz 2003; Hummels and Klenow 2005; Bernard et al. 2009; Kehoe and Ruhl 2013; Arkolakis, Ganapati, and Muendler 2020; Mayer, Melitz, and Ottaviano 2020; Klenow, Hsieh, and Shimizu 2022.

- **Causes and effects of product innovation** Goldberg et al. 2010; Bas 2012; Argente et al. 2020; Rachapalli 2021.

- **Welfare effects of economic integration** Eaton and Kortum 2002; Arkolakis, Costinot, and Rodríguez-Clare 2012; Ossa 2015; Melitz and Redding 2021; Caliendo et al. 2021.

Theory

Environment

- Nests the Romer and the Eaton Kortum models as special cases.
- Arbitrarily many source countries $s \in \mathbf{K}$.
- Three sectors:
  - competitive final goods $\omega \in [0, 1]$, traded internationally;
  - differentiated intermediate goods $\nu \in [0, M_s(t)]$, traded internationally;
  - R&D, use savings to fund new varieties.
- HH supply labor inelastically, consume, and invest in new varieties through equity markets.

Model in one slide

final goods producer

$$y_s(t,\omega) = z_s(t,\omega)[\ell_s(t,\omega)]^{1-\alpha}\left(\frac{1}{\alpha}\sum_{k\in K}\int_0^{M_k(t)}[x_{ks}(t,\omega,\nu)]^{\alpha}d\nu\right)$$

Model in one slide

final goods producer

uses final goods varieties as inputs

traded composite (EK) final good

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$$Y_d(t) = \left[\int_0^1 y_d(t,\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}$$

intermediate goods producer

$$\max_{p_{ks}(t,\omega,\nu)} \frac{1}{\tau_{ks}} p_{ks}(t,\omega,\nu)x_{ks}(t,\omega,\nu) - P_k(t)x_{ks}(t,\omega,\nu)$$

$$p_{ks}(t,\omega,\nu) = \frac{\tau_{ks}P_k}{\alpha}$$

r&d sector

$$r_k(t) = \frac{\psi\cdot\pi_k(t)}{P_k(t)} + \frac{\dot{P}_k(t)}{P_k(t)}$$

consumer demand

$$\max_{C_s(t),c_s(t,\omega)_{\omega\in[0,1]}} \int_0^\infty \exp\{-\rho t\}\log(C_s(t))dt$$

$$s.\,t.\quad P_s(t)I_s(t) + P_s(t)C_s(t) = r_s(t)A_s(t) + w_s(t)L_s$$

uses composite good as input

Production in Final and Intermediate Goods | Trade in Final Goods | R&D Sector

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traded composite (EK) final good

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intermediate goods producer

$$\max_{p_{ks}(t,\omega,\nu)}\frac{1}{\tau_{ks}}p_{ks}(t,\omega,\nu)x_{ks}(t,\omega,\nu) - P_k(t)x_{ks}(t,\omega,\nu)$$

$$p_{ks}(t,\omega,\nu) = \frac{\tau_{ks}P_k}{\alpha}$$

market clearing

$$Y_d(t) = \underbrace{C_d(t)}_{\text{consumption}} + \underbrace{I_d(t)}_{\text{R\&D investment}} + \underbrace{X_d(t)}_{\text{intermediates}}$$

$$w_s(t)L_s(t) = (1-\alpha)\sum_d \underbrace{\lambda^F_{sd}(t)}_{\text{trade shares}} P_d(t)Y_d(t)$$

r&d sector

$$r_k(t) = \frac{\psi\cdot\pi_k(t)}{P_k(t)} + \frac{\dot{P}_k(t)}{P_k(t)}$$

consumer demand

$$\max_{C_s(t),c_s(t,\omega)_{\omega\in[0,1]}}\int_0^{\infty}\exp\{-\rho t\}\log(C_s(t))dt$$

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uses composite good as input

Production in Final and Intermediate Goods | Trade in Final Goods | R&D Sector | HH Problem

Understanding the stock of varieties

Can rewrite the final goods technology as

$$\left[z_s(t,\omega)\right]^{\frac{1}{1-\alpha}} \cdot \tilde{M}_s(t) \cdot \ell_s(t,\omega)$$

with the effective measure of input varieties $\tilde{M}_s(t)$:

$$\tilde{M}_s(t) \equiv \frac{1}{\alpha} \cdot \sum_{k \in \mathbf{K}} \underbrace{M_k(t)}_{\substack{\text{measure of} \\ \text{varieties} \\ \text{in each } k}} \cdot \left(\underbrace{\frac{\tau_{ks} P_k(t)}{\alpha}}_{\substack{\text{optimal monopolist} \\ \text{price from } k \text{ to } s}} \right)^{-\frac{\alpha}{1-\alpha}}$$

- captures heterogeneity in the source-country measure of varieties, price-heterogeneity and substitutability;
- also shows how the model maps to Eaton-Kortum and Romer. Nesting of EK & Romer

Equilibrium

- (Trade Eqm) Given $M_s(t)$, each t, system of N equations solves for wages:

$$w_s(t)L_s(t) = (1-\alpha)\sum_{d\in\mathbf{K}} \underbrace{\lambda^F_{sd}(t)P_d(t)Y_d(t)}_{\text{functions of } w_d(t)}$$

- (Dynamic Eqm) given wages, two differential equations for each country describe the dynamics:

$$\begin{aligned}\dot{C}_s(t) &= \left[\frac{r_s(t)}{P_s(t)} - \rho\right] C_s(t) \\ \dot{M}_s(t) &= \frac{r_s(t)}{P_s(t)} M_s(t) + \psi \frac{w_s(t)}{P_s(t)} L_s - \psi C_s(t)\end{aligned}$$

where $r_s(t)$ and $P_s(t)$ are functions of $w_s(t)$.

Definition of Equilibrium

assets ∝ varieties; consumption constant fraction of wealth

- Households save and fund new varieties through equity markets.
- *Poisson* process success rate with flow arrival rate equal to $\psi \dot{A}_s(t)dt$;
- In equilibrium: $\underbrace{\dot{M}_s(t)}_{\text{flow of varieties}} = \psi \cdot \underbrace{\dot{A}_s(t)}_{\text{investment}}$
- With log-preferences, consumption is a constant fraction of wealth:

$$C_s(t) = \rho \left[\underbrace{A_s(t)}_{\text{wealth at } t} + \underbrace{\int_t^\infty \frac{w_s(\tau)}{P_s(\tau)} L_s \cdot \exp\left\{-\bar{r}_s(\tau) \cdot \tau\right\} d\tau}_{\text{PV of future labor income}} \right]$$

BGP, special cases

Proposition (BGP under autarky)

If $\tau_{sd} \to \infty$ for all $s \neq d$, then there is unique country specific growth rate $g_s^{autarky}$ such that, in every country $s \in \mathbf{K}$, $g_{M_s} = g_{Y_s} = g_{C_s} = g_{w_s} = g_{A_s} = g_s^{autarky}$ with growth rate:

$$g_k^{autarky} = \left[(1-\alpha) \cdot \alpha \cdot \psi \cdot \left[\frac{w_k(t^*) L_k}{M_k(t^*)} \right] - \rho \right]$$

Proposition (BGP under zero gravity)

If $\tau_{sd} = 1$ for all (s, d), then there is a unique world equilibrium growth rate $g^{zero\ gravity}$ such that, in every country $s \in \mathbf{K}$, $g_{M_s} = g_{Y_s} = g_{C_s} = g_{w_s} = g_{A_s} = g^{zero\ gravity}$ with growth rate:

$$g_k^{zero\ gravity} = \left[(1-\alpha) \cdot \alpha \cdot \psi \cdot \left[\frac{\sum_{s \in \mathbf{K}} w_s(t^*) L_s}{\sum_{n \in \mathbf{K}} M_n(t^*)} \right] - \rho \right]$$

Intuition: **no trade costs** $\implies$ complete diffusion of non-rival inputs $\implies$ **growth happens as if world were a single country.**

BGP, general case

Proposition (Balanced growth with costly trade)

If $\tau_{sd} < \infty$ for all $s \neq d$, there exists a ***world equilibrium growth rate****:*

$$g^* \;=\; g_{M_s} = g_{Y_s} = g_{C_s} = g_{w_s} = g_{A_s} \qquad \forall s \in \boldsymbol{K}$$

and the world equilibrium growth rate g^* is pinned down by a vector of wages $\lambda_w \cdot [w_s(t^*)]_{s\in \boldsymbol{K}}$ and a vector of measures of varieties $\lambda_M \cdot [M_s(t^*)]_{s\in \boldsymbol{K}}$, up to the choice of scalars λ_w, λ_M, for a BGP inclusive of each period $t \geq t^*$.

Full Description of Proposition 3

BGP, general case

- Intuition: Trade works as a vehicle that links valuations of R&D stocks and returns;
- Countries with initially relatively many varieties $\implies$ lower relative price in final and intermediate goods ($\sim$ high productivity) $\implies \downarrow \pi$ and $\downarrow r \implies \downarrow g$ over transition path (and vice versa).
- Over BGP, real returns on assets and R&D equalize globally;
- This leads to a stable distribution of income $[w_s(t^*)]_{s\in\mathbf{K}}$ and varieties $[M_s(t^*)]_{s\in\mathbf{K}}$ along the BGP.

Welfare

$$\int_{t^*}^{\infty} \exp\{-\rho(t-t^*)\} \log\left(\exp\{g^* t\} C_s(t^*)\right) dt = \underbrace{\log\left(\frac{1}{\psi} M_s(t^*)\right)}_{\text{transitional}} + \underbrace{\frac{1}{\rho} \log\left(\frac{w_s(t^*) L_s}{P_s(t^*)}\right)}_{\text{static}} + \underbrace{\frac{g^*}{\rho^2}}_{\text{dynamic}}$$

- Important question: what happens after a change in trade costs $\tau + d\tau$?
- Changes in the **static component** are decreasing in the price of the foreign intermediate good
  - Intuition: captures domestic consumer/importer $\rightarrow$ specialization/Ricardo channel
- Changes in the **dynamic component** are increasing in the price of the foreign intermediate good
  - Intuition: captures domestic investor/exporter $\rightarrow$ market access/Romer channel

Welfare

Let $\hat{x} \equiv x(t^{**})/x(t^{*})$. Static component subsumes the ACR welfare formula and is decreasing in relative price of foreign intermediate goods:

$$\frac{1}{\rho}\log\left(\widehat{\frac{w_s}{P_s}}\right) = \frac{1}{\rho}\log\left(\widehat{\lambda_{ss}^F}^{-\frac{1}{(1-\alpha)\theta}}\right) + \frac{1}{\rho}\log\left(\sum_{k\in\mathbf{K}} \underbrace{\mu_k}_{\substack{\text{pre-period}\\ \text{weights}}} \cdot \underbrace{\widehat{M}_k}_{\substack{\text{product}\\ \text{measure in } k}} \cdot \left(\underbrace{\frac{\widehat{\tau}_{ks}\widehat{P}_k}{\widehat{\tau}_{ss}\widehat{P}_s}}_{\substack{\text{relative price of}\\ \text{intermediate}\\ \text{good } k \text{ at } s}}\right)^{-\frac{\alpha}{1-\alpha}}\right)$$

Note that this adds an extensive margin to the Ricardian framework!

Welfare

Dynamic component increasing in relative price of foreign intermediate goods:

$$g_s \propto \pi_s(t) = (1-\alpha)\cdot\alpha\cdot\sum_{n\in\mathbf{K}} \underbrace{w_n(t)L_n}_{\substack{\text{value added in } n\\ =\text{market size}}} \left[\sum_{k\in\mathbf{K}} \underbrace{M_k(t)}_{\substack{\text{product}\\ \text{measure in } k}} \left[\underbrace{\frac{\tau_{kn}P_k(t)}{\tau_{sn}P_s(t)}}_{\substack{\text{relative price of}\\ \text{intermediate}\\ \text{good } k \text{ at } n}}\right]^{-\frac{\alpha}{1-\alpha}}\right]^{-1}$$

During the transition path, as intermediates are substitutes, investors want foreign goods to be relatively more expensive! Equalizes along BGP.

Change in trade costs

Proposition (Change in trade costs over the Long Run in Symmetric Economies)

Suppose there exist a collection of symmetric economies that grow over the BGP with costly trade with trade costs $\tau > 1$*. Then* $\frac{\partial g^*}{\partial \tau} < 0$.

Proposition (Change in trade costs over the Short Run in Asymmetric Economies)

If $\tau_{sd} \in (1, \infty)$ *for all* $s \neq d$*, along the BGP, the first-order effect of market access liberalization is always positive, that is:*

$$\left. \frac{\partial g_s}{\partial \tau_{sd}} \right|_{\mathbf{P}=\mathbf{P}(t^*),\mathbf{w}=\mathbf{w}(t^*),\mathbf{M}=\mathbf{M}(t^*)} < 0$$

The total general equilibrium effect will depend on the cross-elasticities of price levels, wages, and measures with respect to trade costs.

Full Description of Proposition 5

Empirical evidence

Empirical evidence

- Exploit the Eastwards enlargement of the European Union since 2004
- Qualitative evidence: questionnaire of firms
- Stylized facts: comparison of countries that joined that EU vs. candidate countries on key variables of the model
- Causal evidence: event study estimating plausibly exogenous variation in market accession on product innovation

Life among product innovators

- Qualitative evidence on how managers think about the effects of market access on product innovation:
  - Sent qualitative questionnaire to 200+ firms; small number contacted me back

Questionnaire

- **CEO of a Czech Biotech firm**:
  "Once we joined the EU [...] this allowed us to increase our exports and fund our own genetic programmes."

Biotech Portfolio

- **Spokesperson of a Latvian liquor manufacturer**:
  "In 2004, we first started producing the ultra-luxury variation of our signature vodka, which became a popular export product [...] and later started production of 18 new products."

Stylized fact (i): Measure of Varieties

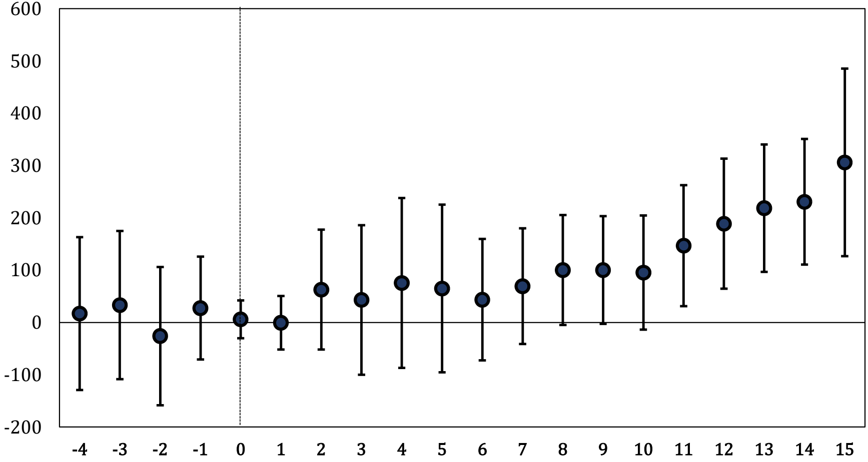


Figure: **Staggered difference-in-differences: Measure of Varieties.** This plot compares, for each horizon, the number of varieties at a country that became a member of the EU, relative to those countries that selected into becoming candidate countries but had not yet become members at that horizon. It shows time-specific average treatment on the treated described by a Callaway-Santana estimator. The bars around the blue dot denote 95% bootstrapped standard errors.

Stylized fact (ii): Private R&D expenditures per capita

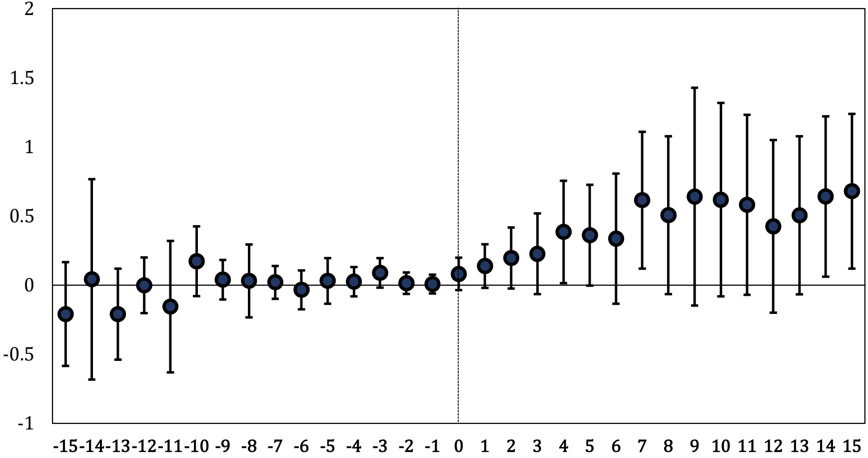


Figure: **Staggered difference-in-differences: Log of Private Research and Development Expenditures.** This plot compares, for each horizon, the log private R&D expenditures at a country that became a member of the EU, relative to those countries that selected into becoming candidate countries but had not yet become members at that horizon. It shows time-specific average treatment on the treated described by a Callaway-Santana estimator. The bars around the blue dot denote 95% bootstrapped standard errors.

Stylized fact (iii): Trade Values

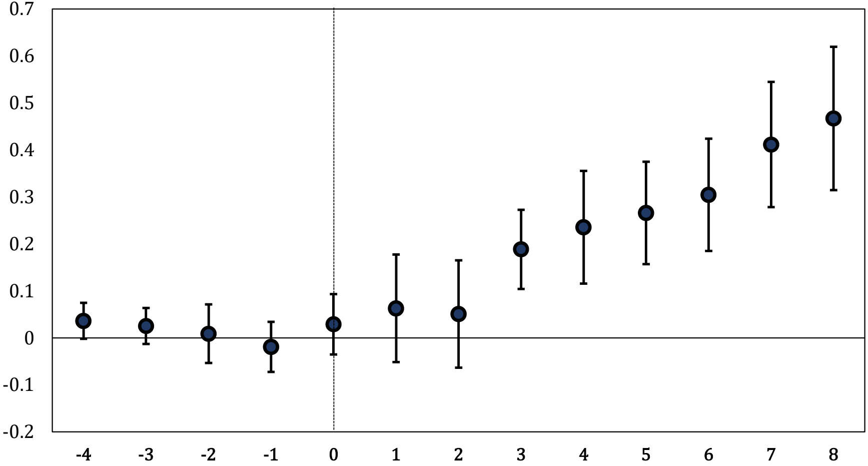
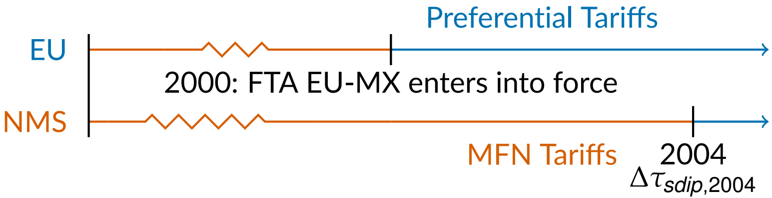


Figure: **Staggered difference-in-differences: Log of Real Value of Yearly Trade.** This plot compares, for each horizon, the log real value of yearly trade at a country that became a member of the EU, relative to those countries that selected into becoming candidate countries but had not yet become members at that horizon. It shows time-specific average treatment on the treated described by a Callaway-Santana estimator. The bars around the blue dot denote 95% bootstrapped standard errors.

Testing the mechanism

- Mechanism: Market Access $\rightarrow\uparrow$ Product innovation
- Strategy: exploit 2004 enlargement wave of the EU and access of New Member States (NMS) to previously negotiated EU trade-agreements.
- Example: EU-Mexico Trade Agreement (FTA EU-MX):



Constructing the trade shock

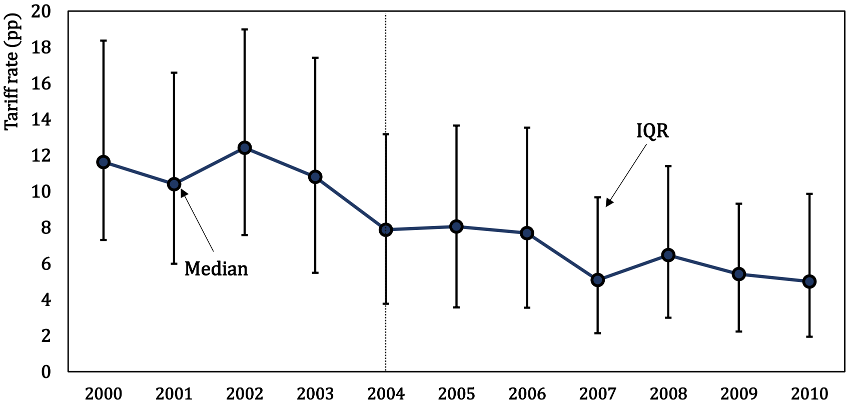
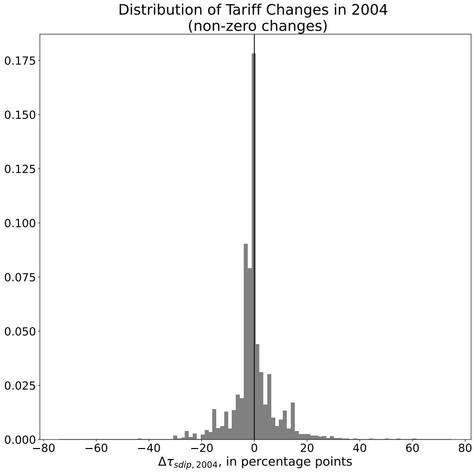


Figure: Interquartile Range Bilateral HS6-Product-Level Tariff Rates Between New Member States (2004 EU Enlargement) and Set of Countries that Concluded Trade Agreements with EU prior to 2004. Source: Constructed from WITS Preferential and MFN databases.

Constructing the trade shock



- Understanding the source of variation:

$$\underbrace{s}_{\text{9 NMS}} \times \underbrace{d}_{\text{13 partners}} \times \underbrace{p}_{\approx 2000 \text{ product codes}}$$

EU Enlargement Timeline | Pre-2004 Trade Agreements List | Product List Example

- $> 230k$ total, $30k$ nonzero obs
- Granularity of the data $\implies$ focus on within source-destination-industry-horizon (across product) variation

Entry regressions

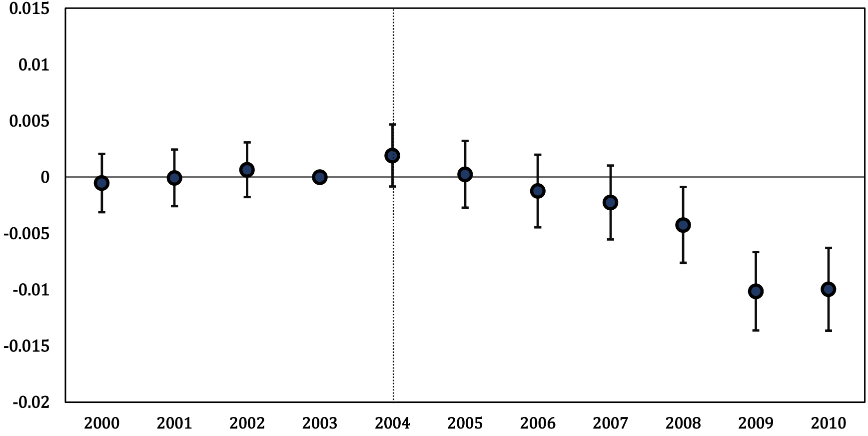
$$P(\underbrace{X_{sdip,h}}_{\substack{\text{Exports from}\\\text{UN Comtrade}}} > 0 \mid \underbrace{Y_{s\cdot ip,2003}}_{\substack{\text{Production from}\\\text{Eurostat Prodcom}}} = 0) = \alpha_h + \beta_h \cdot \Delta\tau_{sdip,2004} + \gamma_{sdi,h} + \nu_{sdip,h}$$

$$\text{for each } h \in \{2000, \cdots, 2010\}$$

- Event-study design using local projections in a linear probability model
- Large-N in each cross-section permits many fixed-effects: $\gamma_{sdi,h}$ are source $\times$ destination $\times$ industry $\times$ period interactions —builds on Baier and Bergstrand (2007).
- Chodorow-Reich (2019), Dube et al. (2023) show can be interpreted as a DiD.
- Intuition: identification is robust to Poland policymakers endogenously targeting EU accession to have preferential access to Mexico's car industry (relative to other industries and countries), but **not** if they want to have preferential access to compact cars relative to SUVs in Mexico.

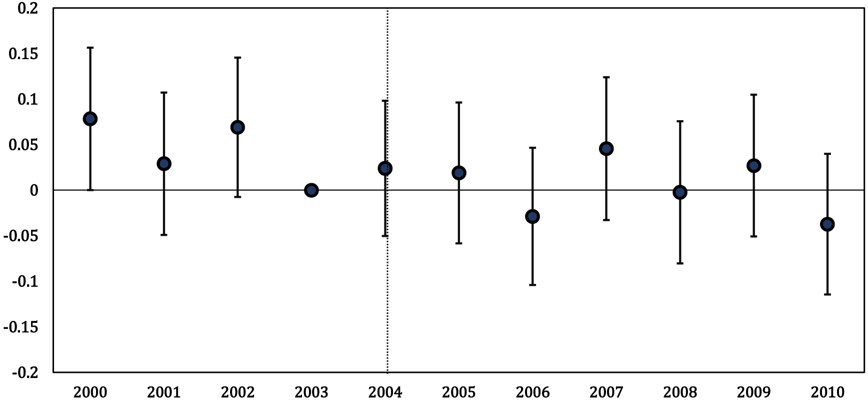
Entry regressions

$$P(\underbrace{X_{sdip,h}}_{\text{Exports}} > 0 | \underbrace{Y_{s \cdot ip,2003}}_{\text{Production}} = 0) = \alpha_h + \beta_h \cdot \Delta\tau_{sdip,2004} + \gamma_{sdi,h} + \nu_{sdip,h}$$



Continuation regressions

$$P(\underbrace{X_{sdip,h}}_{\text{Exports}} > 0 | \underbrace{Y_{s\cdot ip,2003}}_{\text{Production}} = 1) = \alpha_h + \beta_h \cdot \Delta\tau_{sdip,2004} + \gamma_{sdi,h} + \nu_{sdip,h}$$



Summary of empirical results

- Qualitatively, entrepreneurs say market access and exports is related to their decision to create new products
- Compared to candidate countries, NMS produce more varieties, spend more in private R&D, and trade more.
- An increase in market access by 1 percentage point increases the probability of starting to produce and export a given product by about 1 percent.
- $\approx$ one third conditional mean $\mathbb{E}\left[X_{sdip,h} > 0 | Y_{s \cdot ip,2003} = 0, h > 2003\right] = 2.9\%$
- Conditional on initial production, additional market access has no impact on exports.

Quantification and policy exercise

Goal of quantification

- Calibrate the model, along the BGP, to the pre-2004 Enlargement period for groups of countries:
  - the New Member States (NMS) of the 2004 enlargement wave;
  - Portugal, Italy, Spain, Greece, and Ireland;
  - France, Belgium, the Netherlands, and Luxembourg; and
  - Germany, Austria plus the Scandinavians (Denmark, Sweden, and Finland)

- Outcome will be a distribution of wages $[w_s(t^*)]_{s \in \mathbf{K}}$, measures of varieties $[M_s(t^*)]_{s \in \mathbf{K}}$ and a equilibrium growth rate g^*

- Add trade shocks that "reproduce the enlargement," and estimate the new BGP: $\{[w_s(t^{**})]_{s \in \mathbf{K}}, [M_s(t^{**})]_{s \in \mathbf{K}}, g^{**}\}$

- Decompose changes in welfare.

Quantification algorithm

- Along the BGP:

$$\frac{\dot{C}_s(t)}{C_s(t)} = g_s = g^* = \left[\frac{r_s(t)}{P_s(t)} - \rho\right] \qquad \forall s \in \mathbf{K}$$

- After some initial guess of $\mathbf{M}(t^*)$, solve for cross sectional eqm

- Calculate $\frac{r_s(t)}{P_s(t)}$. Countries with “too small” $M_s(t) \implies$ high returns for R&D (high $r\,/\,P$), and vice versa

- Then use law of motion that holds along the BGP:

$$\dot{M}_s(t) = \frac{r_s(t)}{P_s(t)} M_s(t)$$

to update $M_s(t^*)$ until real interest rates $\approx$ equalize.

Model Calibration

Parameter	Value	Calibration and Source
$\{L_s\}$	$[.25, .21, .21, .33]$	Labor Force Distribution, PWT 10.01
σ	0.76	Boehm, Levchenko, and Pandalai-Nayar (2020)
θ	2.12; 4.00	Boehm, Levchenko, and Pandalai-Nayar (2020), rest of lit
α	0.36	Share of intermediate sector, 2000-03, WIOD
ρ	0.01; 0.03	Matches $\beta = 0.99$ or $\beta = 0.97$
$\{\tau_{sd}\}$	$\left(\frac{E_{sd}^F(t^*)}{E_{dd}^F(t^*)}\frac{E_{ds}^F(t^*)}{E_{ss}^F(t^*)}\right)^{-\frac{1}{2\theta(1-\alpha)}}$	Data from WIOD, Head-Ries Index (Eaton, Kortum, et al. 2016)
$\{\psi, \{T_s\}\}$	-	Free parameters to match distributions of wages and growth rate

Model Calibration: Trade Shocks

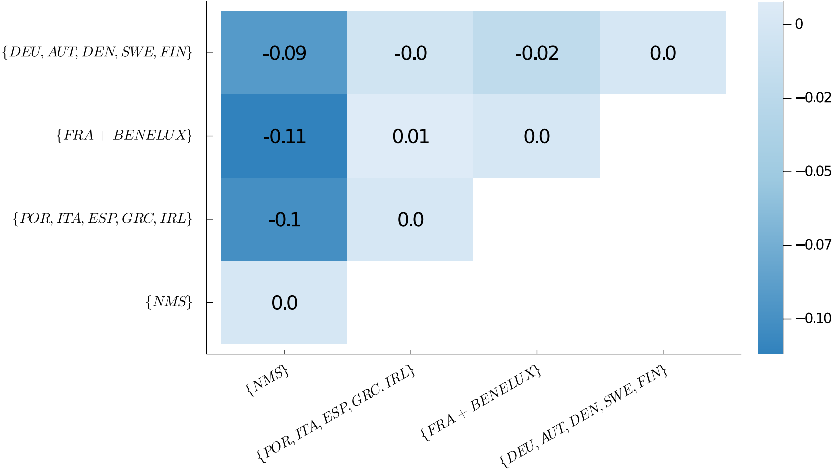


Figure: **Changes in Trade Costs Before and After 2004 EU Enlargement (in percentage terms).** This matrix shows the bilateral changes in trade costs, before and after the 2004 EU Enlargement. The before period is an average for the years 2000-2003 and the after period is an average for the years 2004-2007. Underlying data comes from the World Input-Output Database.

Model Validation (i): Measures of Varieties

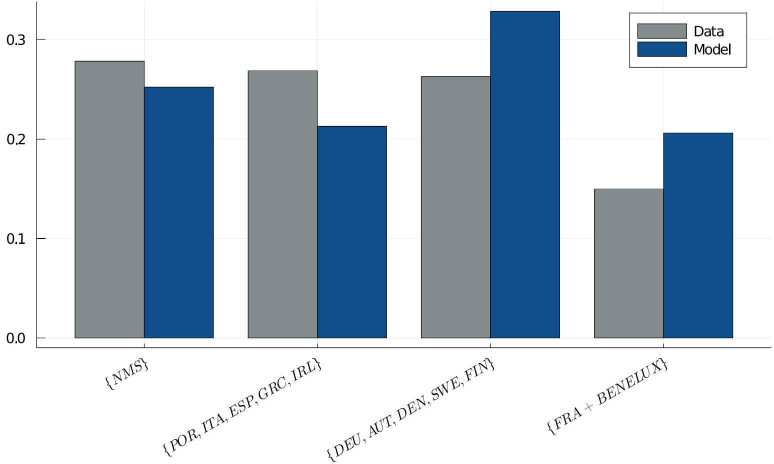


Figure: **Model Validation: Distribution in the Number of Produced Varieties Across Regions.** In the data bars are the relative shares of each country group in the total universe of the product measure, or: $M_s(t) / \sum_{s' \in \mathbf{K}} M_{s'}(t)$. This assumes, as in the model, that product varieties in the data are differentiated across countries, so the global product space is $\sum_{s' \in \mathbf{K}} M_{s'}(t)$. Data comes from Prodcom (Eurostat) and are averages for the 2000-2003 period.

Model Validation (ii): Growth in Relative Real Wages

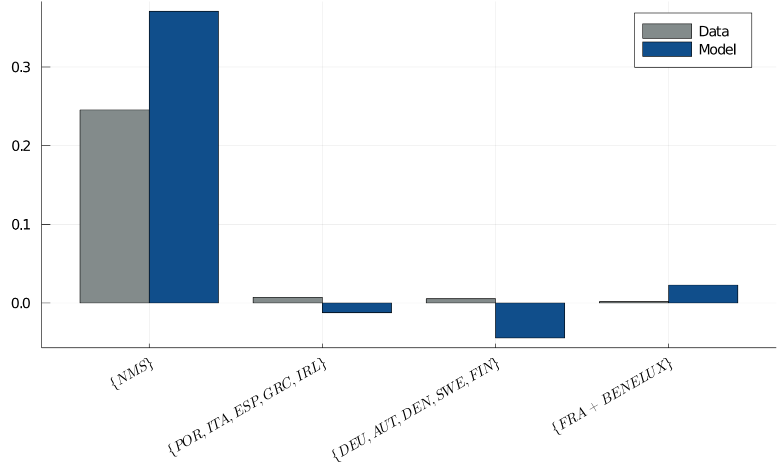


Figure: **Model Validation: Changes in Real Wages, Relative to the Average.** In the chart is the percentage change across equilibria $\frac{w_s(t^{**})-w_s(t^*)}{w_s(t^*)}$. In the data, I calculated GDP per capita then divided it by the average of the group, which gives me a wage that is normalized for the periods of 2000-2003 and 2005-2008. I then calculated changes and plotted the data. Data comes from the Penn World Tables 10.01.

Results

$$\int_{\tau}^{\infty} \exp\{-\rho(t-\tau)\} \log\left(\exp\{g^{**}t\} C_s(t^{**},\tau)\right) - \log\left(\exp\{g^{*}t\} C_s(t^{*},\tau)\right) dt =$$

$$\underbrace{\log\left(\hat{M}_s\right)}_{\text{transitional}} + \underbrace{\frac{1}{\rho}\log\left(\frac{\widehat{w_s}}{P_s}\right)}_{\text{static}} + \underbrace{\frac{g^{**}-g^{*}}{\rho^2}}_{\text{dynamic}}$$

- Transitional component: negligible (only as large as 0.03% of total welfare)
- Static component: can be positive (36% growth for NMS) or negative (-3% growth for $\{DEU, AUT, DEN, SWE, FIN\}$).
  - But small relative to the dynamic component. **At most 6% of total welfare.**
- Dynamic component: increases LR yearly growth rate by 0.16%.
  - Accounts for **more than 90% of total welfare** for all groups.
  - Back of the envelope calculation: between 2004-2023, extra growth would have induced \$517 billion in current production level —or 3% of EU's GDP.

Takeaways

- Reconcile the forces of specialization and market access through a new theoretical framework that integrates insights of trade and macroeconomics.
- Provide new analytical formula for welfare gains from trade that decomposes them into transitional, static, and dynamic components —and relates it to the forces of specialization and market access
- Document novel facts and causal evidence consistent with mechanism of the model exploiting enlargement of the European Union.
- Quantify effects of EU enlargement through numerical exercise and show that dynamic gains from trade are likely very large accounting for more than 90% of total gains from trade in this framework

Appendix

Production

- Final goods producers have CRS technology resembling the Romer model:

$$y_s(t,\omega) = z_s(t,\omega)[\ell_s(t,\omega)]^{1-\alpha}\left(\frac{1}{\alpha}\sum_{k\in\mathbf{K}}\int_0^{M_k(t)}[x_{ks}(t,\omega,\nu)]^{\alpha}d\nu\right)$$

- Intermediate goods producers use final good as inputs. Optimal prices are destination-specific:

$$p_{ks}(t,\omega,\nu) = \frac{P_k(t)\tau_{ks}}{\alpha}$$

where trade costs τ_{ks} include tariffs and non-tariff barriers.

◂ return

Trade in Final Goods

Very similar to standard Eaton-Kortum assumptions:

- Perfect competition: $p_{ss}(\omega) = \underbrace{\dfrac{w_s^{1-\alpha}}{\bar{M}_s^{1-\alpha} z_s(\omega)}}_{\text{Marginal Cost}}$

- Destination prices: $p_d(\omega) = \underbrace{\min_s \{\tau_{sd} \cdot p_{ss}(\omega)\}}_{\text{Lowest Cost Supplier}}$

- $z_s(\omega)$ with Fréchet distribution: $F_s(z) = \exp\left\{-T_s\, z^{-\theta}\right\}$

return

Research and Development

- HHs use equity markets to invest $I_s(t)$ units of the final good in R&D;
- *Poisson* process success rate with flow arrival rate equal to $\psi I_s(t)dt$;
- Non-arbitrage condition:

$$\underbrace{r_s(t)}_{\text{return on savings}} = \underbrace{\frac{\psi \pi_s(t, \nu)}{P_s(t)}}_{\text{flow dividend rate on R\&D}} + \underbrace{\frac{\dot{P}_s(t)}{P_s(t)}}_{\text{capital gains}}$$

return

Households

$$
\begin{aligned}
& \max_{[C_s(t), c_s(t,\omega)]_{\omega \in [0,1]}} && \int_0^\infty \exp\{-\rho t\} \frac{C_s(t)^{1-\phi}}{1-\phi} dt \\
s.t. \quad & P_s I_s + P_s(t) C_s(t) &=& \; r_s(t) A_s(t) + w_s(t) L_s \\
& C_s(t) &=& \left[\int_0^1 c_s(t,\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}} \\
& P_s(t) C_s(t) &=& \int_0^1 p_s(t,\omega) c_s(t,\omega) d\omega
\end{aligned}
$$

◂ return

Nesting of EK and Romer

effective measure of input varieties $\tilde{M}_s(t)$:

$$\tilde{M}_s(t) \equiv \frac{1}{\alpha} \cdot \sum_{k \in \mathbf{K}} \underbrace{M_k(t)}_{\substack{\text{measure of}\\ \text{varieties}\\ \text{in each } k}} \cdot \left(\underbrace{\frac{\tau_{ks} P_k(t)}{\alpha}}_{\substack{\text{optimal monopolist}\\ \text{price from } k \text{ to } s}} \right)^{-\frac{\alpha}{1-\alpha}}$$

- EK: if $\alpha = 0$ there are no intermediates $\implies \tilde{M}_s(t) = 0$
- Romer: $\lim_{\tau_{sd}(s \neq d) \to \infty} \tilde{M}_s(t) = \frac{1}{\alpha} \cdot M_s \cdot \left(\frac{P_s(t)}{\alpha} \right)^{-\frac{\alpha}{1-\alpha}}$, since in autarky LOOP holds, $P_s(t) = 1 \forall t$. Hence: $\lim_{\tau_{sd}(s \neq d) \to \infty} \tilde{M}_s(t) = \alpha^{-\frac{1}{1-\alpha}} \cdot M_s$, as in Romer.

◂ return

Definition of Dynamic Equibrium

Definition (Dynamic Equilibrium)

The dynamic equilibrium of the world economy is defined by a collection of paths of consumption quantities, assets stocks, and profit flows $[C_s(t), A_s(t), \Pi_s(t)]$; paths of final goods varieties output quantities $[c_s(t, \omega)]$; paths of intermediate goods varieties output quantities $[x_{ks}(t, \omega, \nu)]$; paths of prices $[w_s(t), r_s(t), P_s(t), p_{ss}(t, \omega), p_{sk}(t, \omega, \nu)]$; and a vector of fundamentals $(\theta, \sigma, \boldsymbol{T}, \boldsymbol{\tau})'$ where $\boldsymbol{T} \equiv \{T_s\}$ is a collection of location parameters of the Fréchet distribution and $\boldsymbol{\tau} \equiv [\tau_{sd}]$ is a matrix of trade costs, such that: (a) households maximize utility given the path for prices; (b) final goods firms maximize profits given the path for prices; (c) intermediate goods firms choose prices to maximize profits given demand functions and final goods prices; (d) trade balances; and (e) factors and goods markets clear.

◂ return

Proposition 3 ◂ return

Given a vector of fundamentals $(\theta, \sigma, \boldsymbol{T}, \boldsymbol{\tau})$, in the dynamic world economy presented above, if $\tau_{sd} < \infty$ for all $s \neq d$, there **exists a balanced growth path world equilibrium growth rate** satisfying:

$$\begin{aligned} g^* &= g_{M_s} = g_{Y_s} = g_{C_s} = g_{w_s} = g_{A_s} \qquad \forall s \in \mathbf{K} \\ &= \frac{(1-\alpha)\cdot\alpha\cdot\psi}{P_s(t^*)^2} \cdot \sum_{k\in\mathbf{K}} w_k(t^*) L_k \left[\sum_{n\in\mathbf{K}} M_n(t^*) \left(\frac{\tau_{nk} P_n(t^*)}{\tau_{sk} P_s(t^*)} \right)^{-\frac{\alpha}{1-\alpha}} \right]^{-1} - \rho \end{aligned}$$

and the world equilibrium growth rate g^* is pinned down by a vector of wages $\lambda_w \cdot [w_s(t^*)]_{s\in\mathbf{K}}$ and a vector of measures of varieties $\lambda_M \cdot [M_s(t^*)]_{s\in\mathbf{K}}$, up to the choice of scalars λ_w, λ_M, for a BGP inclusive of each period $t \geq t^*$.

Furthermore, if there exists a equilibrium **within a subset of the parameter space** that guarantee that $\frac{\partial P_s(t)}{\partial M_s(t)} < 0$ and the cross-sectional equilibrium is unique, **then the BGP growth rate is unique**.

Proposition 5 ◂ return

If $\tau_{sd} \in (1, \infty)$ for all $s \neq d$, along the BGP, the first-order effect of market access liberalization is always positive, that is:

$$\left.\frac{\partial g_s}{\partial \tau_{sd}}\right|_{\mathbf{P}=\mathbf{P}(t^*),\mathbf{w}=\mathbf{w}(t^*),\mathbf{M}=\mathbf{M}(t^*)} < 0$$

Furthermore, the total general equilibrium effect will depend on the cross-elasticities of price levels, wages, and measures with respect to trade costs and take the following form:

$$\begin{aligned}\frac{\partial g_s}{\partial \tau_{sd}} &= \underbrace{-\frac{\Xi}{\tau_{sd}} \cdot \sum_{n \in \mathbf{K}} \mu_n(t^*) \left[1 + \epsilon^P_{s,sd} - \epsilon^P_{n,sd}\right]}_{\text{net market access effect}} \\ &+ \frac{(g_s + \rho)}{\tau_{sd}} \left(\underbrace{\sum_{k \in \mathbf{K}} \left[\epsilon^w_{k,sd} - \mu_k(t^*) \epsilon^M_{k,sd}\right]}_{\text{global market expansion effect}} - \underbrace{\frac{1}{2} \epsilon^P_{s,sd}}_{\text{input cost effect}} \right)\end{aligned}$$

Qualitative Questionnaire

- After your country joined the European Union, did your company:
  - start producing more products/services or varieties;
  - start producing fewer products/services or varieties; or
  - keep producing about the same number of products/services or varieties?

- If your company changed the number of products/services or varieties after EU accession, how was the change implemented and what were the results? Please include any important information or relevant anecdotes.

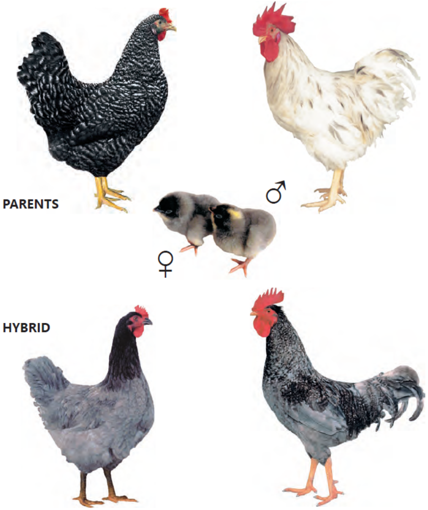
- If your company changed the number of products/services or product/service varieties after EU accession, was the decision primarily motivated by access to new technologies/imports, access to new markets/exports, or both? Explain.

- After your country joined the European Union, did your company:
  - stay in the same industry;
  - expanded to another industry; or
  - move completely to a new industry?

- If your company expanded to another industry or moved to a new industry. Please explain whether the change was related to your country's EU accession.

◂ back

Czech Biotech Firm Products



◂ back

Enlargement of the EU

1957
- Belgium
- France
- Germany
- Italy
- Luxembourg
- Netherlands

1973
- Denmark
- Ireland
- UK

1981
- Greece

1986
- Portugal
- Spain

1995
- Austria
- Finland
- Sweden

2004
- Cyprus
- Czechia
- Estonia
- Hungary
- Latvia
- Lithuania
- Malta
- Poland
- Slovakia
- Slovenia

2007
- Bulgaria
- Romania

2013
- Croatia

Future?
- Albania
- Moldova
- Montenegro
- N. Macedonia
- Serbia
- Turkey
- Ukraine

EU Pre-2004 Trade Agreements

Partner	Signed	Provisional application	Full entry into force
Switzerland	1972		1973
Iceland	1992		1994
Norway	1992		1994
Turkey	1995		1995
Tunisia	1995		1998
Israel	1995	1996	2000
Mexico	1997		2000
Morocco	1996		2000
Jordan	1997		2002
Egypt	2001		2004
North Macedonia	2001	2001	2004
South Africa	1999	2000	2004
Chile	2002	2003	2005

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Prodcom list example

Prodcom Code	Description
…	…
10511133	Milk and cream of a fat content by weight of <= 1%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content <= 2 l
10511137	Milk and cream of a fat content by weight of <= 1%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content > 2 l
10511142	Milk and cream of a fat content by weight of > 1% but <= 6%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content <= 2 l
10511148	Milk and cream of a fat content by weight of > 1% but <= 6%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of a net content > 2 l
10511210	Milk and cream of a fat content by weight of > 6% but <= 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of <= 2 l
10511220	Milk and cream of a fat content by weight of > 6% but <= 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of > 2 l
10511230	Milk and cream of a fat content by weight of > 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of <= 2 l
10511240	Milk and cream of a fat content by weight of > 21%, not concentrated nor containing added sugar or other sweetening matter, in immediate packings of > 2 l
10512130	Skimmed milk powder (milk and cream in solid forms, of a fat content by weight of <= 1,5%), in immediate packings of <= 2,5 kg
10512160	Skimmed milk powder (milk and cream in solid forms, of a fat content by weight of <= 1,5%), in immediate packings of > 2,5 kg
…	…

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