Quantifying the Extensive Margin of Trade

("Pound for Pound" Export Diversification)

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ITI Meeting – NBER

December 5, 2020

Export Diversification is Important ...

For Poor Countries: *"There is both a growth payoff and a stability payoff to diversification [in low-income countries], underscoring the case for paying close attention to policies that facilitate diversification and structural transformation."*

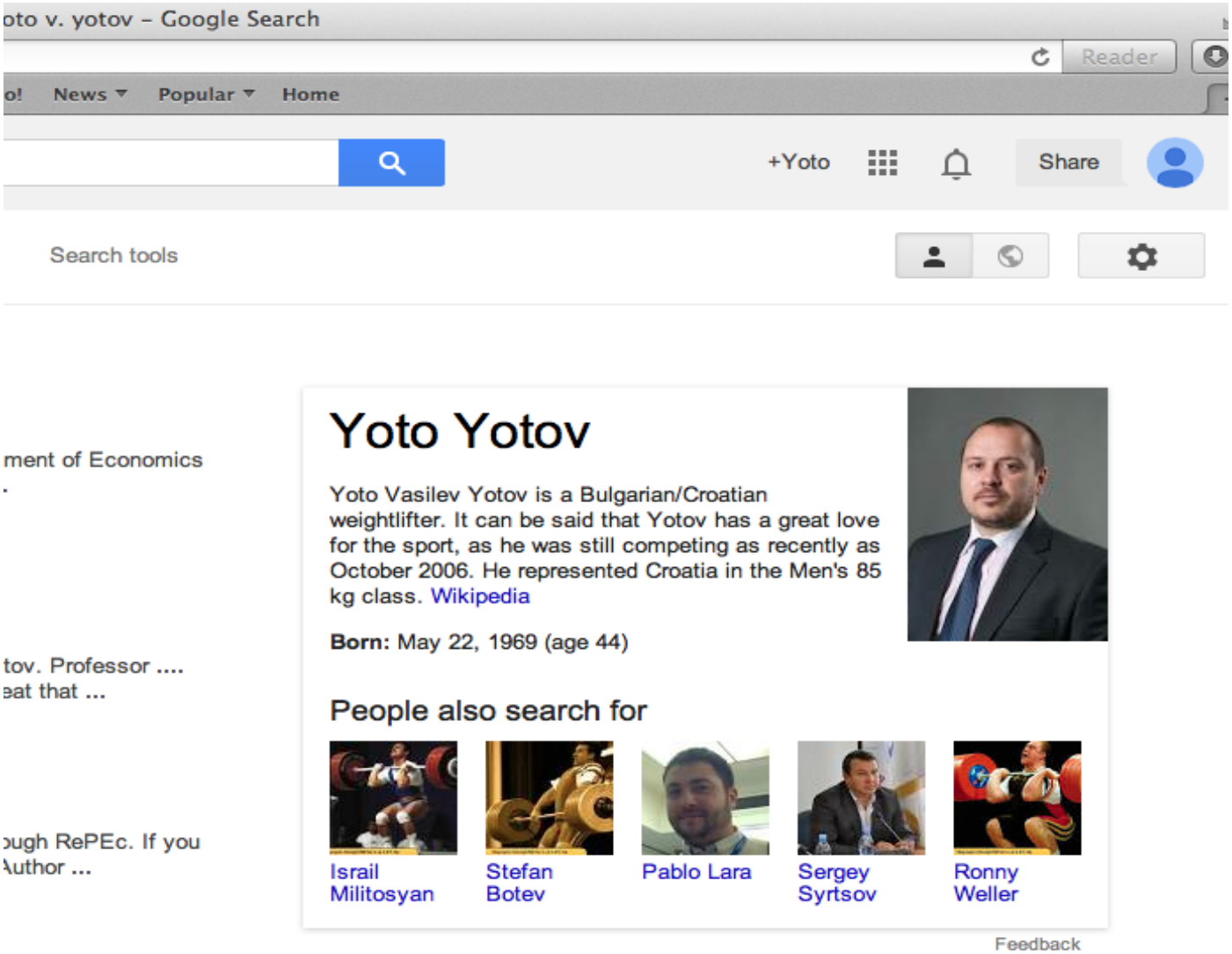
(IMF, March, 2014)

For Rich Countries: *"Trade diversification is a national imperative for the Government of Canada. Over the next six years, starting in 2018-19, Canada's export diversification strategy will invest $1.1 billion to help Canadian businesses access new markets."*

(Government of Canada, March 3, 2020)

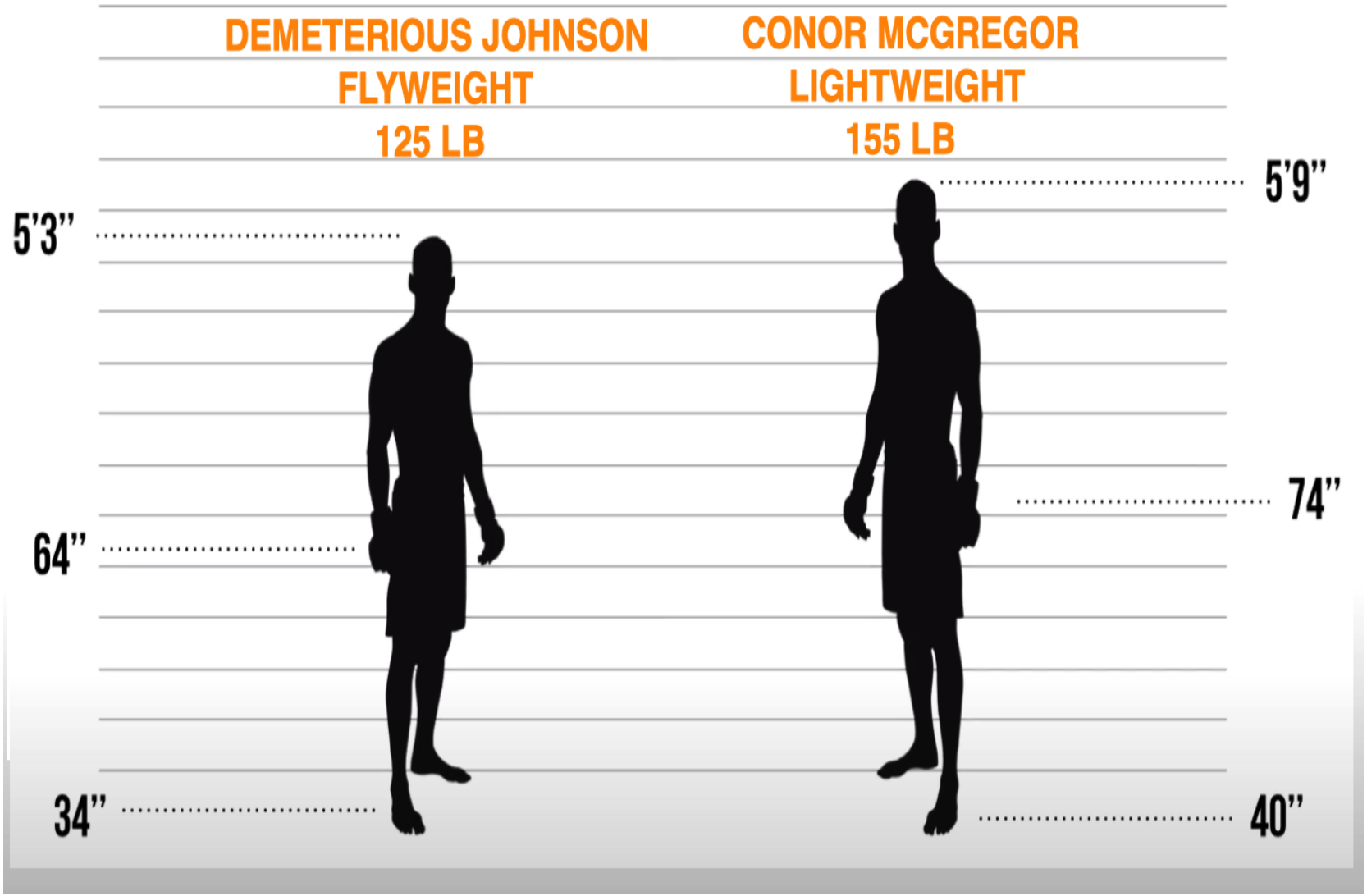
From An Academic Perspective: *Melitz (2003), Hummels and Klenow (2005), Helpman et al. (2008), Chaney (2008), Redding (2011), Cadot et al. (2011), Santos Silva et al. (2014). Many policy/application papers.*

Disclaimer: Not an Olympic Weightlifter

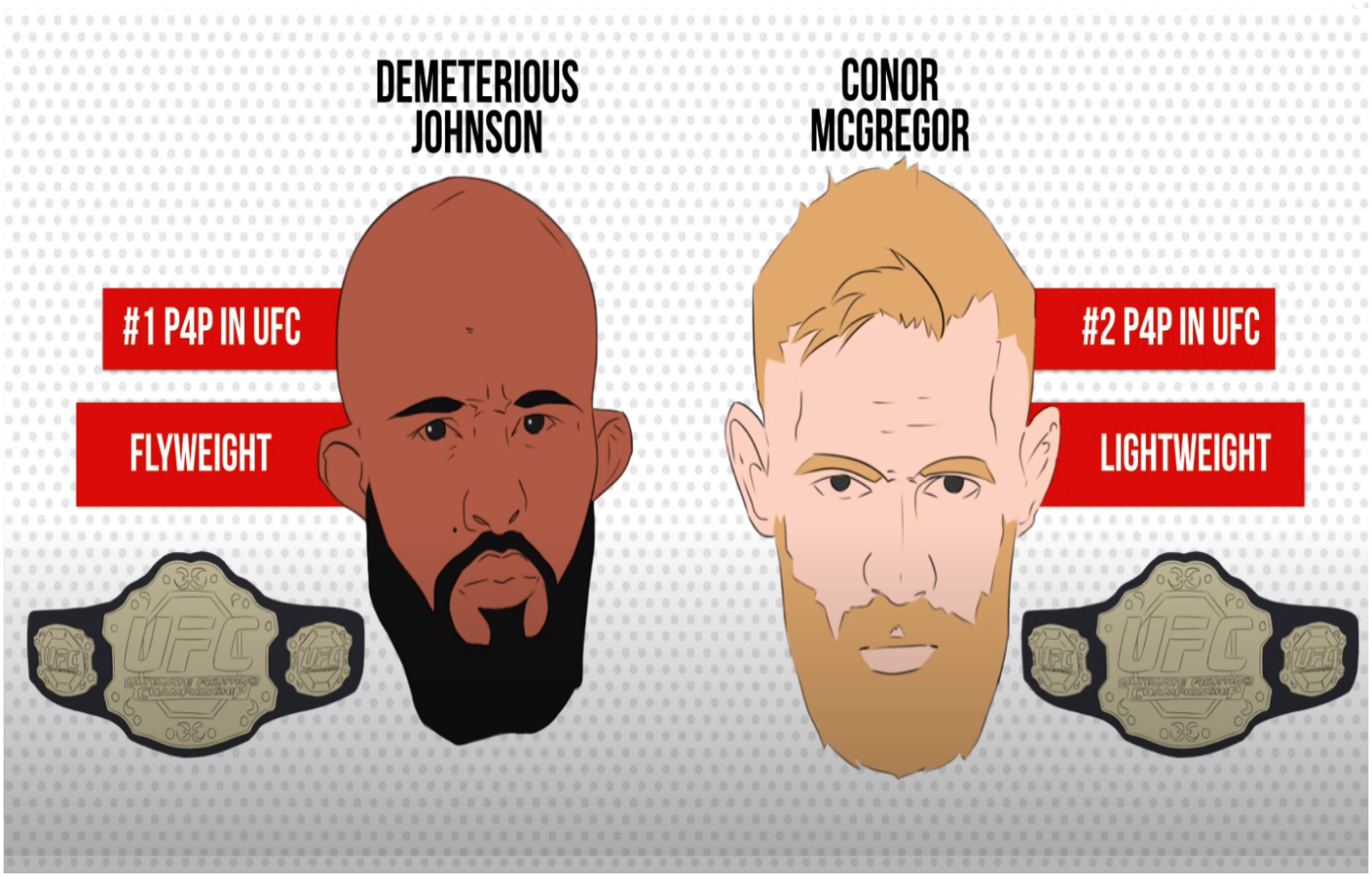


Who is Stronger? vs. Who is Better?

Combat Sports: "Pound for Pound"



Pound for Pound (P4P)



Combat Sports

Who is ‘Stronger’? vs. Who is ‘Better’?

“Pound for Pound” Export Diversification

Combat Sports

Who is ‘Stronger’? vs. Who is ‘Better’?

The Intensive Margin of Trade

Who exports more? vs. Who is ‘More Open’?

“Pound for Pound” Export Diversification

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Who is ‘Stronger’? vs. Who is ‘Better’?

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Who exports more? vs. Who is ‘More Open’?

The Extensive Margin of Trade

Who exports to more destinations and more products? vs. ?

“Pound for Pound” Export Diversification

Combat Sports

Who is ‘Stronger’? vs. Who is ‘Better’?

The Intensive Margin of Trade

Who exports more? vs. Who is ‘More Open’?

The Extensive Margin of Trade

Who exports to more destinations and more products? vs. **“Pound for Pound” Export Diversification, Domestic Extensive Margin**

Contributions

- **Theory:** Propose a short-run gravity model of the extensive margin of trade, which distinguishes between the domestic and cross-border margins of trade.
- **Estimation:** Accounting for the domestic extensive margin allows for identification of policy effects that were not possible to obtain before, and to revisit prior applications.
- **Data:** Build a new database covering the international and the domestic margins of trade for Europe. Propose methods to extend the database to cover more countries.
- **Indexes:** Domestic extensive margin (DEM), and propose "P4P" export diversification indexes that complement existing indexes by highlighting the performance of the 'lighter weight' countries.

Related Literature

- **Structural Gravity:** Anderson (1979), Eaton and Kortum (2002), Anderson and van Wincoop (2003), and Arkolakis et al. (2012).
- **Investment in Bilateral Links:** Arkolakis (2010), Sampson (2016), Crucini and Davis (2016), and Anderson & Yotov (2020).
- **Heterogeneous Firms:** Melitz (2003), Helpman et al. (2008), Chaney (2008), Redding (2011).
- **Extensive Margin of Trade:** Hummels and Klenow (2005), Hillberry and Hummels (2008), Santos Silva et al. (2014).
- **Domestic Trade Flows (Intensive Margin):** Yotov (2012), Ramondo et al. (2016), Heid et al. (2020), Beverelli et al. (2020).

To come ...

- **Theoretical Foundations**
- **From Theory to Empirics**
- **Data: Methods and Sources**
- **Application: European Integration**

Theoretical Foundations: Short-Run Gravity & The Extensive Margin

Building Blocks & Contributions

- **Structural Gravity**
- **Heterogeneous Firms**
- **Bilateral Dynamics**

Building Blocks & Contributions

- **Structural Gravity**
- **Heterogeneous Firms**
- **Bilateral Dynamics**

- **Short-run Extensive Margin**
- **Domestic Extensive Margin**

Assumptions

- **Supply (production-*cum*-distribution)**
  - Heterogeneous firms, multiplicative Pareto productivity draws.
  - Sectoral Cobb-Douglas production with capital and labor.
  - Capital becomes specific once allocated to a destination.
  - Fixed cost, in terms of labor, for each market served.
  - Trade is subject to iceberg frictions in distribution.
  - Efficiency: Labor across sectors; Goods, across destinations.
- **Demand**
  - Armington-CES demand system in a multi-country world.

$$X_{ij,t}^k = \frac{Y_{i,t}^k E_{j,t}^k}{Y_t^k} \left(\frac{t_{ij,t}^k}{\Pi_{i,t}^k P_{j,t}^k} \right)^{(1-\sigma^k)\rho^k} \times f_{ij,t}^{k\ \frac{(\rho^k-1)(\theta^k-\eta^k)}{\eta^k}} M_{ij,t}^{k\ 1-\rho^k} \times \lambda_{ij,t}^{k\ \frac{(1-\rho^k)\theta^k}{\eta^k}}$$

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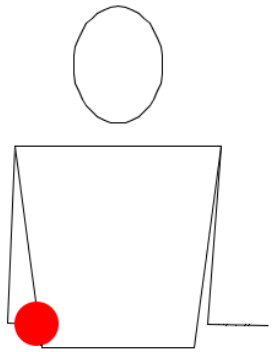
Eaton-Kortum (2002),
Anderson-van Wincoop (2003),
Arkolakis et al. (2012).



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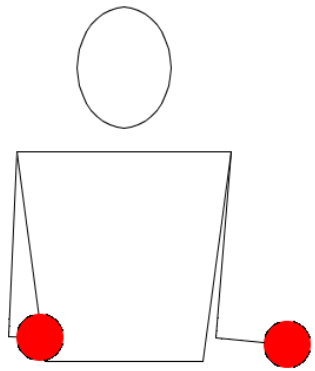

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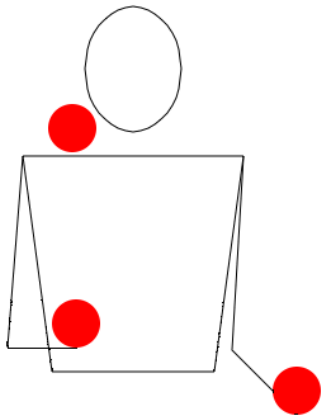

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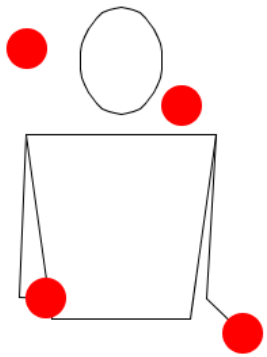
$\rho \equiv (\theta - \eta)/(\theta - \eta + \sigma - 1)$, $\rho \in [0, 1]$

AY (2020): $\rho = 0.27$, $\rho \in [0.19, 0.41]$

S-R Elast. $\simeq 1.5$, L-R Elast. $\simeq 6$

$$X_{in,t}^k = \frac{Y_{i,t}^k E_{n,t}^k}{Y_t^k} \left(\frac{t_{in,t}^k}{\Pi_{i,t}^k P_{n,t}^k} \right)^{(1-\sigma^k)\rho^k} \times \left(\frac{\zeta_{in,t}^k}{\phi_{in,t}^k} \right)^{1-\rho^k}$$

$n \equiv$ **new extensive margin link**



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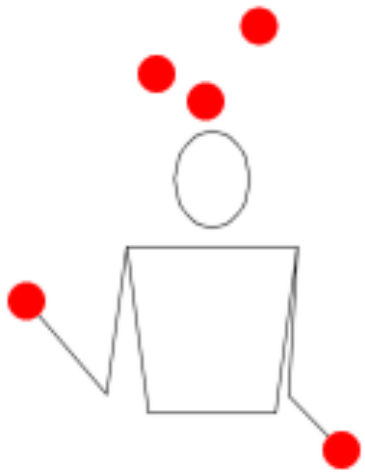
- Challenge: No data on $\zeta_{in,t}^k / \phi_{in,t}^k$.
- Think of $\zeta_{in,t}^k / \phi_{in,t}^k$ (de-)globalization effects.
- Cannot use trends or any time-varying fixed effects either.
- Solution: "The Domestic Extensive Margin".

$$X_{in,t}^k = \frac{Y_{i,t}^k E_{n,t}^k}{Y_t^k} \left(\frac{t_{in,t}^k}{\Pi_{i,t}^k P_{n,t}^k} \right)^{(1-\sigma^k)\rho^k} \times \left(\frac{\zeta_{in,t}^k}{\phi_{in,t}^k} \right)^{1-\rho^k} \qquad \forall \mathbf{i}, \mathbf{n}$$

"The Domestic Extensive Margin": where production and distribution of a product begins (or ends).



From Theory to Empirics: Estimating the Extensive Margin of Trade

From Theory to Empirics

1. **Specify Econometric Model**
2. **Select an Estimator**
3. **Model Covariates**

Specify Econometric Model

Let $N^k_{ij,t} = 1$ when at least one firm ($\pi^k_{ij,t}(\varrho) \geq 0$) exports k from i to j at t:

$$\Pr(N^k_{ij,t} = 1 | x_{ij,t}) = \Pr(\pi^k_{ij,t}(\varrho) \geq 0) = F^k(x'_{ij,t}\beta).$$

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Let $N_{ij,t} = \sum_k N^k_{ij,t}$ be the total number of sectors exported from i to j at t:

$$E(N_{ij,t}|x_{ij,t}) = \sum_k \Pr(N^k_{ij,t} = 1|x_{ij,t}) = \sum_k F^k(x'_{ij,t}\beta) = N_{i,t}F(x'_{ij,t}\beta),$$

where $N_{i,t}$ is the total number of sectors available in origin i, and $F(x'_{ij,t}\beta) = \left(F^k(x'_{ij,t}\beta)\right)/N_{i,t}$ is the probability that a randomly selected sector k will be exported from country i to country j at time t.

Select an Estimator

Note that

$$E(N_{ij,t}|x_{ij,t}) = N_{i,t}F(x'_{ij,t}\beta).$$

has non-stochastic bounds $\rightarrow$ need corresponding $F(x'_{ij,t}\beta)$.

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Follow Santos Silva (2001) and Santos Silva et al. (2014), and let

$$F(x'_{ij,t}\beta) = 1 - \left(1 + \omega \exp\left(x'_{ij,t}\beta\right)\right)^{\frac{-1}{\omega}},$$

where:

- $F(x'_{ij,t}\beta)$ is double-bounded, just like extensive margin.
- $\omega > 0$ is flexible and estimated (rather than imposed).
- Flexible shape parameter potentially important, as lower tail of extensive margin of trade distribution is heavier.

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So that

$$\frac{N_{ij,t}}{N_{i,t}} = 1 - \left(1 + \omega \exp\left(x'_{ij,t}\beta\right)\right)^{\frac{-1}{\omega}} + \epsilon_{ij,t}.$$

- Estimate by Bernoulli pseudo-maximum likelihood, which is easy to implement and it is consistent under very general conditions.

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Model Covariates, $\exp(x'_{ij,t}\beta)$

Traditional approach:

$$\exp\left(x'_{ij,t}\beta\right) = \exp\left(\pi_{i,t} + \chi_{j,t} + \gamma_{ij} + BIPOL_{ij,t}\beta\right),$$

- $\pi_{i,t}$ and $\chi_{j,t}$ are exporter-time and importer-time fixed effects, which control for the unobservable MRs and any other country effects.
- γ_{ij} are country-pair fixed effects, which control for all time-invariant bilateral trade costs and mitigate trade policy endogeneity concerns.
- $BIPOL_{ij,t}$ denotes a vector of bilateral trade policies, e.g. RTAs.

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$$\exp\left(x'_{ij,t}\beta\right) = \exp\left(\pi_{i,t} + \chi_{j,t} + \gamma_{ij} + BIPOL_{ij,t}\beta\right), \quad \forall \mathbf{i} \neq \mathbf{j}$$

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- γ_{ij} are country-pair fixed effects, which control for all time-invariant bilateral trade costs and mitigate trade policy endogeneity concerns.
- $BIPOL_{ij,t}$ denotes a vector of bilateral trade policies, e.g. RTAs.
- **100% of empirical extensive margin papers that we reviewed use only data/observations on international extensive margin.**

Model Covariates, $\exp(x'_{ij,t}\beta)$

New implications of DEM:

$$\begin{aligned}\exp\left(x'_{ij,t}\beta\right) &= \exp\left(\pi_{i,t} + \chi_{j,t} + \gamma_{ij} + BIPOL_{ij,t}\beta_1 + BRDR_{ij,t}\beta_{i,t} + EXS_{i,t}\times BRDR_{ij}\beta_2\right)\times \\ &= \exp\left(IMP_{j,t}\times BRDR_{ij}\beta_3 + CNTRY_{j,t}\times BRDR_{ij}\beta_4 + EXR_{ij,t}\times BRDR_{ij}\beta_5\right), \quad \forall \mathbf{i}, \mathbf{j}\end{aligned}$$

- **$BRDR_{ij,t}$** are border indicators, which are equal to one for international sales, and equal to zero otherwise, i.e., globalization effects.
- **$EXS_{i,t}$** is a vector of non-discriminatory export support policies, e.g., export subsidies, trade fairs, etc.
- **$IMP_{j,t}$** is a vector of non-discriminatory import protection policies.
- **$CNTRY_{j,t}$** denotes a vector of country-specific characteristics, e.g., Institutional quality, SPS, TBT.
- **$EXR_{ij,t}$** is the exchange rate between *i* and *j* at *t*.

Model Covariates, $\exp(x'_{ij,t}\beta)$

New implications of DEM:

$$\begin{aligned}\exp\left(x'_{ij,t}\beta\right) &= \exp\left(\pi_{i,t} + \chi_{j,t} + \gamma_{ij} + BIPOL_{ij,t}\beta_1 + BRDR_{ij,t}\beta_{i,t} + EXS_{i,t}\times BRDR_{ij}\beta_2\right) \times \\ &= \exp\left(IMP_{j,t}\times BRDR_{ij}\beta_3 + CNTRY_{j,t}\times BRDR_{ij}\beta_4 + EXR_{ij,t}\times BRDR_{ij}\beta_5\right), \quad \forall \mathbf{i}, \mathbf{j}\end{aligned}$$

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Data

Sources and Methods

- **Objective:** Construct a dataset that includes consistently constructed cross-border and *domestic* extensive margins.
- **Sources:** Use Eurostat's PRODCOM data for the domestic extensive margin and COMEXT for the external extensive margin.
- **Methods:** Translate the intensive margin data from PRODCOM and COMEXT into extensive margin. Match PRODCOM and COMEXT.

Main Estimating Sample

- Consistent domestic and international extensive margins.
- 32 European countries, 3400 manufacturing products, 2008-2018.
- Only one country (Montenegro) joins WTO in our sample.
- Only one country (Croatia) joins EU in our sample (2013).
- Few EIAs (Bosnia and Herzegovina, Croatia, Montenegro, Serbia).

Alternative Estimating Samples

- **Exporter-based Sample;**
- **Importer-based Sample;**
- **Extended-country Sample;**
- **Conservative-product Sample;**
- **Export-based DEM Sample.**

The Domestic Extensive Margin (DEM)

Define "Domestic Extensive Margin" as $DEM_{i,t} = D_{i,t}/N_{i,t}$

Country Name	2008	2010	2012	2014	2016	2018	%Δ 08-18
Germany	0.90	0.89	0.90	0.90	0.90	0.90	0.69
Italy	0.85	0.86	0.86	0.85	0.85	0.83	-2.13
Spain	0.84	0.84	0.84	0.84	0.84	0.84	-0.21
United Kingdom	0.82	0.81	0.81	0.81	0.81	0.80	-2.08
Hungary	0.52	0.52	0.55	0.56	0.57	0.57	10.94
Portugal	0.59	0.58	0.58	0.54	0.53	0.54	-9.57
Denmark	0.51	0.51	0.51	0.52	0.52	0.53	4.25
Finland	0.53	0.52	0.51	0.51	0.50	0.51	-2.91
Lithuania	0.37	0.36	0.38	0.37	0.38	0.40	8.00
Slovenia	0.36	0.36	0.36	0.36	0.36	0.38	6.52
Greece	0.33	0.33	0.32	0.34	0.34	0.35	6.17
Estonia	0.32	0.33	0.34	0.34	0.33	0.34	5.47
Slovakia	0.31	0.31	0.31	0.31	0.31	0.32	3.23
Norway	0.22	0.22	0.21	0.22	0.22	0.22	-0.47
Latvia	0.20	0.20	0.20	0.20	0.21	0.21	2.12
$N_{i,t}$	3,890	3,860	3,818	3,814	3,811	3,756	-3.44

Globalization/European Integration and the Extensive Margin of Trade

Estimating Globalization Effects

$$\frac{N_{ij,t}}{N_{i,t}} = 1 - \left(1 + \omega \exp\left(\pi_{i,t} + \chi_{j,t} + \gamma_{ij} + \mathbf{BIPOL_{ij,t}}\beta + \sum_{i,t} \beta_{i,t} BRDR_{ij,t}\right)\right)^{\frac{-1}{\omega}} + \epsilon_{ij,t}$$

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- $BRDR_{ij,t}$ a set of border/globalization indicators:
  - $BRDR_{ij,t}$ corresponds to $\zeta^k_{in,t}/\phi^k_{in,t}$;
  - Flexible and comprehensive account for policy & globalization;
  - $\beta_{i,t}$ captures country-specific globalization effects;
  - β_t captures common globalization effects;
  - **NOTE: Neither β_t nor $\beta_{t,i}$ can be identified without DEM.**

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  - β_t captures common globalization effects;
  - **NOTE: Neither β_t nor $\beta_{t,i}$ can be identified without DEM.**
- $BIPOL_{ij,t}$ includes WTO and EIA membership:
  - Only one country (Montenegro) joined WTO in our sample;
  - EIAs for Bosnia-Herzegovina, Croatia, Montenegro, & Serbia.

Benchmark: Common Globalization Effects

	FLEX
GLOB_2010	0.072
	(0.025) **
GLOB_2012	0.154
	(0.034) **
GLOB_2014	0.229
	(0.043) **
GLOB_2016	0.325
	(0.052) **
GLOB_2018	0.456
	(0.065) **
WTO	0.390
	(0.054) **
EIA	-0.067
	(0.047)
N	9656

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- Can identify globalization effects, even with exporter-time and importer-time fixed effects.

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	(0.025) **
GLOB_2012	0.154
	(0.034) **
GLOB_2014	0.229
	(0.043) **
GLOB_2016	0.325
	(0.052) **
GLOB_2018	0.456
	(0.065) **
WTO	0.390
	(0.054) **
EIA	-0.067
	(0.047)
N	9656

- Can identify globalization effects, even with exporter-time and importer-time fixed effects.
- Can identify country-specific policy effects, even with exporter-time and importer-time fixed effects.

Benchmark: Common Globalization Effects

	FLEX
GLOB_2010	0.072
	(0.025) **
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	(0.034) **
GLOB_2014	0.229
	(0.043) **
GLOB_2016	0.325
	(0.052) **
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	(0.065) **
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- No "Missing Globalization Puzzle" on the extensive margin of trade.

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- Globalization led to 271 more internationally traded products.

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- Can identify globalization effects, even with exporter-time and importer-time fixed effects.
- Can identify country-specific policy effects, even with exporter-time and importer-time fixed effects.
- No "Missing Globalization Puzzle" on the extensive margin of trade.
- Globalization led to 271 more internationally traded products.
- WTO membership led to extensive margin gains for Montenegro.

Robustness: Alternative Estimators

	FLEX	DB TOBIT	PPML	OLS
GLOB_2010	0.072	42.212	0.034	0.040
	(0.025) **	(14.843) **	(0.011) **	(0.018) *
GLOB_2012	0.154	102.959	0.067	0.076
	(0.034) **	(19.107) **	(0.016) **	(0.031) *
GLOB_2014	0.229	145.953	0.102	0.150
	(0.043) **	(24.266) **	(0.021) **	(0.036) **
GLOB_2016	0.325	198.697	0.147	0.255
	(0.052) **	(28.392) **	(0.029) **	(0.047) **
GLOB_2018	0.456	268.345	0.200	0.339
	(0.065) **	(37.192) **	(0.038) **	(0.057) **
WTO	0.390	-16.522	0.396	0.389
	(0.054) **	(15.460)	(0.051) **	(0.070) **
EIA	-0.067	-24.227	-0.063	-0.028
	(0.047)	(24.562)	(0.032) *	(0.093)
N	9656	9656	9656	9656

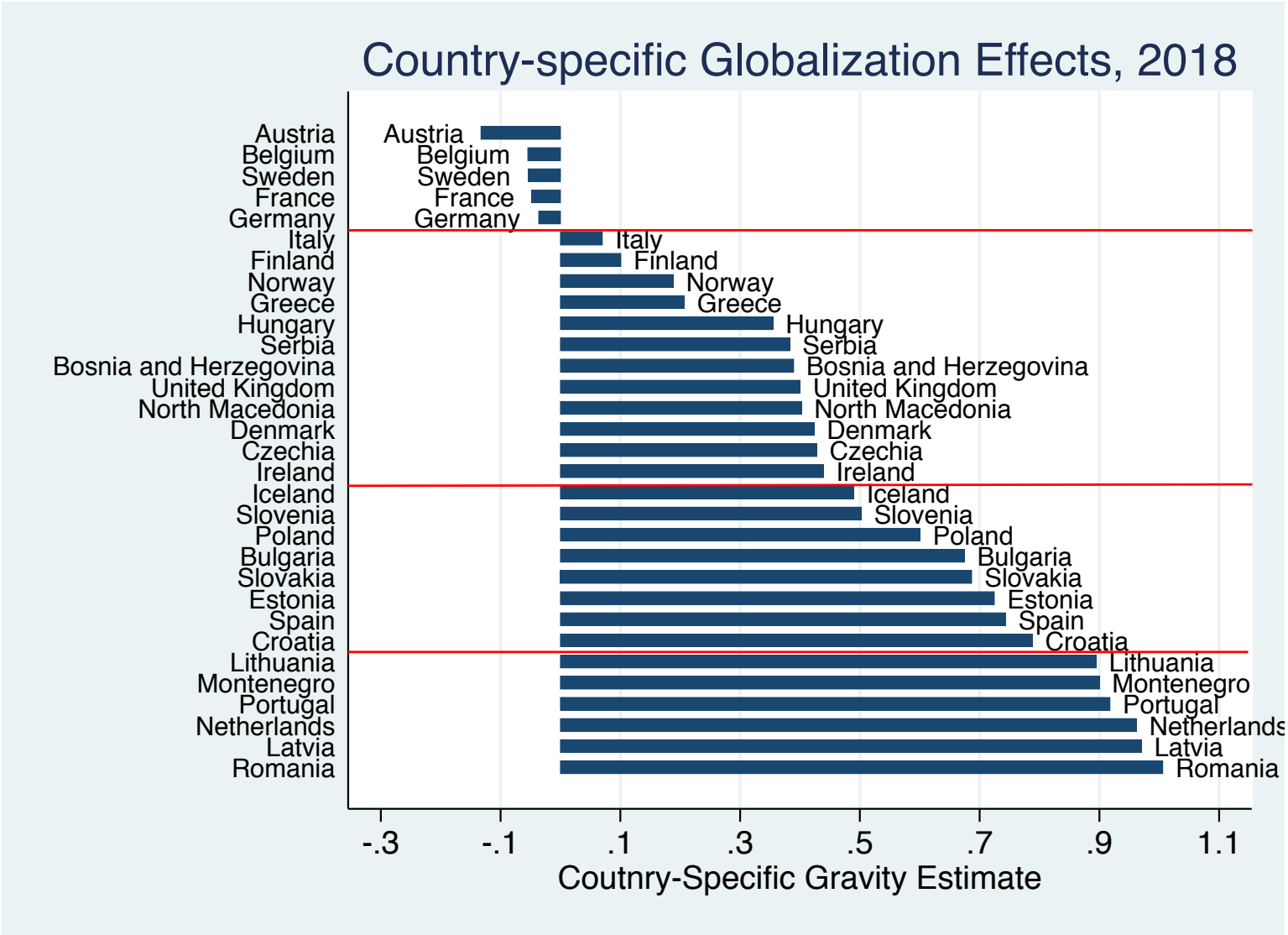
Robustness: No DEM

	FLEX	DB TOBIT	PPML	OLS	No DEM
GLOB_2010	0.072	42.212	0.034	0.040	
	(0.025) **	(14.843) **	(0.011) **	(0.018) *	
GLOB_2012	0.154	102.959	0.067	0.076	
	(0.034) **	(19.107) **	(0.016) **	(0.031) *	
GLOB_2014	0.229	145.953	0.102	0.150	
	(0.043) **	(24.266) **	(0.021) **	(0.036) **	
GLOB_2016	0.325	198.697	0.147	0.255	
	(0.052) **	(28.392) **	(0.029) **	(0.047) **	
GLOB_2018	0.456	268.345	0.200	0.339	
	(0.065) **	(37.192) **	(0.038) **	(0.057) **	
WTO	0.390	-16.522	0.396	0.389	
	(0.054) **	(15.460)	(0.051) **	(0.070) **	
EIA	-0.067	-24.227	-0.063	-0.028	-.065
	(0.047)	(24.562)	(0.032) *	(0.093)	(0.048)
N	9656	9656	9656	9656	9326

Country-specific Globalization Effects

ISO	2010	2012	2014	2016	2018
AT	0.019	-0.060	-0.045	-0.092	-0.133
	(.016)	(.028)*	(.035)	(.039)*	(.047)**
BE	-0.029	-0.056	-0.019	-0.015	-0.055
	(.019)	(.034)	(.035)	(.041)	(.053)
DE	0.297	0.152	0.168	0.009	-0.036
	(.035)**	(.053)**	(.058)**	(.054)	(.061)
HU	0.244	0.199	0.237	0.326	0.355
	(.02)**	(.032)**	(.037)**	(.041)**	(.053)**
GB	0.095	0.150	0.227	0.297	0.400
	(.021)**	(.043)**	(.052)**	(.059)**	(.073)**
BG	0.044	0.350	0.391	0.510	0.675
	(.04)	(.049)**	(.05)**	(.048)**	(.061)**
EE	0.031	0.222	0.313	0.550	0.725
	(.036)	(.052)**	(.065)**	(.081)**	(.102)**
LV	0.189	0.445	0.541	0.706	0.970
	(.038)**	(.079)**	(.083)**	(.093)**	(.114)**
RO	0.269	0.453	0.607	0.704	1.006
	(.037)**	(.048)**	(.052)**	(.058)**	(.071)**

Country-specific Estimates, 2018



New EU Members: Bulgaria (2007), Romania (2007), Croatia (2013)

Year	A. Symmetric	B. Asymmetric		C. Bulgaria	
	Old⇔New	Old⇒New	New⇒Old	Old⇒BGR	BGR⇒Old
*GLOB*_2010	0.026	-0.020	0.076	0.040	-0.023
	(.019)	(.057)	(.058)	(.067)	(.094)
*GLOB*_2012	0.029	0.378	-0.322	0.393	-0.407
	(.033)	(.069)**	(.077)**	(.107)**	(.113)**
*GLOB*_2014	-0.001	0.355	-0.356	0.477	-0.286
	(.034)	(.062)**	(.067)**	(.102)**	(.092)**
*GLOB*_2016	0.074	0.401	-0.251	0.393	-0.226
	(.035)*	(.059)**	(.062)**	(.097)**	(.097)*
*GLOB*_2018	0.160	0.424	-0.104	0.389	-0.0860
	(.042)**	(.067)**	(.066)	(.103)**	(.103)

Robustness Checks

Main results (both benchmark and country-specific) are robust to the use of:

- **Alternative Estimators:**
  - Double-bounded Tobit;
  - PPML;
  - OLS.
- **Alternative Samples:**
  - Positive trade only;
  - Interval Data;
  - Export-based trade;
  - Import-based trade;
  - Conservative-product;
  - Extended-country;
  - **Export-based DEM.**

Discussion

- **Data:** UN's COMTRADE (HS6) data, World Bank's Enterprise Survey.
- **Theory:** Own theory implications, Melitz (2003), Welfare implications.
- **Applications:** Non-discriminatory trade policies (e.g., Export subsidies, promotion), Country-specific policies/characteristics (e.g., TBT, SPS, Institutions), Exchange rates, Bilateral policies (WTO, RTAs, Sanctions).
- **Indexes:** "Pound for Pound" Export diversification: $IEM_{i,t}/DEM_{i,t}$.