Productivity, (Mis)allocation and Trade

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Motivation

- Decline in trade, transportation and communication costs over past 20 years has triggered rapid expansion in international trade
- How does globalization affect aggregate productivity?
  - Reallocations across firms and innovation within firms
  - Impact of export expansion and import penetration
  - Role of imperfect institutions, factor and product market frictions
- Implications for trade policy and structural reforms
  - Gains from trade with firm heterogeneity
  - Importance of efficient resource allocation for realization of gains

Overview

- Examine effects of international trade on aggregate productivity
  - Export demand vs. import competition
  - Average firm productivity vs. reallocations across firms
- Theory: numerically simulate gains from trade in standard Melitz (2003) model with varying degree of allocative efficiency
  - Definite gains from bilateral and unilateral export liberalization, but ambiguous effects of unilateral import liberalization
  - Misallocation can amplify or dampen trade effects
- Empirics: exploit unique cross-country panel data that captures underlying firm heterogeneity
  - 14 European countries, 20 manufacturing industries, 1998-2011
  - Establish causality using IV strategy (tariffs, Bartik, China shock)

Empirical Results

- International trade significantly increases aggregate productivity
  - Export demand boosts both avg productivity and allocative efficiency
  - Import compet raises avg productivity but lowers allocative efficiency

- Mechanisms
  - Selection: export demand and import compet induce exit by less productive firms
  - Misallocation: efficient institutions, factor and product mkts amplify gains from import compet, but dampen gains from export expansion

Contribution to the Literature

- Macro: productivity dispersion and resource misallocation across firms contributes to productivity differences across countries
  - Hsieh-Klenow 2009, Bartelsman et sl 2013, Gopinath et al 2015, Edmond et al 2015, Foster et al 2008, Foster et al 2015,2016 …
- Trade: role of firm heterogeneity, within-firm productivity upgrading and reallocations across firms for gains from trade
  - Pavcnik 2002, Bustos 2011, Arkolakis-Costinot-RodriguezClare 2012, de Loecker 2013, Khandelwal-Topalova 2013, Melitz-Redding 2014, Goldberg et al 2010 …
- Trade: impact of financial and labor market frictions
  - Manova 2013, Chor-Manova 2012, …
  - Helpman-Itskhoki-Redding 2010, Cuñat-Melitz 2012, …

Outline

1. Conceptual framework
2. Data
3. Empirical evidence
   a. OLS baseline
   b. IV baseline
   c. Robustness
   d. Other misallocation measures
4. Conclusions

Theoretical Approach

- Examine how trade liberalization affects aggregate productivity in a standard heterogeneous-firm model: Melitz (2003)
  - unilateral vs. bilateral reduction in trade costs
  - perfect vs. imperfect resource allocation across firms
- Evaluate contribution of three mechanisms
  - extensive margin: firm selection
  - intensive margin: allocation across firms
  - intensive margin: within-firm productivity upgrading
- Derive comparative statics based on closed-form analytical solutions and numerical calculations
  - Results extend to multi-sector economy

Theoretical Set-Up

- CES demand with monopolistic competition and free entry in differentiated sector + numeraire CRS outside good
- Production and trade technology
  - Sunk cost of entry
  - Fixed cost of domestic production, constant marginal production cost
  - Fixed cost of exporting, asymmetric iceberg trade costs τ_i and τ_e
- No misallocation: firms draw productivity φ from a known lognormal distribution
  - Marginal production cost = w / φ
- Misallocation: firms draw productivity φ and distortion η from a known joint lognormal distribution
  - Marginal production cost = $w / \varphi\eta$

Bilateral Trade Liberalization With No Misallocation

- A decline in trade costs $\tau = \tau_i = \tau_e$ increases both export demand and import competition
  - Lower productivity cut-off for exporting φ_X^* → higher productivity cut-off for domestic production φ^* due to free entry
  - Reallocation of activity towards more productive firms
- With economies of scale in innovation / adoption, falling trade costs can induce endogenous within-firm productivity upgrading
  - Exporters expect higher export sales (Bustos 2011)
  - Innovation may become more or less attractive due to higher competition in domestic market

$\downarrow \tau$ → $\uparrow$ Export demand, $\uparrow$ Import competition →
→ $\uparrow$ Aggregate productivity

Unilateral Export Liberalization With No Misallocation

- A unilateral decline in export costs τ_e increases export demand and has similar effects as bilateral liberalization
  - Lower export cut-off φ_X^* → higher production cut-off φ^*
  - Reallocation of activity towards more productive firms
  - Within-firm productivity upgrading

$\downarrow \tau_e$ → ↑ Export demand → ↑ Aggregate productivity

Unilateral Import Liberalization With No Misallocation

- A unilateral decline in import costs τ_i still increases import competition, but has ambiguous aggregate effects
  - Lower foreign export cut-off → higher foreign production cut-off
  - Direct effect: increase home production cut-off φ^* as home demand for home varieties falls
  - Indirect effect: increase home export cut-off φ_X^* and decrease home production cut-off φ^* as foreign market becomes more competitive
  - Metzler paradox: indirect effect dominates iff small or no decline in home wage (Demidova-RodriguezClare 2013, Bagwell-Lee 2016)
  - Within-firm productivity upgrading and reallocation of activity towards more productive firms possible, but not guaranteed

$\downarrow \tau_i \rightarrow \uparrow$ Import competition $\rightarrow \uparrow\downarrow$ Aggregate productivity

Resource Misallocation

- Firms draw both productivity φ and distortion η
  - Employment = f + q / φ
  - Total cost = (f + q / φη) w
- We interpret η as any distortion that creates a wedge b/w social marginal cost of input bundle and private marginal cost to the firm
  - Ex: capital or labor market frictions, imperfect institutions, corruption
- Firm selection, production and export activity depend on φη, while optimal resource allocation would depend on φ alone
  - Misallocation arises from inefficient allocation of production resources and market shares across firms
  - With CES, there is no misallocation due to variable mark-ups (Dhingra-Morrow 2014)

Trade Liberalization with Misallocation

- Market frictions can amplify or dampen the effects of trade liberalization on aggregate productivity
  - Misallocation acts both on the extensive margin (firm selection) and on the intensive margin (allocation of activity across operating firms)
  - Trade can induce more or less efficient allocation of resources
- Trade can induce more or less efficient allocation of resources depending on the type and magnitude of market frictions
  - Correlation between productivity φ and distortion η, $\rho(\varphi,\eta)$
  - Variance of distortion η, σ_η
- Theoretical ambiguity necessitates numerical simulations

From Theory to Empirics

- While theoretical notion of productivity is quantity based (TFPQ), empirical measures are revenue based (TFPR, LPR)
  - In principle, LPR = real value added per worker
  - Theory: TFPQ = LPR = $q / (f + q/\varphi)$ increasing in φ despite constant mark-ups because of fixed costs
  - Data: TFPR is a revenue-based residual subject to simultaneity and omitted variable bias due to endogenous input choice
  - Data: TFPR and LPR are subject to measurement error due to unobserved variable mark-ups and use of sector-level price deflators

From Theory to Empirics

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- Theoretical predictions for effects of trade liberalization pertain to changes in tariffs or trade costs
  - In reality, other supply and demand shocks also drive import competition and export expansion

From Theory to Empirics

- While theoretical notion of productivity is quantity based (TFPQ), empirical measures are revenue based (TFPR, LPR)
- Theoretical predictions for effects of trade liberalization pertain to changes in tariffs or trade costs
  - In reality, other supply and demand shocks also drive import competition and export expansion
- Distinguishing misallocation from efficient reallocation poses conceptual challenges
  - Different model assumptions about market structure and production technology lead to different sufficient statistics for misallocation

➔ Need to bridge gap between theory and empirics

Measuring Misallocation

- The literature has proposed different indicators of resource misallocation across firms
  - TFPR dispersion (Hsieh-Klenow 2009, Bartelsman et al 2013)
  - MRPK and MRPL dispersion (Hsieh-Klenow 2009, Gopinath et al 2015)
  - PCM (price-cost mark-up) dispersion (Edmond et al 2015)
  - Productivity-size covariance (Olley-Pakes 1996, Bartelsman et al 2013)

- There are four concerns with interpreting these indicators and linking them to theoretical predictions for impact of trade with misallocation

Allocation vs. Misallocation

- Four concerns

1. Measurement error
   - ME in TFPR, MRPK, MRPL, PCM can inflate dispersion measures
   - Using dispersion measures based on estimated variables and parameters as outcome variables complicates regression analysis

2. Market structure
   - TFPR, MRPK, MRPL dispersion implies misallocation under constant mark-ups (e.g. HK 2009), but not under variable mark-ups (e.g. Foster et al 2008, Berman et al 2012)
   - Market-share misallocation arises with variable mark-ups even without distortions in factor markets (Dhingra-Morrow 2014)

Allocation vs. Misallocation

- Four concerns

3. Production technology
   - TFPR, MRPK, MRPL dispersion implies misallocation with CRS (e.g. HK 2009), but not with IRS (e.g. Bartelsman et al 2013, Foster et al 2015, 2016)

4. Firm dynamics
   - TFPR, MRPK, MRPL dispersion does not imply misallocation when there are demand or TFPQ shocks and adjustment costs (e.g. Bartelsman et al 2013, Foster et al 2015, 2016)

Productivity Decomposition

- Aggregate productivity can be decomposed into two components (Olley and Pakes 1996, Melitz-Polanec 2015)
  - Average firm productivity
  - Covariance between firm productivity and share of economic activity

$$Prod_{ikt} = \underbrace{\frac{1}{N_{ikt}} \sum_f Prod_{fikt}}_{AvgProd_{ikt}} + \underbrace{\sum_f \left(\theta_{fikt} - \overline{\theta_{ikt}}\right)\left(Prod_{fikt} - \overline{Prod_{ikt}}\right)}_{CovProd_{ikt}}$$

- Implementation
  - $Prod_{fikt}$: log real value added per worker
  - θ_{fikt} : employment share
  - $Prod_{ikt}$ and $\overline{Prod_{ikt}}$ are weighted and unweighted averages

Interpreting Productivity Decomposition

$$Prod_{ikt} = \underbrace{\frac{1}{N_{ikt}} \sum_f Prod_{fikt}}_{AvgProd_{ikt}} + \underbrace{\sum_f (\theta_{fikt} - \overline{\theta_{ikt}})(Prod_{fikt} - \overline{Prod_{ikt}})}_{CovProd_{ikt}}$$

$$\Delta Prod_{ikt} = \Delta AvgProd_{ikt} + \Delta CovProd_{ikt}$$

- Accounting interpretation
  - $AvgProd_{ikt}$ captures firm selection and within-firm productivity gains
  - $CovProd_{ikt}$ reflects allocation of labor across firms

Interpreting Productivity Decomposition

$$Prod_{ikt} = \underbrace{\frac{1}{N_{ikt}}\sum_f Prod_{fikt}}_{AvgProd_{ikt}} + \underbrace{\sum_f \left(\theta_{fikt} - \overline{\theta_{ikt}}\right)\left(Prod_{fikt} - \overline{Prod_{ikt}}\right)}_{CovProd_{ikt}}$$

$$\Delta Prod_{ikt} = \Delta AvgProd_{ikt} + \Delta CovProd_{ikt}$$

- Economic interpretation: no market distortions
  - Optimal entry, exit, (re)allocation and productivity upgrading
  - $CovProd_{ikt}$ optimally determined by market conditions (e.g. aggregate demand, degree of product differentiation, …)
  - Control for $\min Prod_{ikt}$ to isolate selection effect

Interpreting Productivity Decomposition

$$Prod_{ikt} = \underbrace{\frac{1}{N_{ikt}} \sum_f Prod_{fikt}}_{AvgProd_{ikt}} + \underbrace{\sum_f \left(\theta_{fikt} - \overline{\theta_{ikt}}\right)\left(Prod_{fikt} - \overline{Prod_{ikt}}\right)}_{CovProd_{ikt}}$$

$$\Delta Prod_{ikt} = \Delta AvgProd_{ikt} + \Delta CovProd_{ikt}$$

- Economic interpretation: market distortions
  - Inefficient entry, exit, (re)allocation and productivity upgrading
  - Lower covariance term (Bartelsman-Haltiwanger-Scarpetta 2013)
  - Control for $\min Prod_{ikt}$ to isolate selection effect and distinguish between misallocation along extensive and intensive margins
  - Use direct measures of market frictions to identify misallocation

From Theory to Empirics: Numerical Simulation

- No misallocation: log-normal productivity distribution with parameters $\mu_\varphi = 1$, $\sigma_\varphi = 1$
- Misallocation: joint log-normal distribution for productivity and distortion with parameters
  - $\mu_\eta = 1$, $\sigma_\eta \in \{0, 0.05, 0.15\}$
  - correlation $\rho(\varphi, \eta) \in [-0.5, 0.5]$
- Model parameters (Burstein-Cravino 2015)
  - Elasticity of substitution $\sigma = 3$
  - Initial trade costs $\tau = \tau_i = \tau_e = 1.81$
  - Fixed cost of production 1.2
  - Fixed cost of exports 1.75
  - Sunk cost of entry 0.1

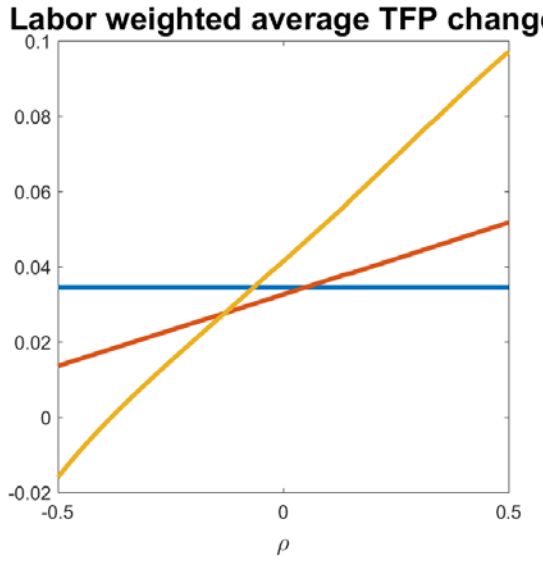
Numerical Simulation

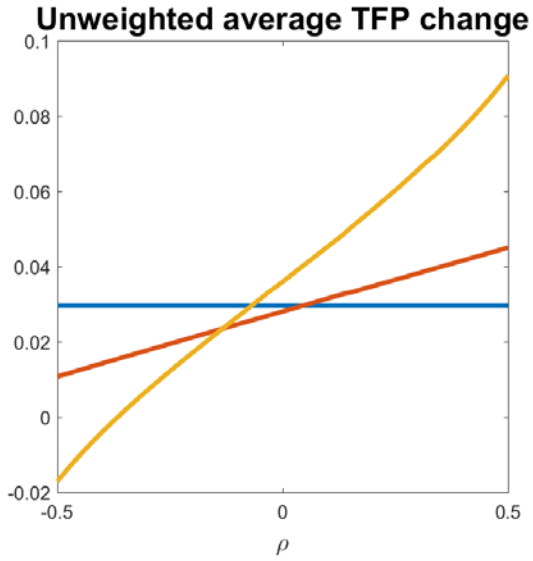
- Counterfactual productivity gains with 20% fall in variable trade costs

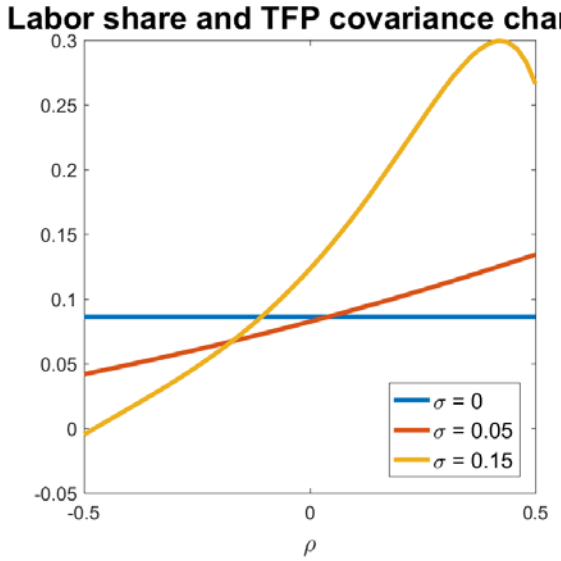
	Bilateral Liberalization			Export Liberalization			Import Liberalization		
	Aggr Prod	Avg Prod	Cov Term	Aggr Prod	Avg Prod	Cov Term	Aggr Prod	Avg Prod	Cov Term
No Misallocation: $\sigma_\eta = 0$									
	3.51%	2.75%	0.75%	4.89%	3.84%	1.05%	-0.59%	-0.47%	-0.12%
Misallocation: $\sigma_\eta = 0.05$									
$\rho = -0.5$	1.37%	0.98%	0.38%	3.46%	2.70%	0.76%	-1.35%	-1.17%	-0.18%
$\rho = 0$	3.31%	2.62%	0.69%	4.61%	3.63%	0.98%	-0.50%	-0.39%	-0.11%
$\rho = 0.5$	5.31%	4.27%	1.03%	6.03%	4.79%	1.24%	0.14%	0.20%	-0.06%

Numerical Simulation: Bilateral Trade Liberalization

- 20% reduction in bilateral variable trade cost τ

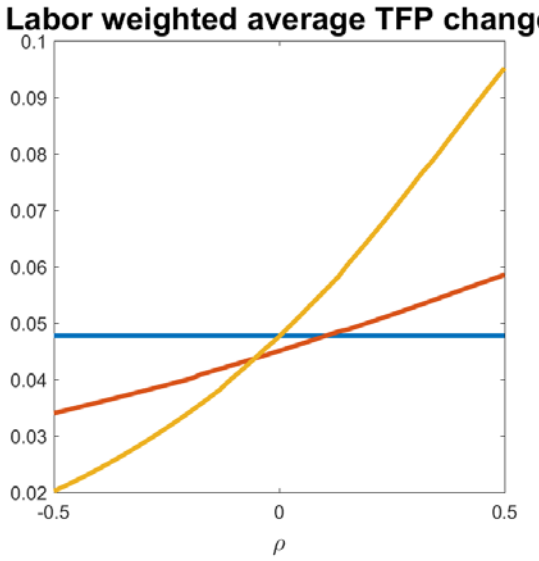


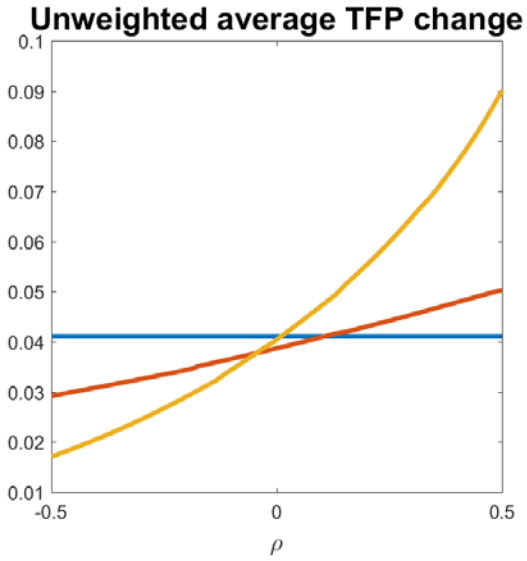


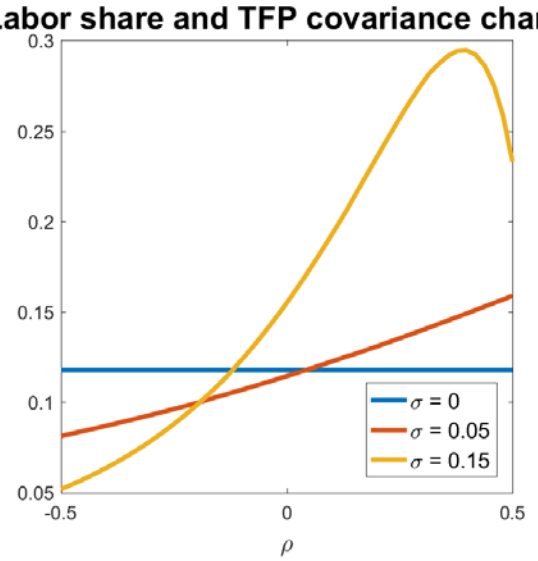


Numerical Simulation: Unilateral Export Liberalization

- 20% reduction in export variable trade cost τ_e

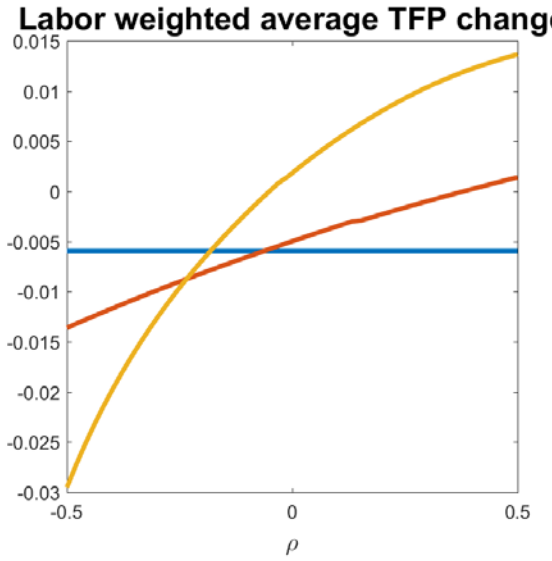


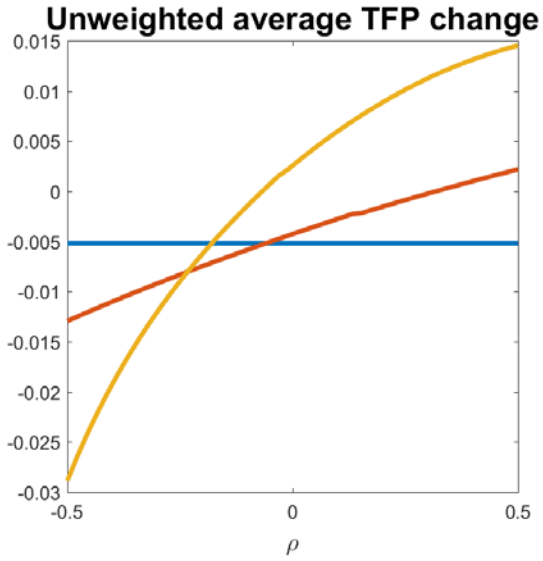


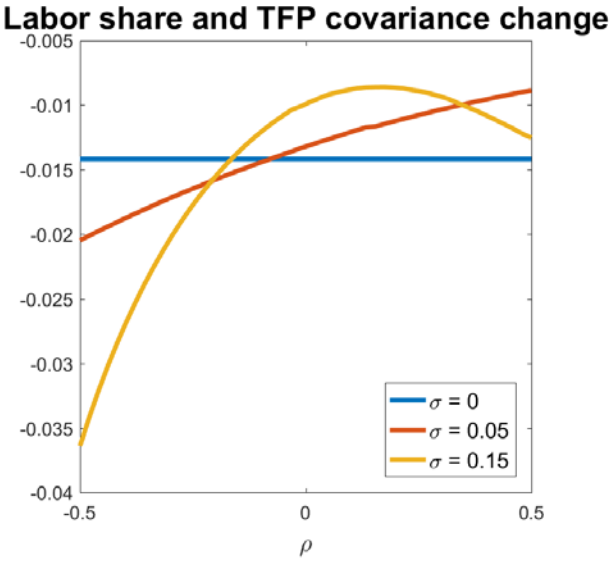


Numerical Simulation: Unilateral Import Liberalization

- 20% reduction in export variable trade cost τ_i







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CompNet Productivity Data

- Unique cross-country, cross-sector panel data on macro aggregates and micro heterogeneity (Lopez-Garcia et al 2015)
  - Standardized aggregation of firm-level data country by country, coordinated by ECB and European System of Central Banks
  - 14 countries: Austria, Belgium, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Poland, Portugal, Slovakia, Slovenia, Spain
  - 20 NACE-2 manufacturing sectors
  - 1998-2011 unbalanced panel
- Indicators for firm labor productivity, capital productivity, TFP, size
  - Multiple moments of each distribution and joint distributions
  - Olley-Pakes (1996) decomposition of aggregate productivity

CompNet Data Coverage

	Years	# Sector-Years	Avg # Firms
AUSTRIA	2000-2011	222	60
BELGIUM	1998-2010	260	709
ESTONIA	1998-2011	274	166
FINLAND	1999-2011	260	585
FRANCE	1998-2009	240	3488
GERMANY	1998-2011	280	719
HUNGARY	2003-2011	180	1446
ITALY	2001-2011	220	4327
LITHUANIA	2000-2011	240	220
POLAND	2005-2011	140	717
PORTUGAL	2006-2011	120	1607
SLOVAKIA	2001-2011	218	102
SLOVENIA	1998-2011	249	211
SPAIN	1998-2011	280	3125
Total			1238

Summary Statistics

- Covariance term ≈ 7.4% of aggregate productivity level and 20% of its variance

	Aggregate Productivity	Average Productivity	Covariance Term
Avg across countries, sectors, years	3.16	2.93	0.23
St dev across sector-years for avg country	1.14	1.20	0.22
Avg change: 1 year	0.04	0.03	0.01
Avg change: 3 years	0.10	0.09	0.01
Avg change: 5 years	0.18	0.16	0.02

WIOD Trade Data

- Annual bilateral trade data in value added by sector of final use
  - 14 countries, 20 NACE-2 sectors, 1998-2011

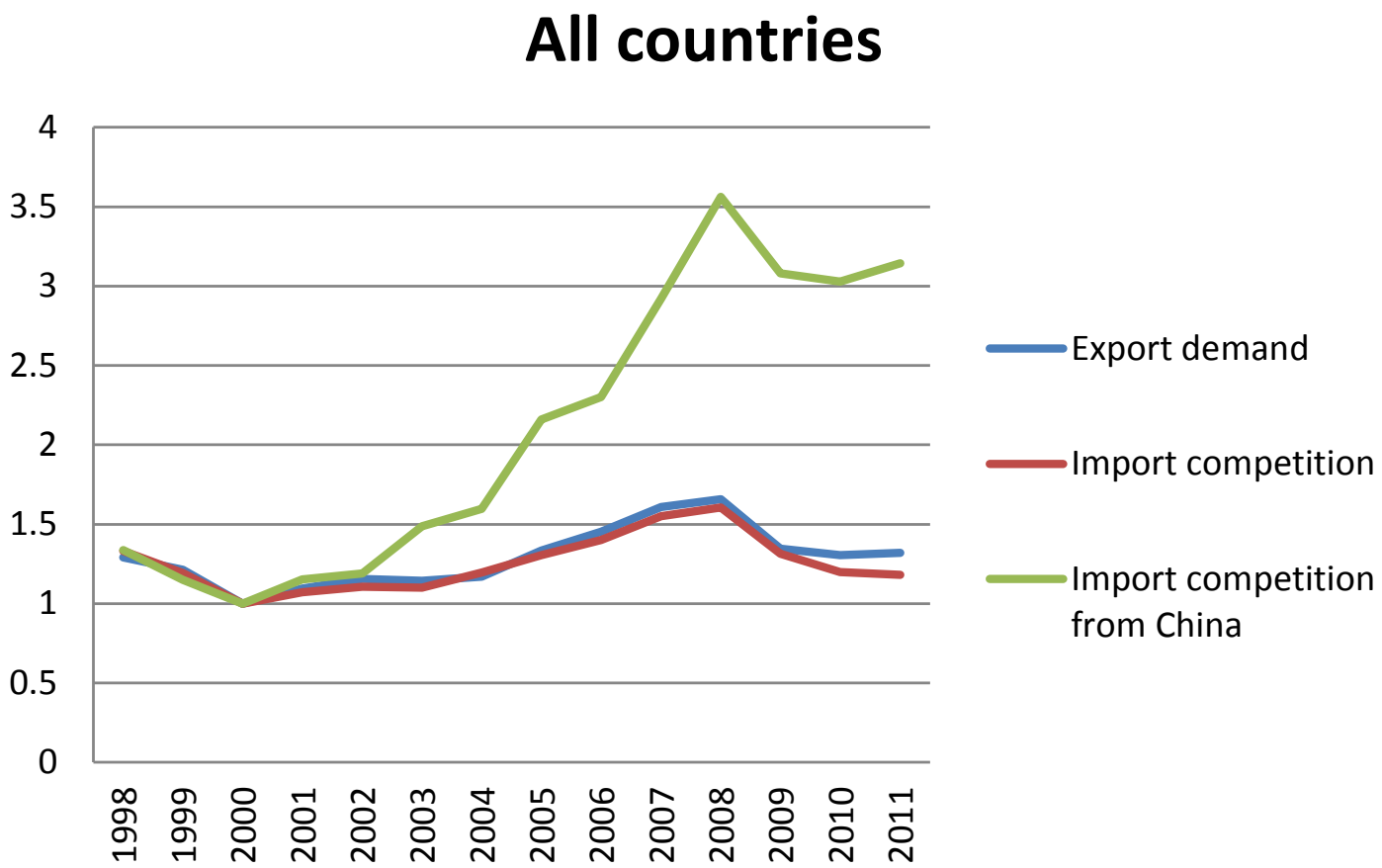
- Trade exposure in country i, sector k, year t
  - Export demand: mean 7.46, st dev 1.82

$$ExpDemand_{ikt} = \ln Exports_{ikt}$$

  - Import competition: mean 6.28, st dev 1.99

$$ImpComp_{ikt} = \ln(Imports_{ikt} - ImpInputs_{ikt})$$

Trade Exposure over Time (Index 2000 = 1)



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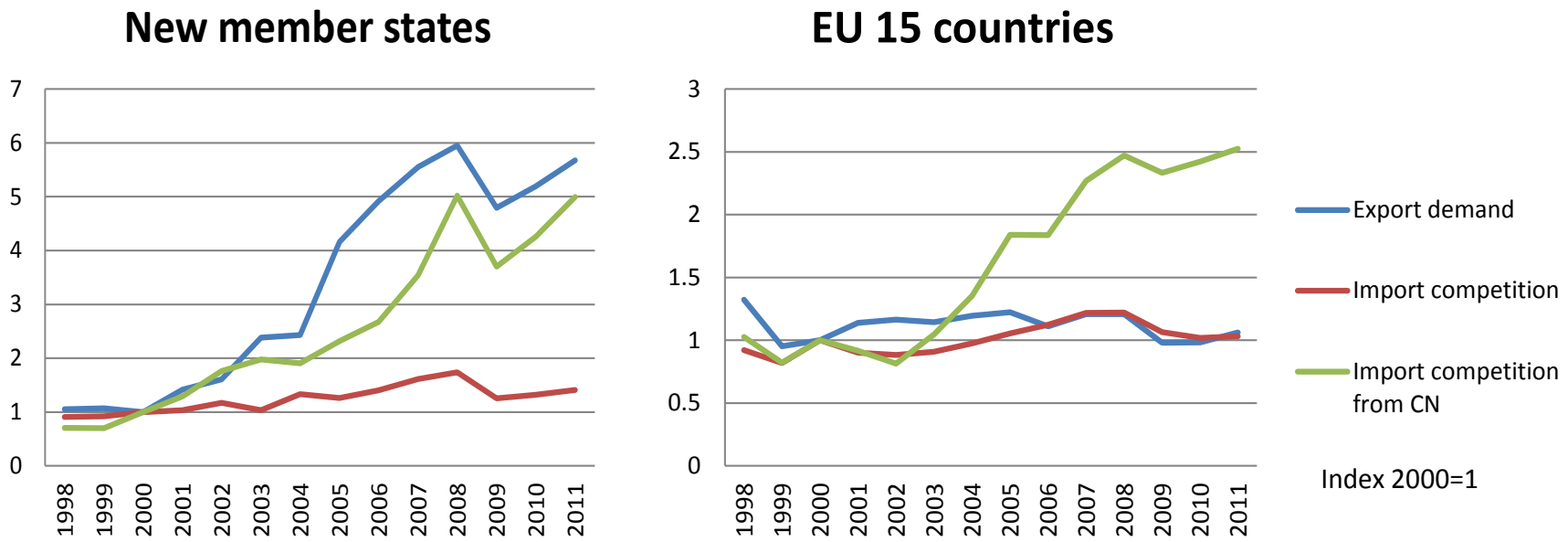

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Empirical Strategy I: OLS Levels

- OLS estimate of the long-run relationship between aggregate productivity and trade exposure

$$Y_{ikt} = \alpha + \beta_1 \cdot ExpDemand_{ikt} + \beta_2 \cdot ImpComp_{ikt} + \Gamma \cdot Z_{ikt} + \varphi_{it} + \varepsilon_{ikt}$$

  - Y_{ikt} : productivity measure in country i, sector k, year t
  - Z_{ikt} : # firms ($\ln N_{ikt}$), sector trends ($\ln N_{kt}$, $\ln L_{kt}$)
  - φ_{it} : 14 country * 13 year FE
    (subsume GDP per capita, GDP, institutions, macro shocks)
  - ε_{ikt} : robust standard errors

Measurement Error & Sample Selection

- Size threshold varies across countries
  - Include country fixed effects
  - Control for $\ln N_{ikt}$
- $CovProd_{ikt}$ underestimated due to classical ME in L_{fikt}
  - Control for $\ln N_{ikt}$
- Outliers
  - Drop observations with $N_{ikt} < 20$
  - Drop observations in top and bottom percentile by annual change in Y_{ikt}, $ExpDemand_{ikt}$ and $ImpComp_{ikt}$
  - Drop one country at a time

Aggregate Performance

- High export demand associated with high productivity, output, employment
- High import competition also associated with high productivity, but low output and employment

	ln Output (ikt)	ln Value Added (ikt)	ln Employ-ment (ikt)	ln Aggr Prod (ikt)
Exp Dem (ikt)	**0.381*** **	**0.371*** **	**0.238*** **	**0.122*** **
	(0.017)	**(0.016)**	**(0.010)**	**(0.012)**
Imp Comp (ikt)	**-0.137*** **	**0.040*** **	**-0.067*** **	**0.105*** **
	(0.008)	**(0.010)**	**(0.005)**	**(0.008)**
ln N Firms (ikt)	0.565***	0.577***	0.738***	-0.160***
	(0.022)	(0.024)	(0.016)	(0.018)
ln N Firms (kt)	-0.990***	-0.718***	-0.730***	0.019
	(0.030)	(0.035)	(0.021)	(0.026)
ln Employment (kt)	1.301***	0.658***	0.860***	-0.180***
	(0.035)	(0.036)	(0.022)	(0.026)
# Observations	2,809	2,809	2,809	2,809
R-squared	0.924	0.928	0.948	0.849
Country * Year FE	Y	Y	Y	Y

Productivity Decomposition

- High export demand and import competition ↔ high aggregate productivity
  - Average firm productivity rises with both export demand and import competition
  - Covariance term rises with export demand but falls with import competition
- One-standard-deviation rise in export demand and import competition ↔ 22% and 21% higher aggregate productivity

	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
Exp Dem (ikt)	**0.125*** **	**0.084*** **	**0.041*** **
	(0.012)	**(0.011)**	**(0.005)**
Imp Comp (ikt)	**0.105*** **	**0.123*** **	**-0.018*** **
	(0.008)	**(0.007)**	**(0.003)**
# Observations	2,828	2,828	2,828
R-squared	0.848	0.867	0.516
Ctry*Year FE, Controls	Y	Y	Y

Empirical Strategy II: OLS Changes

- OLS estimate of the short- to medium-term relationship between aggregate productivity and trade exposure

$$\Delta Y_{ikt} = \alpha + \beta_1 \cdot \Delta ExpDemand_{ikt} + \beta_2 \cdot \Delta ImpComp_{ikt} + \Gamma \cdot \Delta Z_{ikt} + \varphi_t + \varepsilon_{ikt}$$

  - ΔY_{ikt} : 1-, 3- or 5-year change in productivity, overlapping periods
  - $\Delta ExpDemand_{ikt}$, $\Delta ImpComp_{ikt}$, ΔZ_{ikt} : concurrent or lagged change
  - country x sector FE differenced out
  - φ_t : trends in productivity growth
  - ε_{ikt} : robust standard errors

Short- and Medium-Term Effects

- Qualitatively similar relationship between trade exposure and productivity at different horizons, with bigger magnitudes at longer horizons

	Δ = 1 year			Δ = 3 years			Δ = 5 years		
	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
Δ Exp Dem (ikt)	**0.115*** **	**0.033**	**0.082*** **	**0.137*** **	**0.049** **	**0.088*** **	**0.157*** **	**0.085*** **	**0.072*** **
	(0.028)	**(0.024)**	**(0.028)**	**(0.025)**	**(0.023)**	**(0.018)**	**(0.027)**	**(0.025)**	**(0.019)**
Δ Imp Comp (ikt)	**0.082*** **	**0.101*** **	**-0.019**	**0.064*** **	**0.103*** **	**-0.039** **	**0.079*** **	**0.108*** **	**-0.029***
	(0.023)	**(0.022)**	**(0.021)**	**(0.025)**	**(0.024)**	**(0.016)**	**(0.027)**	**(0.025)**	**(0.015)**
Observations	2,544	2,544	2,544	2,071	2,071	2,071	1,585	1,585	1,585
R-squared	0.113	0.114	0.022	0.099	0.115	0.043	0.095	0.093	0.034
Year FE, Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y

Endogeneity

- OLS results identify correlations rather than causal effects since aggregate productivity can endogenously affect trade activity

- Reverse causality
  - More productive countries may export more because they are more competitive on world markets → β_1 biased up
  - Lower local productivity may induce more entry by foreign exporters → β_2 biased down

- Omitted variable bias
  - Country-year FE control for aggregate demand and supply shocks, remoteness, institutions, etc.
  - OVB must vary systematically across sectors within country-years

Empirical Strategy III: 2SLS

- Use 2SLS to identify causal effect of trade exposure on aggregate productivity and its constituent parts

$$Y_{ikt} = \alpha + \beta_1 \cdot \widehat{ExpDemand}_{ikt} + \beta_2 \cdot \widehat{ImpComp}_{ikt} + \Gamma \cdot Z_{ikt} + \varphi_{it} + \varepsilon_{ikt}$$

$$\{ExpDemand_{ikt}, ImpComp_{ikt}\} = \gamma + \Lambda \cdot Z_{ikt} + \Theta \cdot IV_{ikt} + \phi_{it} + \epsilon_{ikt}$$

- Ideal instruments for trade exposure
  - $ExpDemand_{ikt}$: separate exogenous foreign demand for ik goods from i's endogenous export supply of k goods
  - $ImpComp_{ikt}$: separate exogenous foreign supply of k goods to i from i's endogenous import demand for k goods
  - Validity and exclusion restriction

Bartik Instruments

- Initial trade structure of each country-sector + contemporaneous trade flows of each trade partner (Hummels et al AER 2014, Berman et al JIE 2015)

- IV for $ExpDemand_{ikt}$
  - Foreign demand: weighted average absorption by i's export partners, using i's initial export shares as weights (WIOD)

$$Fdemand_{ikt} = \ln\left[\sum_{j \neq i} \frac{X_{ijk,t=0}}{X_{ik,t=0}} \left(Y_{jkt} + M_{jkt} - X_{jkt}\right)\right]$$

- IV for $ImpComp_{ikt}$
  - Foreign supply: weighted average export value added for final consumption by i's import partners, using i's initial import shares as weights (WIOD)

$$Fsupply_{ikt} = \ln\left[\sum_{j \neq i} \frac{M_{ijk,t=0}}{M_{ik,t=0}} XVA_{jkt}^{final}\right]$$

  - Import tariffs $Tariff_{ikt}$: average applied tariff (WITS)

Valid Instruments (First Stage)

	Exp Dem (ikt)		Imp Comp (ikt)	
Foreign Demand (ikt)	**0.647*** **	**0.448*** **	**0.117*** **	**-0.007**
	(0.023)	**(0.061)**	**(0.012)**	**(0.028)**
Foreign Supply (ikt)	**0.127*** **	**0.148** **	**0.874*** **	**0.420*** **
	(0.010)	**(0.060)**	**(0.005)**	**(0.027)**
Import Tariff (ikt)	**-4.090*** **	**0.233**	**3.078*** **	**-0.958** **
	(0.417)	**(0.603)**	**(0.351)**	**(0.475)**
ln N Firms (ikt)	0.557***	0.566***	0.007	0.007
	(0.026)	(0.024)	(0.014)	(0.013)
ln N Firms (kt)	-0.708***	-0.539***	-0.046**	0.110
	(0.031)	(0.205)	(0.019)	(0.085)
ln Employment (kt)	0.307***	0.497***	0.059***	-0.042
	(0.043)	(0.160)	(0.019)	(0.068)
# Observations	2,775	2,775	2,775	2,775
R-squared	0.893	0.922	0.979	0.985
Country*Year FE	Y	Y	Y	Y
Sector FE	N	Y	N	Y

Causal Effects of Trade (Second Stage)

- One-standard-deviation rise in export demand and import competition → 72% and 10% higher aggregate productivity

	ln Aggregate Productivity (ikt)	ln Average Productivity (ikt)	Covariance Term (ikt)
^Exp Dem (ikt)	**0.408*** **	**0.316*** **	**0.092*** **
	(0.027)	**(0.026)**	**(0.008)**
^Imp Comp (ikt)	**0.049*** **	**0.077*** **	**-0.028*** **
	(0.010)	**(0.009)**	**(0.003)**
Observations	2,775	2,775	2,775
R-squared	0.817	0.849	0.489
Ctry*Year FE, Controls	Y	Y	Y

Mechanisms: Firm Selection

- Controlling for min observed productivity across firms reduces estimated coefficients on export demand and import competition
  - Consistent with impact of trade on the extensive margin of firm selection: less productive firms exit

	ln min Prod (ikt)	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	**0.225*** **	**0.264*** **	**0.151*** **	**0.113*** **
	(0.025)	**(0.019)**	**(0.016)**	**(0.008)**
^Imp Comp (ikt)	**0.066*** **	**0.011**	**0.031*** **	**-0.020*** **
	(0.009)	**(0.007)**	**(0.006)**	**(0.003)**
ln min Prod (ikt)		0.652***	0.737***	-0.085***
		(0.018)	(0.015)	(0.007)
Observations	2,749	2,749	2,749	2,749
R-squared	0.910	0.913	0.948	0.482
Ctry*Year FE, Controls	Y	Y	Y	Y

Mechanisms: Productivity Upgrading

- Controlling for R&D activity reduces (increases) estimated coefficients on export demand (import competition)
  - Consistent with export demand (import competition) stimulating (depressing) within-firm productivity upgrading

	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	**0.332*** **	**0.263*** **	**0.069*** **
	(0.027)	**(0.026)**	**(0.006)**
^Imp Comp (ikt)	**0.068*** **	**0.104*** **	**-0.036*** **
	(0.011)	**(0.010)**	**(0.003)**
ln R&D (ikt)	-0.028***	-0.061***	0.033***
	(0.010)	(0.009)	(0.003)
Observations	2,164	2,164	2,164
R-squared	0.796	0.827	0.631
Ctry*Year FE, Controls	Y	Y	Y

Robustness: Sector FE

- Sector FE control for systematic variation in global supply and demand conditions across sectors

	ln Aggregate Productivity (ikt)	ln Average Productivity (ikt)	Covariance Term (ikt)
^Exp Dem (ikt)	**0.315*** **	**0.207** **	**0.108*** **
	(0.100)	**(0.090)**	**(0.039)**
^Imp Comp (ikt)	**0.294** **	**0.306*** **	**-0.012**
	(0.117)	**(0.107)**	**(0.042)**
Observations	2,775	2,775	2,775
R-squared	0.868	0.895	0.633
Ctry*Year FE, Controls	Y	Y	Y
Sector FE	Y	Y	Y

Robustness: Import Competition Measure

- Import penetration relative to domestic turnover or employment

$$ImpCompRatio_{ikt} = \left\{ \ln \frac{Imports_{ikt} - ImpInputs_{ikt}}{\overline{Turnover_{ik}}} , \ln \frac{Imports_{ikt} - ImpInputs_{ikt}}{\overline{Employment_{ik}}} \right\}$$

	Imp Comp Ratio: Turnover			Imp Comp Ratio: Employment		
	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	**0.416*** **	**0.319*** **	**0.097*** **	**0.386*** **	**0.285*** **	**0.101*** **
	(0.024)	**(0.022)**	**(0.007)**	**(0.024)**	**(0.023)**	**(0.008)**
^Imp Comp Ratio (ikt)	**0.058*** **	**0.093*** **	**-0.035*** **	**0.074*** **	**0.101*** **	**-0.027*** **
	(0.007)	**(0.007)**	**(0.002)**	**(0.008)**	**(0.007)**	**(0.003)**
Observations	2,794	2,794	2,794	2,794	2,794	2,794
R-squared	0.817	0.853	0.509	0.824	0.857	0.479
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y

Robustness: Chinese Import Competition

- Dramatic rise in Chinese exports since WTO accession in 2001 and removal of MFA quotas in 2005
  - Large, exogenous trade shock serves as quasi-natural experiment for identification (Autor et al 2015, Bloom et al 2015)

- $ChinaImpComp_{ikt} = \ln\left(Imports_{China \to i,kt} - ImpInputs_{China \to i,kt}\right)$

- IV for $ChinaImpComp_{ikt}$
  - Import tariffs $Tariff_{ikt}$: average applied tariff
  - China's global export supply: weighted average Chinese export value added for final consumption, using China's share in i's initial imports as weights
  - China's export supply to the US: weighted average Chinese exports to the US by NACE-4 product, using i's initial global import shares as weights

$$ChinaSupply_{ikt} = \left\{ \ln\left[\frac{M_{China \to i,k,t=0}}{M_{ik,t=0}} XVA^{final}_{China,kt}\right], \ln\left[\sum_{p \in k} \frac{M_{ip,t=0}}{M_{ik,t=0}} X_{China \to US,pt}\right] \right\}$$

Robustness: Chinese Import Competition

- More nuanced effects of Chinese import competition on productivity across vs. within sectors

	No Sector FE			Sector FE		
	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	**0.431*** **	**0.384*** **	**0.047*** **	**0.316*** **	**0.205*** **	**0.111*** **
	(0.022)	**(0.022)**	**(0.006)**	**(0.084)**	**(0.076)**	**(0.032)**
^China Imp Comp (ikt)	**-0.001**	**0.023*** **	**-0.024*** **	**0.104*** **	**0.106*** **	**-0.002**
	(0.008)	**(0.008)**	**(0.002)**	**(0.036)**	**(0.033)**	**(0.013)**
# Observations	2,775	2,775	2,775	2,775	2,775	2,775
R-squared	0.811	0.835	0.542	0.876	0.903	0.630
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y
Sector FE	N	N	N	Y	Y	Y

Alternative Misallocation Measures

- The literature has proposed other indicators of resource (mis)allocation across firms
  - MRPK and MRPL dispersion (Hsieh-Klenow 2009, Gopinath et al 2015)
  - TFPR dispersion (Hsieh-Klenow 2009, Bartelsman et al 2013)
  - PCM dispersion (Edmond et al 2015)
- Recall conceptual and practical challenges with distinguishing between efficient allocation and misallocation

Alternative Misallocation Measures

- Compared to OP cov term, alternative misallocation measures deliver different results for the effects of export demand and import competition

	MRPK St Dev	MRPL St Dev	TFPR St Dev	PCM p80 / p20
^Exp Dem (ikt)	**-0.137*** **	**0.279*** **	**0.127** **	**0.026*** **
	(0.032)	**(0.025)**	**(0.052)**	**(0.008)**
^Imp Comp (ikt)	**0.213*** **	**0.081*** **	**-0.037*** **	**-0.011*** **
	(0.013)	**(0.009)**	**(0.013)**	**(0.003)**
# Observations	2,775	2,775	2,272	2,773
R-squared	0.560	0.809	0.387	0.695
Country * Year FE	Y	Y	Y	Y

Imperfect Institutions & Market Frictions

- World Justice Project : rule of law
  - Index of overall institutional capacity
  - Mean 1.86, st dev 0.91
- OECD Employment : labor market flexibility
  - Average of 21 indicators for firing and hiring costs
  - Mean 3.47, st dev 0.66
- Beck et al (2013) : private credit / GDP
  - Commonly used outcome-based measure
  - Mean 0.78, st dev 0.42
- OECD Market Regulation : product market regulation
  - Average of 18 indicators for state control, barriers to entrepreneurship, and barriers to trade and investment
  - Mean 1.84, st dev 0.25

Imperfect Institutions & Market Frictions

- Strong institutions and efficient factor and product markets amplify gains from import competition, but dampen gains from export expansion

Efficiency Measure	Rule of Law (World Justice Project Index)			Labor Market Flexibility (OECD Index)		
	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	1.099***	0.924***	0.175***	3.528***	3.016***	0.512**
	(0.084)	(0.078)	(0.025)	(1.253)	(1.078)	(0.252)
^Imp Comp (ikt)	-0.168***	-0.102***	-0.067***	-0.573*	-0.449	-0.124*
	(0.036)	(0.033)	(0.009)	(0.327)	(0.282)	(0.064)
^Exp Dem (ikt) x	**-0.490*** **	**-0.432*** **	**-0.058*** **	**-0.886*** **	**-0.756*** **	**-0.130* **
Efficiency Measure (it=0)	**(0.048)**	**(0.044)**	**(0.014)**	**(0.341)**	**(0.293)**	**(0.069)**
^Imp Comp (ikt) x	**0.163*** **	**0.132*** **	**0.031*** **	**0.176** **	**0.146* **	**0.030* **
Efficiency Measure (it=0)	**(0.024)**	**(0.022)**	**(0.006)**	**(0.089)**	**(0.077)**	**(0.018)**
Observations	2,775	2,775	2,775	2,775	2,775	2,775
R-squared	0.784	0.827	0.471	0.766	0.806	0.465
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y

Imperfect Institutions & Market Frictions

- Strong institutions and efficient factor and product markets amplify gains from import competition, but dampen gains from export expansion

Efficiency Measure	Financial Market Development (Private Credit / GDP)			Product Market Regulation (OECD Index)		
	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)	ln Aggr Prod (ikt)	ln Avg Prod (ikt)	Cov Term (ikt)
^Exp Dem (ikt)	0.371***	0.019	0.352***	-1.018***	-0.899***	-0.119**
	(0.064)	(0.160)	(0.133)	(0.203)	(0.189)	(0.056)
^Imp Comp (ikt)	0.057**	0.179***	-0.122**	0.282***	0.236***	0.046**
	(0.024)	(0.061)	(0.051)	(0.082)	(0.078)	(0.023)
^Exp Dem (ikt) x Efficiency Measure (it=0)	**-0.058**	**-1.450**	**1.392***	**0.760*****	**0.646*****	**0.113*****
	(0.314)	**(0.890)**	**(0.733)**	**(0.114)**	**(0.106)**	**(0.031)**
^Imp Comp (ikt) x Efficiency Measure (it=0)	**-0.003**	**0.363**	**-0.366***	**-0.130*****	**-0.090****	**-0.040*****
	(0.089)	**(0.250)**	**(0.203)**	**(0.046)**	**(0.043)**	**(0.012)**
Observations	2,775	2,775	2,775	2,596	2,596	2,596
R-squared	0.821	0.610	-5.724	0.814	0.842	0.462
Ctry*Year FE, Controls	Y	Y	Y	Y	Y	Y

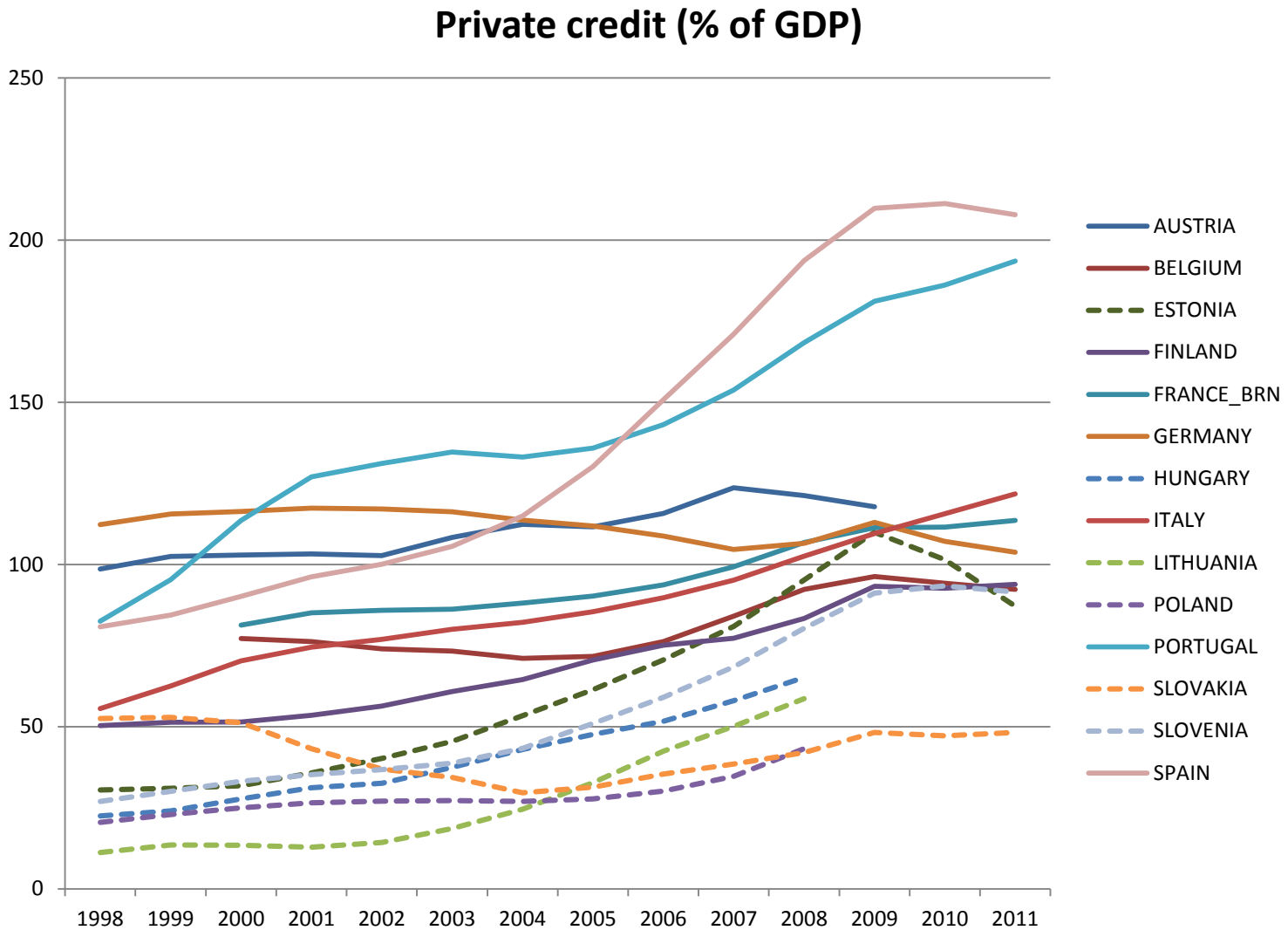
Conclusions and Next Steps

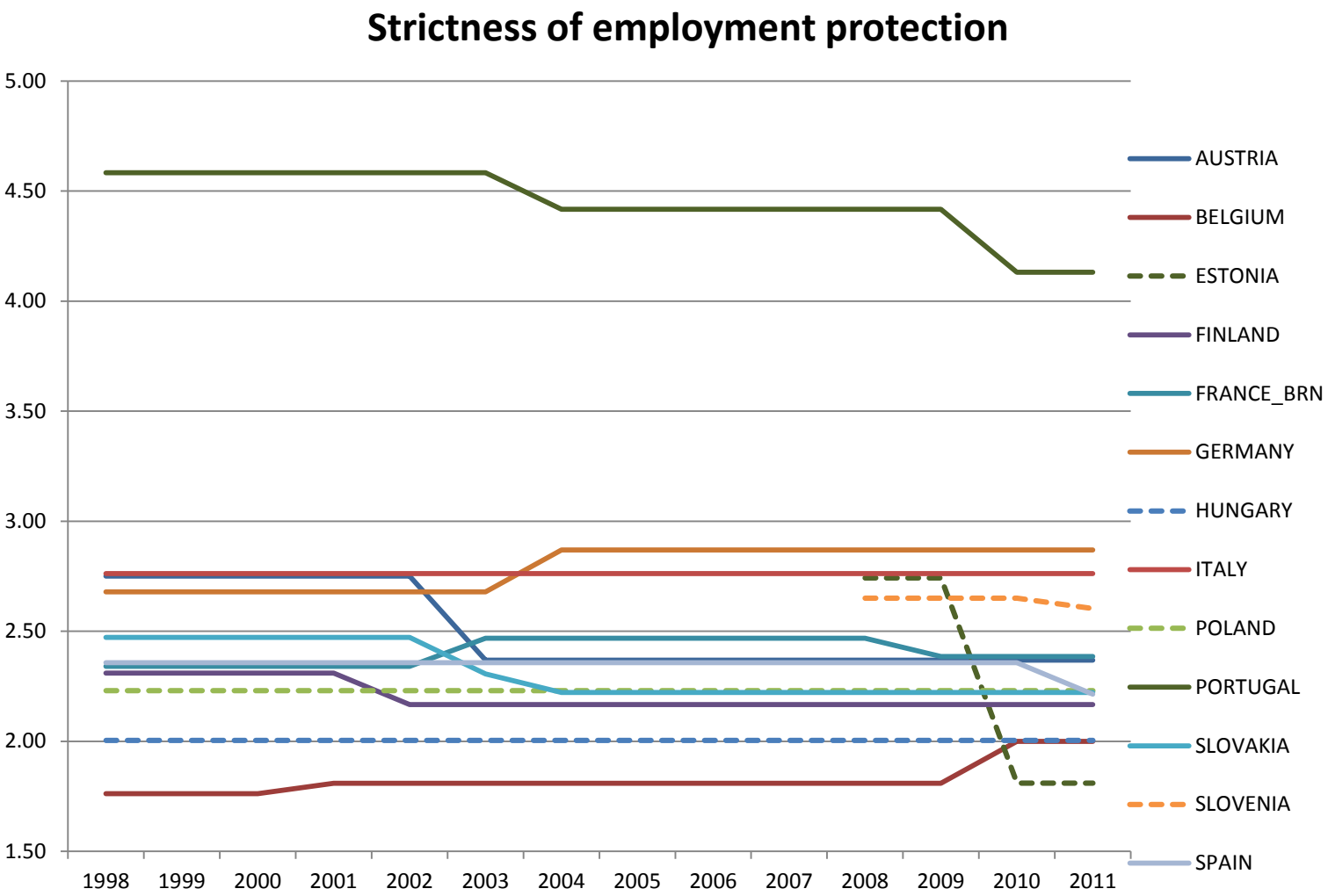
- Evidence that export demand and import competition both increase aggregate productivity, but through different channels
  - Firm entry and exit
  - Within-firm productivity upgrading
  - Reallocation of market shares across firms

- Puzzle?
  - What form of resource misallocation, market structure and parameter space can reconcile theory with data?

Pros & Cons of OP Approach

- Advantages
  - Welfare relevance: link between aggregate productivity & (mis)allocation
  - Attractive accounting properties: linear additivity and first-differencing
  - Agnostic decomposition: no assumptions on market structure, production technology, productivity distribution, demand/supply dynamics
  - Versatility: no restriction on firm productivity and market share measures
  - Practicality: no need for TFPQ, MRK, MPL, PCM estimates
- Disadvantages
  - Agnostic decomposition: cannot confirm specific economic mechanisms
  - Static decomposition: cannot separate entry/exit from within-firm productivity upgrading
- Our estimation approach capitalizes on advantages and uses different techniques to overcome disadvantages


Private credit (% of GDP)
250
200
150
100
50
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
AUSTRIA
BELGIUM
ESTONIA
FINLAND
FRANCE_BRN
GERMANY
HUNGARY
ITALY
LITHUANIA
POLAND
PORTUGAL
SLOVAKIA
SLOVENIA
SPAIN


Strictness of employment protection
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
AUSTRIA
BELGIUM
ESTONIA
FINLAND
FRANCE_BRN
GERMANY
HUNGARY
ITALY
POLAND
PORTUGAL
SLOVAKIA
SLOVENIA
SPAIN