Productivity Dispersion, Reallocation, and Growth

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Overview

- Productivity Dispersion
- Dispersion and Misallocation
- From Reallocation to Growth
- Growth Forecast 2017-2042

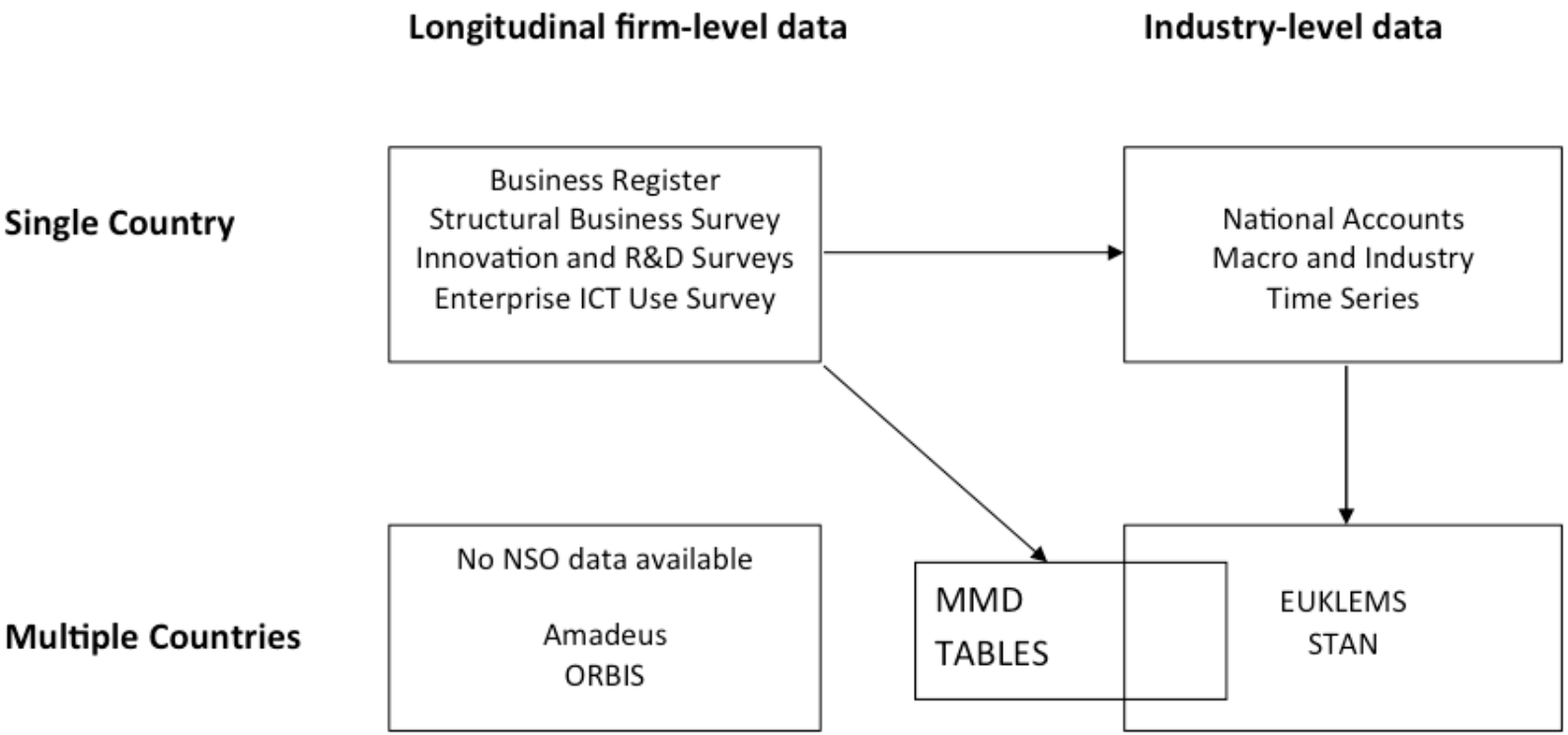
Firm Heterogeneity

- Persistently high rates of job creation and destruction (15%). Both creation and destruction occur at the same time within an industry
- Size Distribution of firms skewed to right and fat-tailed.
- Gibrat's law: the growth rate of a firm is, to a first order, independent of its size. (but: careful about age and size)
- Young firms have a small probability of survival
- Entry and Exit rates are high. And positively correlated in industry cross-section (so not a matter of industy growth or decline.)

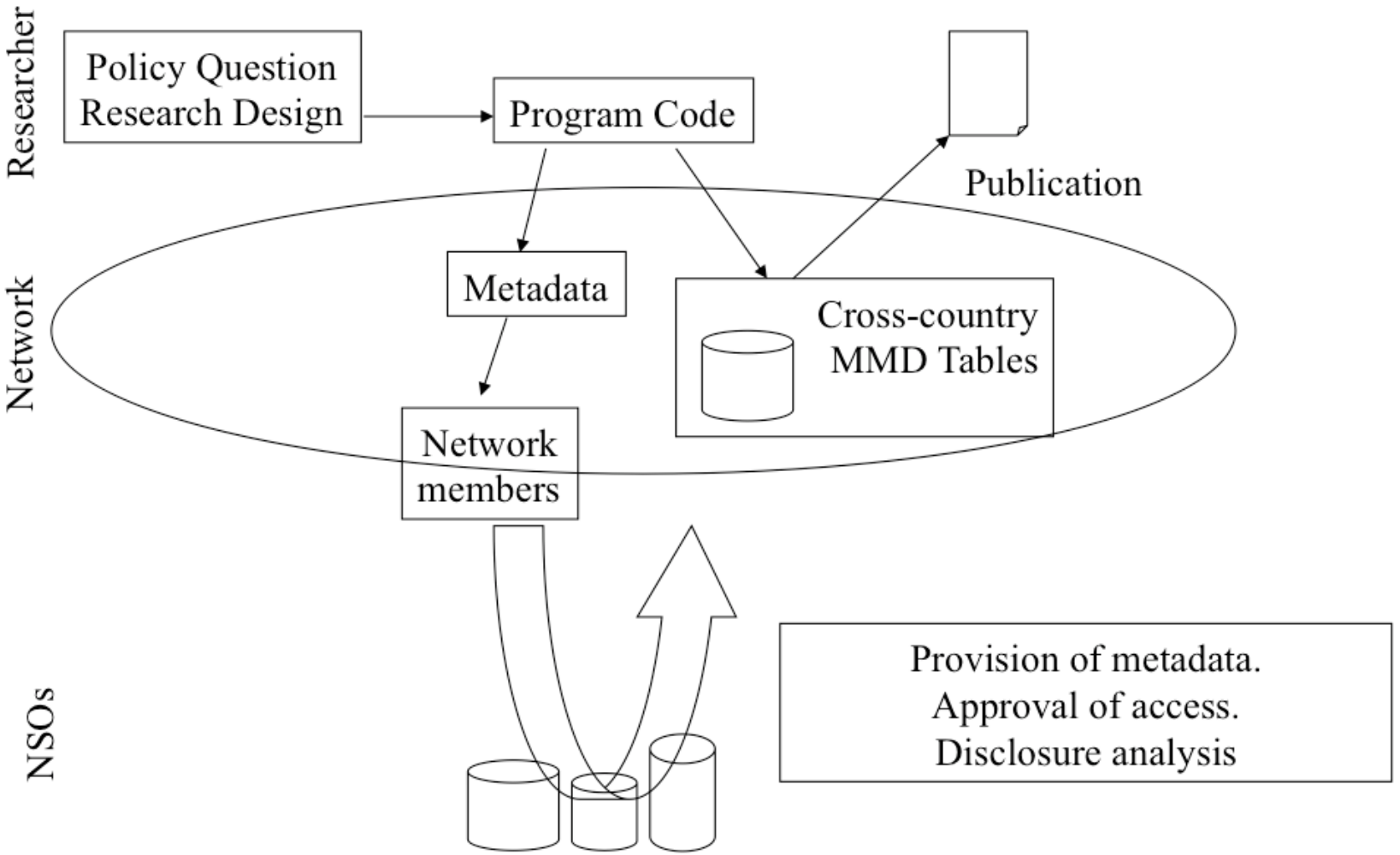
Sources of Data used in this Presentation

- Distributed Micro Data Analysis
- Method to allow cross-country analysis of confidential firm-level data
- (without actually stacking firm-level data from multiple countries)
- First used and described in Bartelsman et al. (2004)
- Since then, multiple projects at OECD, WB, Eurostat, ECB

Data for cross-country analysis



Distributed Micro Data Analysis



Source: Bartelsman, Hagsten, Polder, *JEMS 2017*

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Distributed Micro Data Projects

- OECD 2000-2002
- WorldBank 2004-2006, 8 countreis
- Eurostat MMD: 2007-2013, 14 countries, BR, ICT, CIS, Trade
- OECD DynEmp, (MultiProd)
- ECB CompNet: 2001-2013, 20 countries, 2-digit NACE, Balance sheet, trade, finance

Productivity Dispersion

- from Bartelsman and Wolf (*Handbook of Prod*, forthcoming)
- Heterogeneity in measured firm-level of productivity. Interquartile range 2-3:1, 90-10 range 4:1.
- Large share of dispersion is not attributable to observables (size, age, industry, location, ownership)
- Productivity dispersion is highly persistent
- Dispersion correlated with ICT
- Many conceptual and technical issues remain in measurement of productivity dispersion

Table 2: Dispersion in (log) TFP, EU (Eurostat), 2001-2010

	Manufacturing				Services			
	VA		GO		VA		GO	
	ALL	CO	ALL	CO	ALL	CO	ALL	CO
AUSTRIA	0.56	0.52	0.20	0.19	0.76	0.75	0.38	0.38
DENMARK	0.58	0.57	0.25	0.24	0.73	0.72	0.34	0.33
FINLAND	0.70	0.67	0.36	0.33	0.81	0.78	0.48	0.45
FRANCE	0.55	0.53	0.25	0.25	0.62	0.61	0.39	0.37
GERMANY	0.47	0.47	0.19	0.19	0.51	0.51	0.22	0.22
ITALY	0.86	0.83	0.40	0.35	1.04	1.00	0.52	0.46
NETHERLANDS	0.56	0.56	0.24	0.24	0.72	0.71	0.38	0.37
NORWAY	0.80	0.79	0.38	0.37	0.96	0.94	0.51	0.50
POLAND	1.01	0.99	0.55	0.52	1.18	1.15	0.96	0.93
SWEDEN	0.70	0.70	0.40	0.39	0.84	0.83	0.60	0.59
UK	0.76	0.74	0.45	0.43	0.98	0.96	0.60	0.58

Source: Calculated from ESSNet. see Bartelsman et al. (2015). Solow Residual measures of productivity, Value Added base or Gross Output based. ALL firms, or Continuing firms (5yr windows).

Source: Bartelsman and Wolf using MMD database

Table 2. Productivity dispersion regressed on broadband intensity.

	Levels		First-differences	
Dependent variable: $\sigma_{\log\ (Y/L)}$	Coef	se	Coef	se
Broadband intensity	0.26	0.07	0.19	0.08
Fixed effects	*c,i,t*		*c,i,t*	
R^2	0.48		0.03	
Number of observations	1719		1516	

Note: Estimating equation: $\sigma_{c,i,t} = \alpha + \gamma \mathrm{BBI}_{c,i,t} + \mathrm{FE} + \varepsilon_{c,i,t}$ where BBI is broadband intensity, and FE are fixed effects. MMD data, 2001–2010; Fixed Effects: country (*c*), industry (*i*), time (*t*); Countries: AT, DE, DK, FI, FR, IT, LU, NL, NO, SE, SI, UK; Industries: 17 1- or 2-digit, covering manufacturing, trade, finance, and business services.

Source: Bartelsman, van Leeuwen, Polder, EINT 2017.

Table 5: Correlates of Productivity Dispersion

	ESSNet Data	
	Coef	t-stat
Industry Growth	-.04	6.4
Human Capital Intensity	.75	10.6
IT Human Capital	.65	6.1
Process Innovation	.08	2.4
Product Innovation	.13	4.2
Organization Innovation	.12	3.0
New Product Turnover	.20	2.9
Broadband Intensity	.11	2.8
Pct ICT Intensive Firms	.14	2.8
Supply Chain Integration	-.10	2.0

Source: Bartelsman and Wolf. Regression of Std of prod on country, industry, time fixed effects and one technology indicator

Background on Reallocation

- Reducing dispersion (left tail), or moving resources to most productive firms would improve aggregate productivity
- Reallocation of resources is very large even in normally functioning economies
  - Resulting from the entry and exit of firms, and also from the expansion and contraction of incumbents
  - Within-sector input reallocation larger in magnitude than between sector
  - In the long-run 'Reallocation is Everything'

Conditions for Reallocation

- Imperfect substitutability on output markets
  - Market demand does not shift completely and immediately to best price/quality firm
  - Competitive structure of the market matters
  - 'Technical' frictions such as search and transport costs, but also policy and regulation, matter
- Frictions in input markets
  - Intensive (incumbent) and extensive (entry/exit) margin are not instantaneously adjusted
  - 'Technical frictions' (labor market search, asymmetric info in capital markets, fixed entry costs) but also regulation and (macro) policy matter

Overview

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Dispersion and Misallocation

- In Hsieh-Klenow (HK) model, within industry dispersion of revenue productivity is the key indicator of misallocation
- Dispersion in 'undistorted economy' is benchmark. Higher dispersion points to misallocation and the gains from removing distortions can be calculated
- Criticism on HK model is building:
  - Bartelsman, Haltiwanger, Scarpetta (AER 2013); Brown, Dinlersoz, Earle (CES WP, 2016); Bils, Klenow, Ruane (2017)
  - Std of revenue productivity only related to distortions under specific HK assumptions
  - Std of rev prod is endogenous to 'supply and demand' forces
  - 'which margin' should be used for assessing misallocation

Bartelsman, Haltiwanger, Scarpetta (AER: 2013)

- Story about Transition economies
- Transition countries had an abrupt shock tot system
- Evidence on evolution over decade varies by country
- Are there good summary measures of change in performance (productivity)?
- Are there good summary measures of policy distortions?

Three Moments

- OP cross-term
  - start with productivity decomposition:
  - $\Omega_t = \sum_i \theta_{it}\omega_{it} = \bar{\omega}_t + \sum_i (\theta_{it} - \bar{\theta}_t)(\omega_{it} - \bar{\omega}_t)$
  - OP $= \sum_i (\theta_{it} - \bar{\theta}_t)(\omega_{it} - \bar{\omega}_t)$
  - ω is firm-level (log)productivity, θ is firm share (in industry inputs)
- Standard Deviation of Revenue Labor Productivity
- Standard Deviation of Revenue TFP

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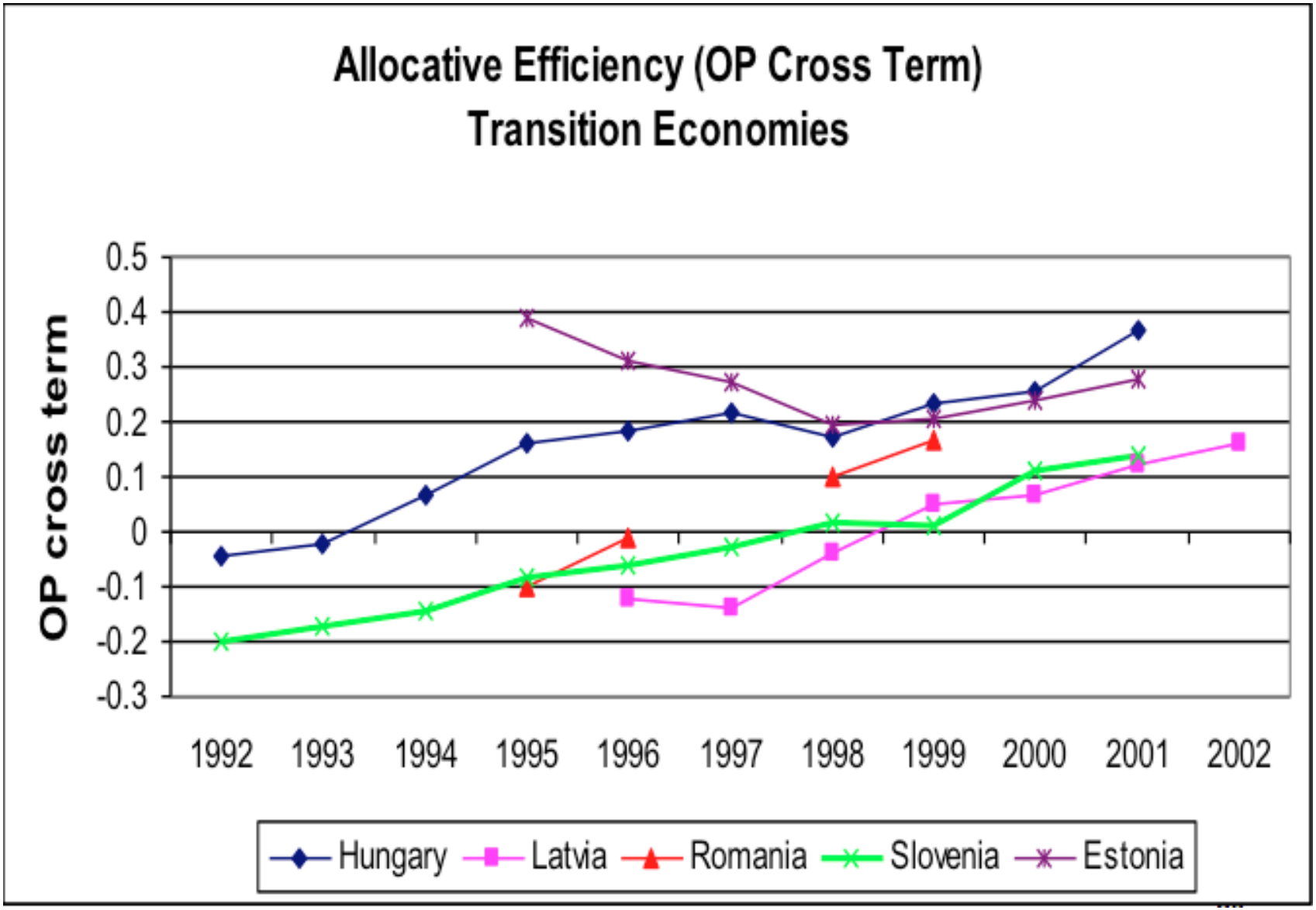
OP Cross Term



OP Cross Term

TABLE 1—WITHIN-INDUSTRY PRODUCTIVITY DISPERSION AND OP COVARIANCE TERM
(*Weighted averages of industry-level data, US industry weights*)

	STD in revenue labor productivity	STD in revenue total factor productivity	OP covariance term
United States	0.58	0.39	0.51
United Kingdom	0.59	0.42	0.15
Germany	0.71	NA	0.28
France	0.53	0.23	0.24
Netherlands	0.55	0.15	0.30
Hungary	1.04	0.92	0.16
Romania	1.05	0.55	−0.03
Slovenia	0.80	0.22	0.04

Notes: Averages over 1993–2001 data. Industry-level firm based TFP measures not available for Germany.

Source: Firm-level database; see Bartelsman, Haltiwanger, and Scarpetta (2009).

OP Cross Term

TABLE 2—CHANGES IN PRODUCTIVITY DISPERSION AND OP COVARIANCE TERM
(*Weighted averages of industry-level data, US industry weights*)

	STD in revenue labor productivity	STD in revenue total factor productivity	OP covariance term
United States	0.02	0.00	0.09
United Kingdom	0.04	0.03	0.06
Germany	0.06	NA	0.14
France	NA	NA	NA
Netherlands	0.01	0.00	0.11
Hungary	−0.02	−0.03	0.18
Romania	0.03	−0.03	0.25
Slovenia	−0.06	−0.02	0.16

Notes: Change is difference in moments between the average value in 1997–2001 and the average value in 1993–1996. Data for France available only from 1992 to 1995 and for the United States for 1992 and 1997.

Source: Firm-level database; see Bartelsman, Haltiwanger, and Scarpetta (2009).

Allocation versus Selection

- Resource Allocation channel of distortion is available in RR and HK
- distortions put wedge bewteen marginal revenue product and marginal cost
- In HK, std(LPR) and std(TFPR) are proportional to distortion dispersion, and LPR would be constant across firms without distortions and overhead labor
- In our model std(LPR) correlated with std(TFPQ) even without distortions
- because of overhead labor, quasi-fixed capital and selection

$$LPR_i = \frac{P_i Y_i}{n^*} = \frac{C}{1-\tau_i} - \frac{Cf}{(1-\tau_i)n^*}$$

Uncorrelated Distortion

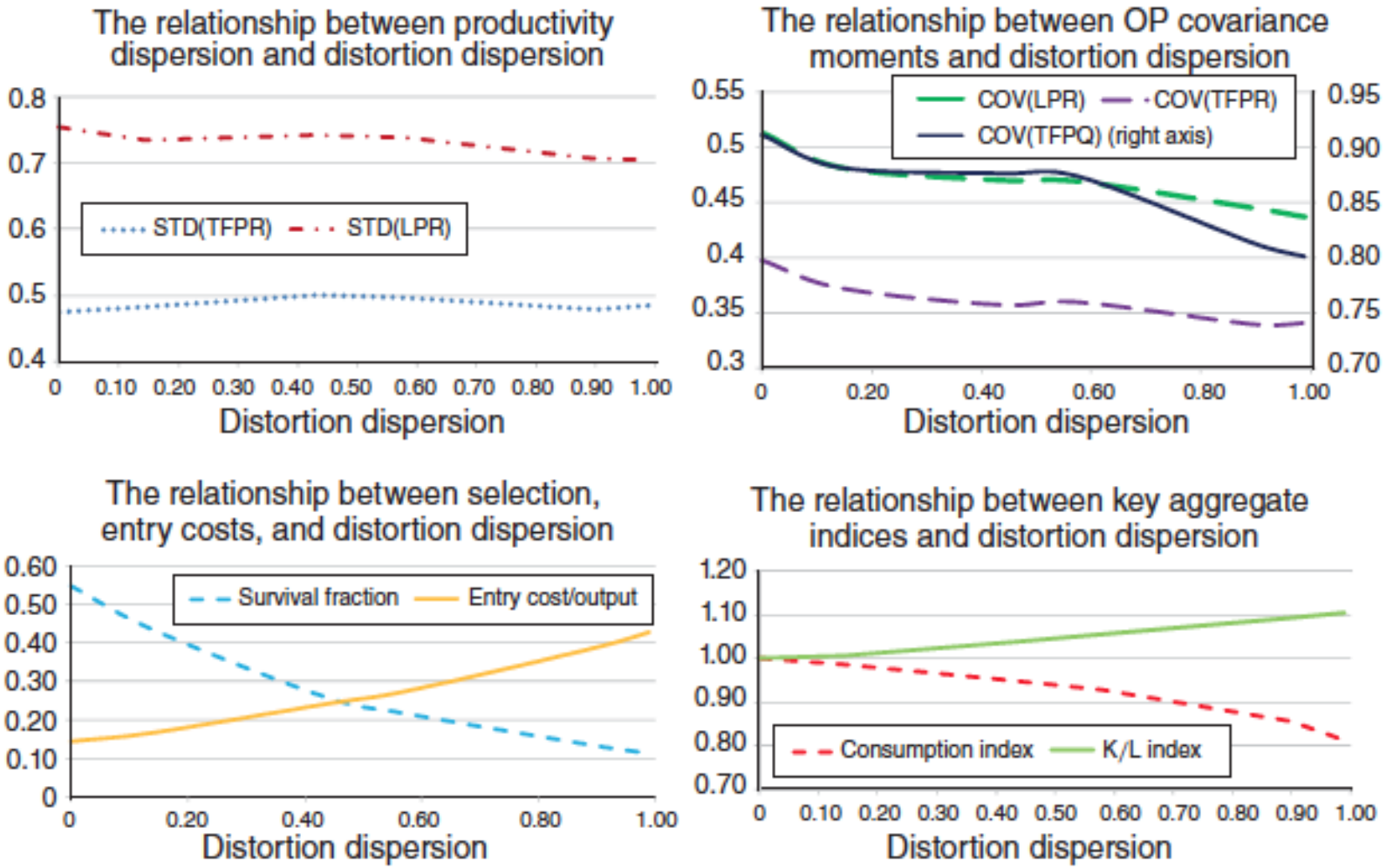


FIGURE 2. THE RELATIONSHIP BETWEEN KEY MOMENTS AND OUTCOMES WITH DISTORTION DISPERSION
(*Uncorrelated case*)

Endogenous Dispersion:

- Bartelsman, Gautier, de Wind (IER, 2016) on Empl Protection and Growth
- 2 technologies/ sectors compete for workers
  - 0: safe sector, known technology and productivity (i.e. Pissarides, 2000)
  - 1: risky sector, gets draws from prod. distribution (i.e. Mortensen Pissarides, 1994)
- Labor market states: unemployment, employed in safe sector, employed in risky sector
- Why productivity dispersion? $->$ Search frictions
- Employment Protection (EPL) makes using the risky technology more expensive.

Endogenous Productivity Dispersion

The variance of output per worker depends on shocks z and endogenous exit threshold

$$\begin{aligned}\widehat{\sigma}^2 &= s\frac{1}{1-F\left(x_d\right)}\int_{x_d}^{\infty}\left(y+z-\widehat{y}\right)^2 dF\left(z\right)+\left(1-s\right)\left(y-\widehat{y}\right)^2 \\ &= \frac{\lambda}{\delta+\lambda}\left(\int_{x_d}^{\infty}z^2 dF\left(z\right)-\frac{\lambda}{\delta+\lambda}\left(\int_{x_d}^{\infty}z dF\left(z\right)\right)^2\right).\end{aligned}$$

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Productivity Enhancing Reallocation

- Bartelsman, Lopez-Garcia, Presidente, work in progress (CompNet)
  - On average reallocation is productivity-enhancing
  - Differences across countries are found to be correlated with size distribution of firms and market regulation
  - The process of productivity-enhancing reallocation (PER) is enhanced over the cycle
  - However, the great recession (GR) was different from other cycles: PER was significantly lower. Related to trade collapse and credit crunch

Costs/Benefits of Reallocation

- Costs/benefits of reallocation are subject to trends, e.g. changes in technology
  - They can differ across countries due to *economic structure and framework conditions* Large literature on impact of market distortions: Hsieh and Klenow (2009), Restuccia and Rogerson (2008), Bertola and Rogerson (1997), Bernanke et al. (1996)
- And may vary over the *cycle*
  - Reallocation is less costly in downturns, although some distortions may make it more costly
  - Costs/benefits dynamics over the cycle might depend on the underlying causes and magnitude of shocks
  - Might differ for reallocation of labour and of capital

Data used in the paper

- Observations for 25 'representative firms' based on three-year transitions from/to quintiles of the firm size distribution
- The dependent variables: employment and capital growth over 3-year windows of median of all firms in each transition matrix cell (representative firm)
  - Firms are 3-year survivors*
  - Countries: BE, FI, SP, IT, SI, EE; 8 macro sectors; 12 years (2001-2012)
- Main independent variable: average productivity (TFP) of firms in transition matrix 'cell' in initial year of window. Median financial position of firms also available.
- Other variables from CompNet project: Herfindahl indexes, price-cost mark-ups, credit constraints (various measures)

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Average Employment growth (pct) in transition matrix cells

$\frac{Q_{i,t}}{Q_{i,t-3}}$	$Q1_t$	$Q2_t$	$Q3_t$	$Q4_t$	$Q5_t$
$Q1_{t-3}$	6%	24%	49%	86%	170%
$Q2_{t-3}$	-19%	0%	16%	45%	113%
$Q3_{t-3}$	-32%	-14%	-1%	17%	81%
$Q4_{t-3}$	-45%	-31%	-16%	-2%	40%
$Q5_{t-3}$	-58%	-47%	-36%	-20%	0%

Q1: smallest firms, Q5: largest.

Baseline Specification

$$\Delta x_{i,c,s,t} = \beta_1 \Delta \text{cycle}_{c,s,t} + \beta_2 \text{Rel. prod}_{i,c,s,t-3} + \gamma \text{FE} + \varepsilon_{i,c,s,t} \quad (1)$$

- Δ gives 3 year growth
- x is either capital or labor
- Cycle given by 'downstream demand indicator'
- Rel. prod gives log of productivity relative to industry mean in initial year.
- FE are fixed effects. Now: C, I, T, Sz_{-3}, CxI, IxSz_{-3}

Baseline estimates of PER

VARIABLES	(1) ΔL	(2) ΔK
Δ Cycle	0.203***	0.321***
	(0.0564)	(0.0917)
Rel. prod$_{t-3}$	0.752***	0.507***
	(0.0706)	(0.0454)
Constant	0.365***	0.246***
	(0.0313)	(0.0311)
Observations	7,924	7,924
Adjusted R-squared	0.399	0.342
Fixed Effects	YES	YES
FE: Country*sector; sector*size; year		
Robust standard errors in parentheses		
*** p¡0.01, ** p¡0.05, * p¡0.1		

PER Interacted with Regulatory Indicator

	Regulatory Indicator*	Employment growth	Capital growth
PMR	PMR (OECD)	-0.184***	-0.177***
	Legal barrier to entry (OECD)	-0.162***	-0.143***
	State control (OECD)	-0.166***	-0.149***
	Barriers trade-investment (OECD)	-0.136***	-0.119***
	Regulatory impact of services (OECD)	-0.238***	-0.111*
	Days needed to start a business (WB)	-0.0712***	-0.104***
	Costs to start a business (WB)	-0.0396*	-0.0204
	PC: start a business (WB)	-0.0771***	-0.0441**
	Cost of starting a business (WEF)	-0.0316	-0.000714
LMR	EPL (OECD)	-0.124***	-0.110***
	Hiring and firing regulation (WEF)	-0.0263	-0.0479
	Centralized bargaining (WEF)	-0.0131	-0.0423
	Union denstity (OECD)	0.000433	-0.0508
OTHER	Bureaucracy cost (WEF)	-0.0574***	-0.0625***
	PC: Insolvency costs	-0.0346**	-0.0428**
	PMR=1 and EPL=0**	-0.145**	-0.151**
	PMR=0 and EPL=1**	0.0470	0.0565

*Coefficient on indicator*Relprod; **Reference category is PMR=0 and EPL=0

PER over the Cycle

VARIABLES	(1) cycle	(2) $cycle_{GR}$	(3) $cycle_{GR}$	(4) precrisis	(5) crisis
Δ cycle	0.260***	0.0895	0.178	-0.0583	0.159
	(0.0553)	(0.0946)	(0.109)	(0.141)	(0.133)
cycle*GR		0.259**	0.180		
		(0.117)	(0.115)		
Rel. $prod_{t-3}$	0.937***	0.890***	1.001***	1.042***	1.011***
	(0.0837)	(0.0889)	(0.0845)	(0.0994)	(0.0884)
Relprod*GR		0.0449**	-0.0438		
		(0.0208)	(0.0355)		
Relprod*cyle	-0.907**		-2.048***	-3.057***	0.426
	(0.350)		(0.544)	(0.710)	(0.435)
Relprod*cyle*GR			2.307***		
			(0.636)		
Observations	8,087	8,087	8,087	4,539	3,548
Adjusted R-squared	0.475	0.473	0.479	0.464	0.502
Fixed Effects	YES	YES	YES	YES	

FE: Country*sector; sector*size; year
Robust standard errors in parentheses
*** p¡0.01, ** p¡0.05, * p¡0.1

Reallocation over the GR

The process of productivity-enhancing reallocation slowed down over the GR. Why?

- Clues
  - Same finding for the US and the UK (Haltiwanger et al. (2014), Barnett et al (2014)
  - Only happened during the first phase of the crisis (2008-2011). Thereafter, cleansing over the cycle returned to 'normal' parameters — differences in bust vs slow recovery
  - It happened only amongst the smallest and the largest size classes – regression by size class
- Suspects:
  - Trade collapse: it affected large productive firms who saw their demand collapse had to downsize?
  - Credit crunch: Decreases cleansing when affects not only low but also high productive firms small/young productive firms?

Indirect Path from Reallocation to Growth

- Resource flexibility and markets with substitutability may effect firms choice of innovation strategy
- Even if investment is risky, leveraging upside increases expected returns
- One needs appropriate data to track micro choices, allocation and selection, and macro outcomes
- Bartelsman, Hagsten, Polder (JEMS forthcoming); Bartelsman, van Leeuwen, Polder (EINT 2017)

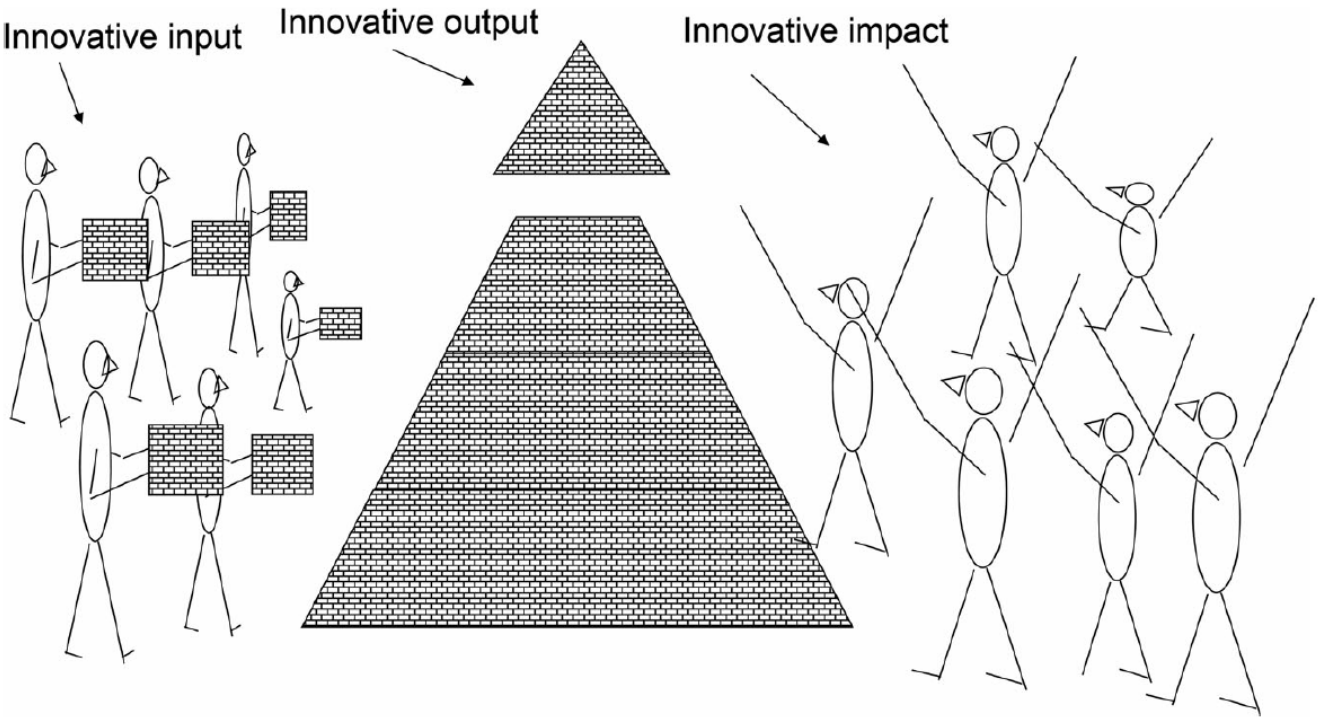

Figure 1. The CDM approach.

Source: Bartelsman, van Leeuwen, Polder, (EINT 2017)

Table 3. Marginal effects (ME) Probit regressions for product innovation.

	Averaged data		Aggregated data	
Dependent variable: product Innovation	ME	se	ME	se
Broadband intensity	2.29	0.41	2.02	0.28
Electronic buying	0.14	0.29	−0.49	0.21
Electronic selling	1.05	0.29	0.78	0.17
ICT human capital	8.15	0.81	4.42	0.52
Size	0.00	0.00	0.00	0.00
Reallocation	0.34	0.19	0.10	0.17
Fixed effects	*c,i,t*		*c,i,t*	
Likelihood	−184.4		−226.8	
Number of observations	732		732	

Note: MMD data, 2002–2010; Fixed effects are for dimensions country (*c*), industry (*i*), and year (*t*); Countries: AT, DK, FI, FR, IE, IT, LU, NL, NO, PL, SE, SI, SK. Industries: Six sectors; manufacturing of consumption goods, manufacturing of intermediate goods, manufacturing of electronics and telecommunication equipment, manufacturing of other investment goods, finance, trade, and other distributional services.

Source: Bartelsman, van Leeuwen, Polder, (EINT 2017)

Table 4. GMM Productivity regression with product innovation.

	Averaged data		Aggregated data	
Dependent variable: log (*Y/L*)	Coef	se	Coef	se
log (*K/L*)	0.02	0.02	0.09	0.02
log (*L*)	0.06	0.03	0.01	0.05
ICT human capital	0.69	0.31	1.07	0.23
Reallocation	0.32	0.06	0.60	0.07
Innovation (dummy)	0.03	0.06	0.12	0.07
Fixed effects	*c,i,t*		*c,i,t*	
R^2	0.53		0.6	
Number of observations	634		636	

Note: MMD data, 2001–2010; fixed effects are for dimensions country (*c*), industry (*i*), and year (*t*). Countries: AT, DK, FI, FR, IE, IT, LU, NL, NO, PL, SE, SI, SE. Industries: six sectors; manufacturing of consumption goods, manufacturing of intermediate goods, manufacturing of electronics and telecommunication equipment, manufacturing of other investment goods, finance, trade, and other distributional services.

Source: Bartelsman, van Leeuwen, Polder, (EINT 2017)

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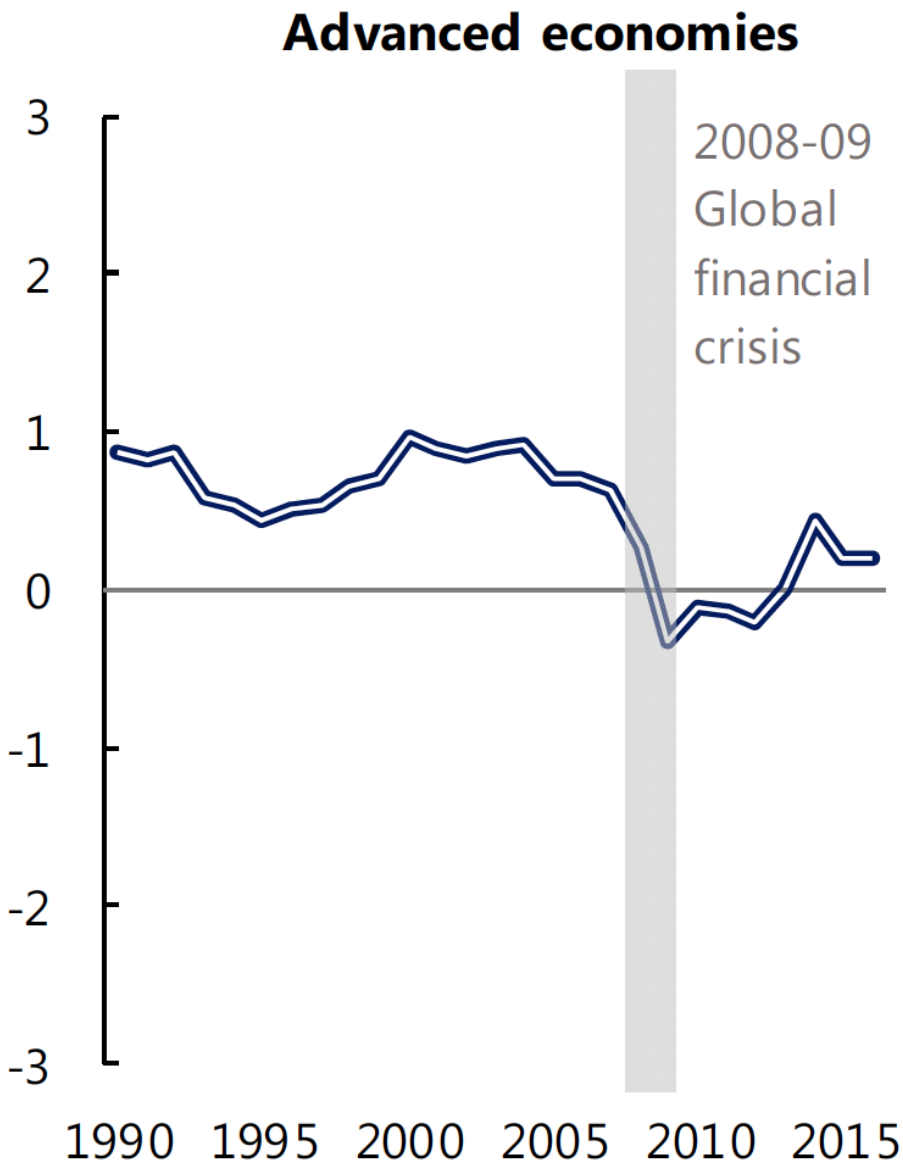
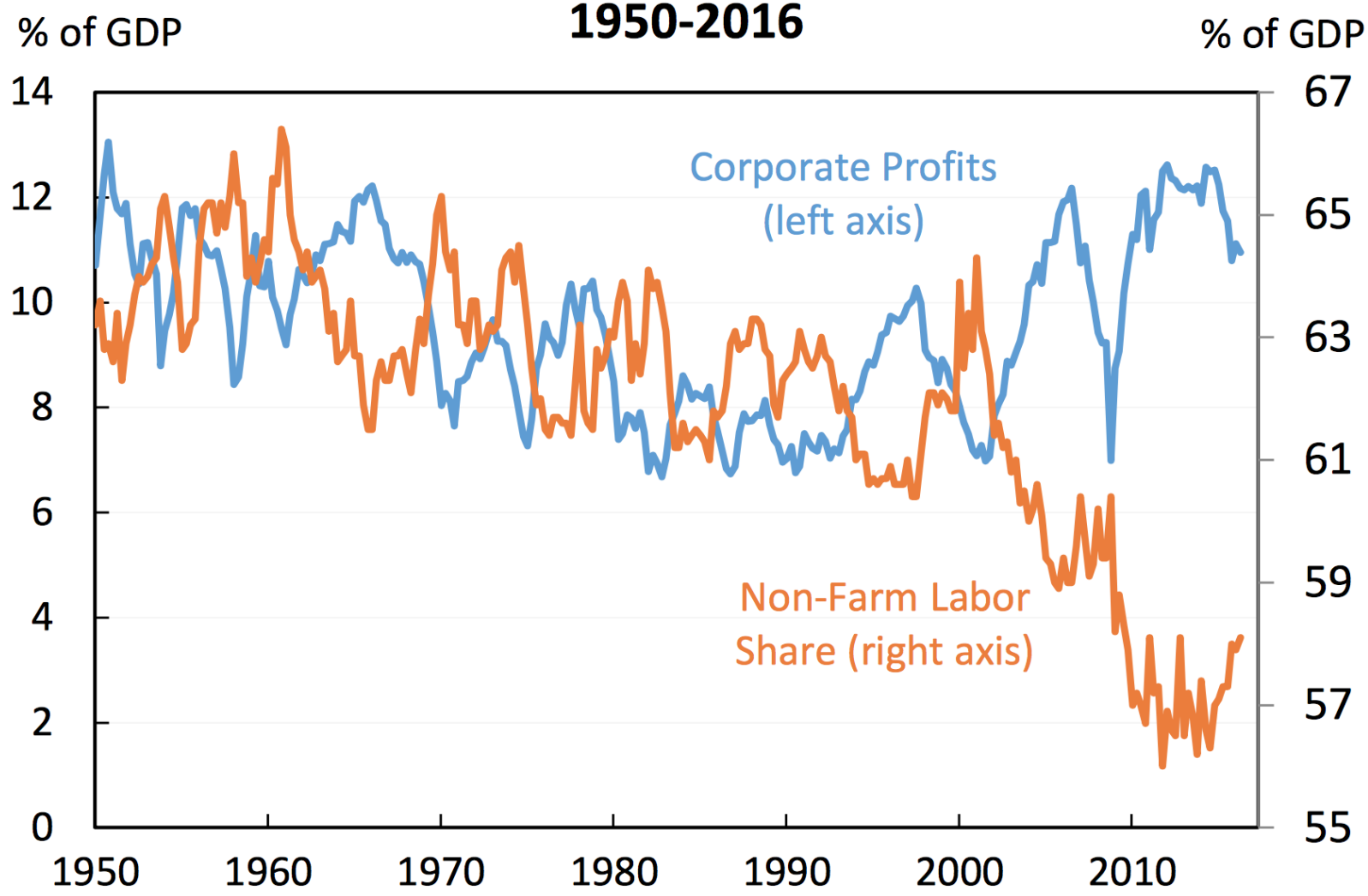
TFP Time series, declining trend



Labor Share of Income declining

Figure 5: Non-Farm Labor and Corporate Profits Share of GDP, 1950-2016



Source: Bureau of Economic Analysis, Bureau of Labor Statistics; CEA calculations

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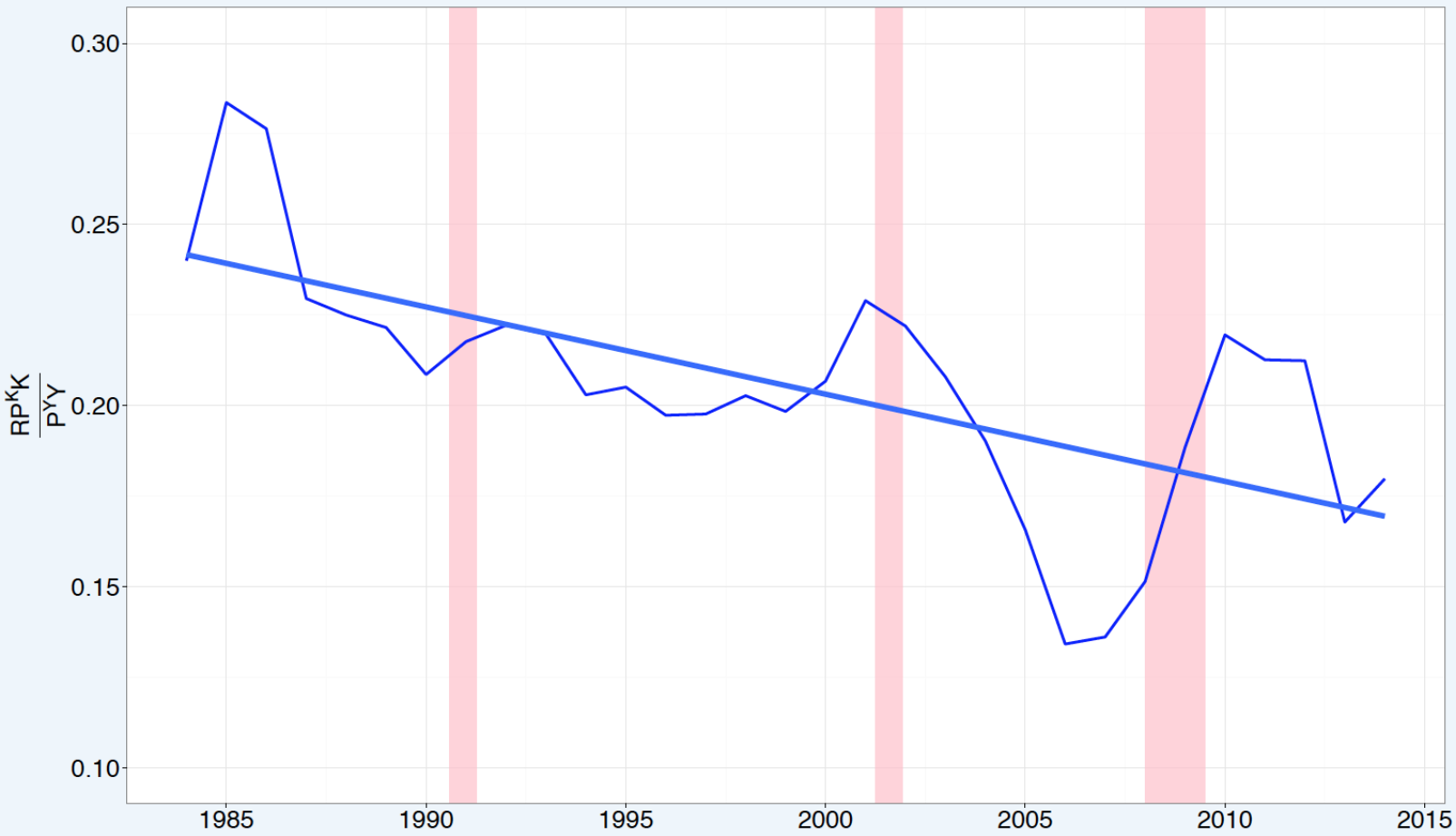
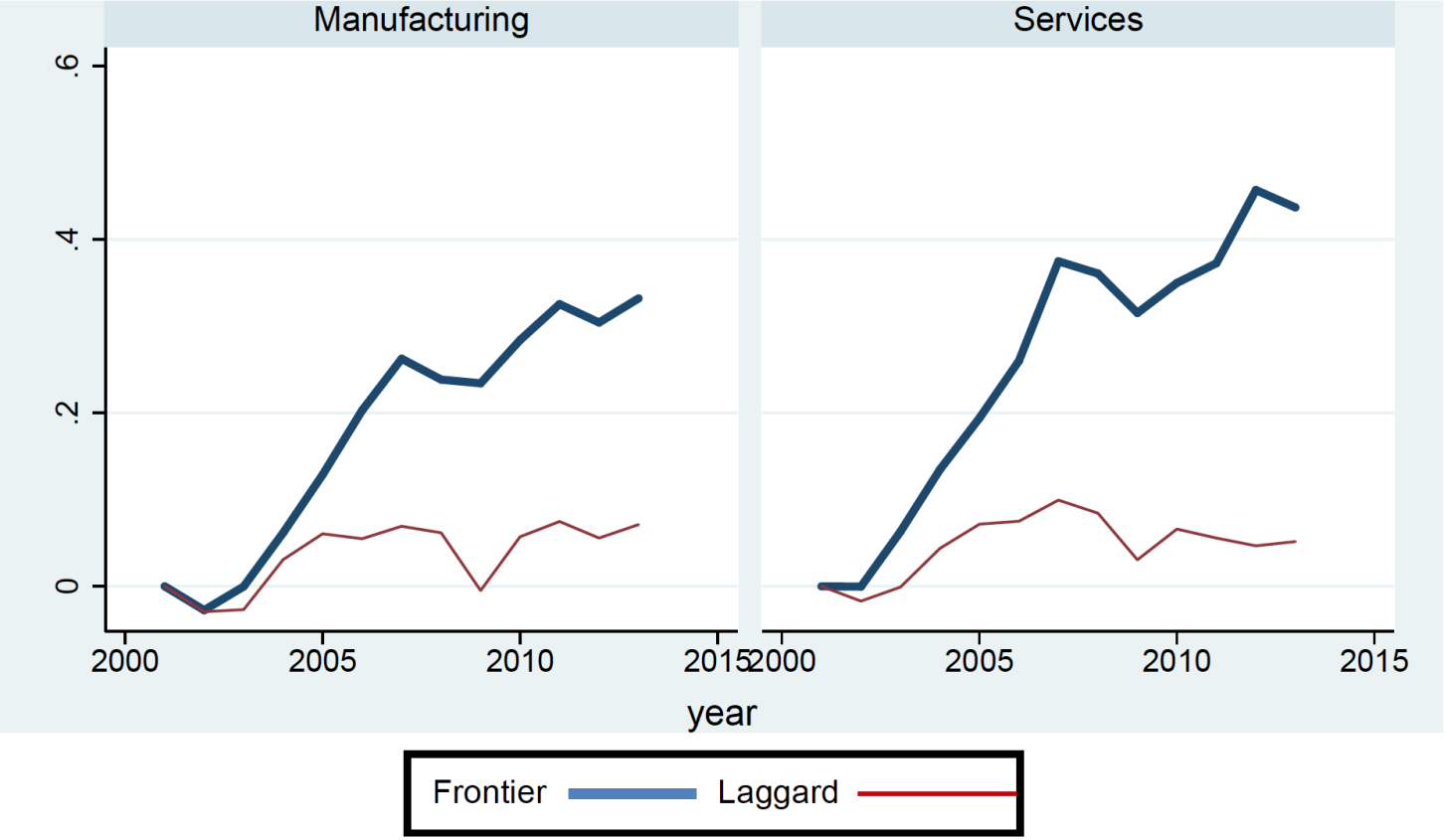
Capital Share of Income



Source: Simchas Barkai (2017)

Frontier Growth is Robust

FIGURE 2. DIVERGENCE BETWEEN THE FRONTIER AND THE REST: LABOUR PRODUCTIVITY



Source: Andrews, Criscuolo, Gal (2106)

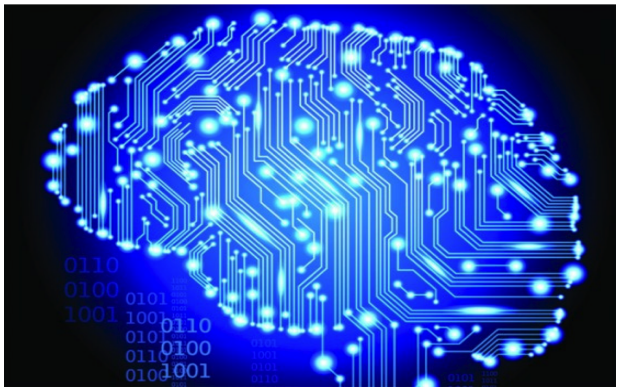
What can explain these features?

- Rapidly Changing Technology!
- Not just innovation shifting production function, but also new methods for bringing together supply and demand
- The importance of Cobb-Douglas CRTS production function in economy is waning
- In its place, high fixed (intangible) costs, low marginal cost production firms
- Or, linear, CRTS production with search costs for location in network of inputs and outputs
- ICT is changing the search/match process in ways that typical production function framework cannot quantify

The Intangible Future is Here

A Driving Vision

Eyeing the Future



Historical Prescience

A New Crop of Applications

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Economics of Intangible Capital

- Intangible assets are not rival in use
- Once an idea exists, it is not scarce
- The best idea receives large share of revenue/profit
- The share of income going to labour and traditional capital decreases
- Uncertainty concerning sales, profits, and jobs increases
- Intangible assets are difficult to tax
- Intangible assets likely a substitute for traditional capital
- Intangible investments are difficult to finance

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New Metrics to Measure Impact of Technology

- Income/wealth distribution
- Time-use studies
- Pictures over long-run (one generation) change in households (see www.gapminder.org/dollar-street)
- Measurement by layer of Maslow's Hierarchy
- Longevity; untimely death hazard;
- Reductions in uncertainty, jealousy, regret, stress

My Consensus Forecast: 2.5% Growth Rate for 25 years

- GDP per capita?
- Work-life balance
- Wellbeing of then future generation
- Capital vs Labor share of income
- Distributional aspects of income, consumption, wealth, power
- Societal coherence, peace, sustainability