

# Changing Production Technology

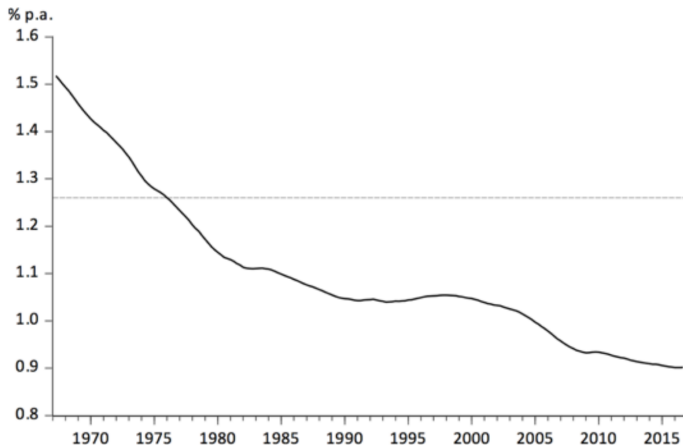
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# Declining Trend TFP Growth (US)

**Figure 1** 'Smoothed' trend TFP growth using complete sample

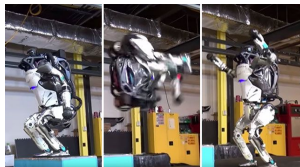


source: Crafts and Mills (2017)

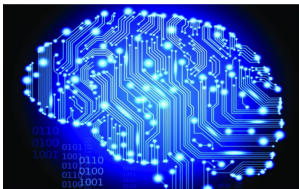
# ...juxtaposed with new technologies



Public-Private Technology



Embodied Technology



Learning Technology



Harvesting Technology

## ...and other puzzling trends

- Continued weak investment in EU (to lesser extent in US)
- Labor share of income declining
- Return to tangible capital remains low
- Mark-ups are on the increase
- Profit distribution among firms more skewed
- Global frontier growth appears robust

# Is there an explanation?

- Rapidly Changing Technology!
- Not just upward shift of production possibilities or interactions between factors.
- The familiar neoclassical 'production technology'  $AF(K, L)$  no longer matches facts.
- Romer-style aggregate growth models also have trouble explaining recent trends
- Lucas/Hopenhayn/Melitz production with fixed intangible investment, stochastic productivity and firm dynamics (entry, optimal size, exit).
- The new production technologies have implications for economics and legal institutions and for individual and societal choices

# Production Technology with Intangibles

- Features of Hopenhayn (1992) production technology:
  - Initial intangible investment generates productivity draw
  - Ex-ante expected profit is zero, and profit among incumbents is skewed
  - Equilibrium with entry/exit and heterogeneous incumbent firms
- With change to new production technology, we are observing:
  - Volatility of firm outcomes increase with use of new technology
  - Share of intangibles in total investment increases
  - Income share of flexible factors decrease
  - Total rents increase and distribution becomes more skewed

# Will measured TFP growth remain low?

- Crafts: This question fits into the 'too difficult' box.
- Technology for the coming decade is mostly available now
- Its productivity impact may be mismeasured
  - Relationship between producer and consumer surplus shifting
  - Blurring of GDP-production and asset boundaries
- Allocation and selection mechanisms are key
  - Doubling in a generation: 2.5% per annum growth. But, could be higher or lower.
  - Are entrants innovative?
  - Do markets allow strong reallocation to highly productive firms

# Example: Productivity Enhancing Reallocation in Europe

- Bartelsman, Lopez-Garcia, Presidente (2018) using CompNet data:
- $\Delta x_{i,c,s,t} = \beta_1 \Delta \text{cycle}_{c,s,t} + \beta_2 \text{Rel.prod}_{i,c,s,t-3} + \gamma \text{FE} + \varepsilon_{i,c,s,t}$
- Do resources flow to more productive firms?
  - $\Delta$  gives 3 year growth;  $x$  is either capital or labor
  - Rel.prod gives log of productivity relative to industry mean in initial year.
  - Cycle is an exogenous 'downstream demand indicator'
  - $i$ , denotes a 'representative firm' (one of the 25 transition cells);  $c$ : country;  $s$ : sector;  $t$ : year
  - FE are fixed effects: CxSxSz<sub>-3</sub>, CxT, SxT



# Baseline estimates of PER

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

VARIABLES	(1) $\Delta L$	(2) $\Delta K$
$\Delta$ Cycle	0.039 (0.0304)	0.185*** (0.0465)
Rel. prod <sub>t-3</sub>	0.815*** (0.0845)	0.483*** (0.0616)
Observations	8,064	8,064
Adjusted R-squared	0.489	0.503
Fixed Effects	YES	YES

FE: Country\*Sector\*Size<sub>-3</sub>; Country\*Year; Sector\*Year

Robust standard errors in parentheses

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

# Cross-country differences in PER: the role of regulation

... +  $\beta_3$  Rel.prod<sub>*i,c,s,t-3*</sub> Regulatory Indicator Dummy<sub>*c,s,t-3*</sub>...

Regulatory Indicator*	$\Delta L$	$\Delta K$
Concentration of sales, top-10	-0.231*	-0.175**
Herfindahl index	-0.194	-0.155*
Price-cost margin	-0.211*	-0.133
Employment Protection (OECD)	-0.659**	-0.003

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

- Stimulate the production of new ideas and new technology: *IP and market power vs open source+*
- Encourage firms to invest in (adopt) welfare enhancing technology: *carrot and stick; flexible markets*
- Keep circular flow of consumption and production going smoothly: *income distribution, watch for winner-take-all*
- Allay societal fears about jobs, income, future: *clear and factual narrative*
- Encourage socially beneficial aspects of new technologies: *well regulated platforms and directed innovation*

- Beware of hypes: AI is not yet 'general', but solves very specific problems
- Don't worry unduly about 'singularity', or machines taking over.
- Beware of anthropomorphic actions attributed to machines (learn, think, imagine, describe)
- Positive spillovers often are balanced by negatives
- Consider long adoption lags
- Don't overestimate the near future and don't underestimate the longer horizon

see: Rodney Brooks (2017)