Discussion of Do R&D and ICT Affect Total Factor Productivity Differently?

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Overview

- How – and when – do R&D and ICT capital affect total factor productivity?
- Impacts on TFP are here called “indirect” effects, as the direct effects of these capital have already been removed in the estimation of TFP
- Briefly, the authors argue that TFP is affected contemporaneously indirectly by R&D, and with a decade long lag, indirectly by ICT

Bottom line:

- R&D impacts are hard to capture
- More important result:
  - ICT, particularly software, appears to be a GPT, as argued by Basu and co-authors
  - Initially, there are expenses associated with adopting ICT that reduce TFP
  - In the longer run – 8+ years – there are important positive effects of ICT on TFP

ICT

Intended to fulfill or enable the function of information processing and communications by electronic means, including transmission and display

(OECD 2009)

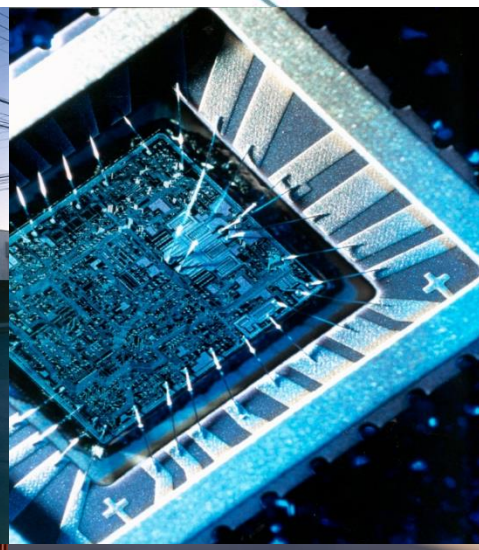
R&D

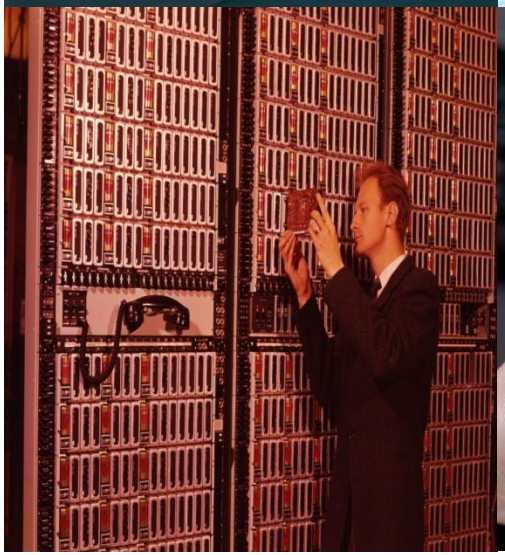
Creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society

(OECD 2002)

Overview

- ICT and R&D have been engines of growth
- Important to understand how investments in ICT and R&D affect productivity growth





Questions

- Is there any evidence of indirect effects from ICT and R&D on Swedish industry level data?
- Do investments in hardware and software affect TFP differently?

Indirect Effects

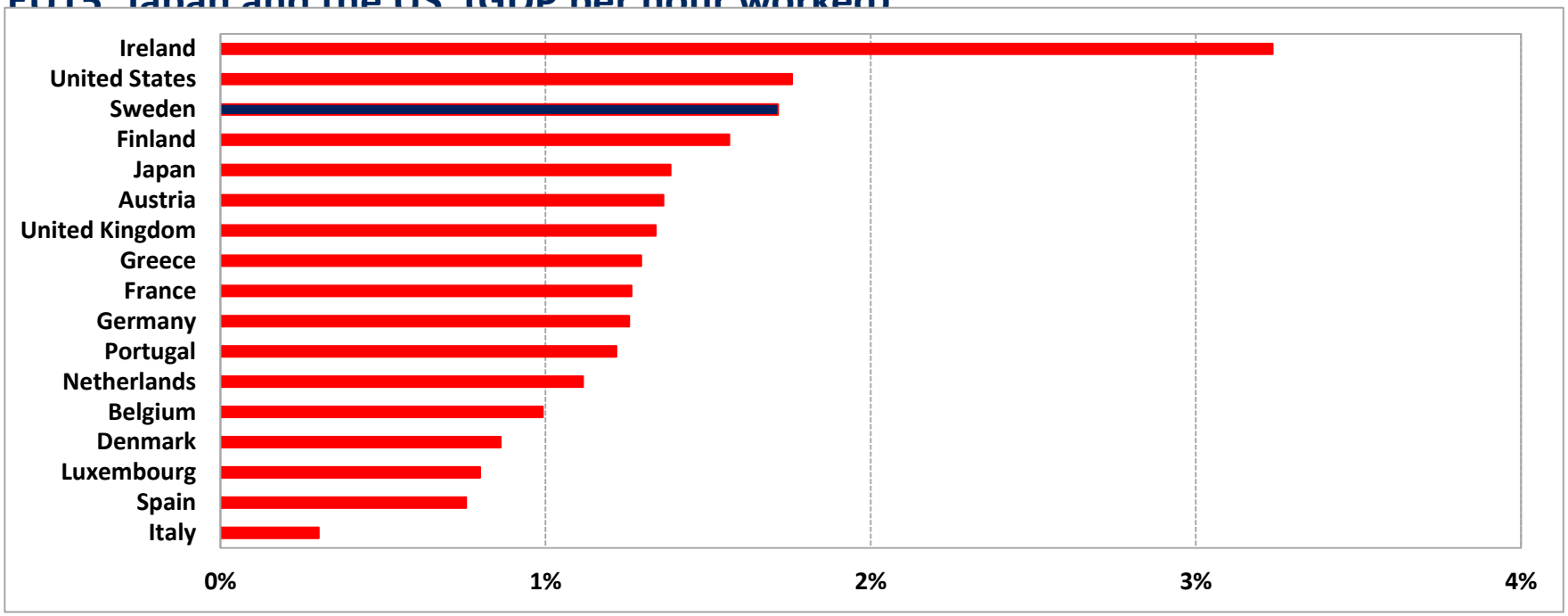
- We define indirect effects as the contribution from ICT and R&D to TFP at the industry level
  - After removing the standard direct effects
- Direct effect: Neoclassical theory predicts that ICT is a normal piece of equipment – effect on labor productivity through capital deepening
- Network effects – higher investments in ICT would result in higher TFP growth due to improved information management and more rapid diffusion of best practice

Data

- Based on Swedish National Accounts
- 47 industries for the period 1993–2013
- Value added based on double deflation
- Labor input defined as hours worked
- Capital services have been calculated for ICT, R&D and other capital

Annual Labor Productivity growth 1995–2014

EU15, Japan and the US, (GDP per hour worked)



Source: OECD (2016).

Estimating TFP

Growth accounting

Assumes: Constant returns to scale and perfect markets

$$\Delta \ln TFP_{i,t} = \Delta \ln V_{i,t} - s_{ICT} \Delta \ln K_{ICT,i,t} - s_N \Delta \ln K_{O,i,t} - s_R \Delta \ln R_{i,t} - s_L \Delta \ln L_{i,t}$$

V is aggregate value added, K_{ICT} is ICT capital, K_O is other capital than ICT and R&D, *R* is R&D capital, *L* is labor input measured in hours, all for industry *i* at time *t*.

Testing for Indirect Effects

$$\Delta \ln TFP_{i,t} = \beta_{Ict}\,\Delta \ln K_{ICT,i,t} + \beta_O\,\Delta \ln K_{O,i,t} + \beta_R \Delta \ln R_{i,t} + \beta_L \Delta \ln L_{i,t} + \delta_t + v_{i,t}$$

$\Delta TFP_{i,t}$ is the TFP growth of industry *i*,

K_{ICT} is ICT-related capital services and K_O is capital services other than ICT and R&D, *R* is R&D capital, *L* is labor input,

δ_t are year dummies, and $v_{i,t}$ is the differenced residual.

$$K_{ICT,i,t} = K_{S,i,t} + K_{H,i,t}$$

It is also possible to divide ICT capital into hardware and software, where $K_{S,i,t}$ is software capital and $K_{H,i,t}$ is computer and communications hardware capital.

Results (I)

	Dependent variable: TFP (current)	
	Drop ICT-producing	
ΔHours worked (ΔlnL)	0.08	0.08
	(0.121)	(0.121)
ΔICT capital (ΔlnK_{ICT})	–0.04	
	(0.057)	
ΔSoftware capital (ΔlnK_S)		–0.07***
		(0.021)
ΔHardware capital (ΔlnK_H)		–0.02
		(0.030)
ΔOther capital (ΔlnK_O)	–0.35***	–0.34***
	(0.089)	(0.087)
ΔR&D capital (ΔlnR)	0.10***	0.10***
	(0.030)	(0.030)
Time dummies	Yes	Yes
Adjusted R^2	0.10	0.10

Lagged Indirect Effects

Instead of changing the length of the period we include lagged periods in the analysis by dividing the sample into two time periods: 1993–2003 and 2004– 2013:

$$\Delta \ln TFP_i^{2004-2013} = \beta_{ICT}\, \Delta \ln K_{ICT,i}^{2004-2013} + \beta_{ICT} \Delta K_{ICT,i}^{1993-2003} \beta_O\, \Delta \ln K_{o,t}^{2004-2013}$$
$$+ \beta_R \Delta \ln R_i^{2004-2013} + \beta_R \Delta \ln R_i^{1993-2003} + \beta_L \Delta \ln L_i^{2004-2013} + u_{i,t}$$

Results (III)

	Dependent variable: $TFP^{2004–2013}$	
	Base case OLS	Lag ICT and R&D (OLS)
ΔICT capital (ΔlnK_{ICT})$^{2004-2013}$	–0.11	–0.23*
	(0.135)	(0.129)
ΔICT capital (ΔlnK_{ICT})$^{1993-2003}$		0.19***
		(0.068)
ΔR&D capital (ΔlnR)$^{2004-2013}$	0.20**	0.18
	(0.088)	(0.148)
ΔR&D capital (ΔlnR)$^{1993-2003}$		0.002
		(0.185)

Additional Robustness checks

- Measurement errors
- Omitted variable bias – other intangibles
- Simultaneity

My comments

- Very nice paper, easy to read, very important topic, useful results!
- Highly recommended!

Minor data issue

- Maybe adjust capital utilization for business cycle effects, as in Basu et al?
  - These are smaller for Sweden, but not nonexistent

Comments on R&D

- R&D should have lagged effects on output
  - R&D is the creation of future products.
- Why does R&D have contemporaneous effects on TFP?
  - Reverse causation. Successful R&D causes successful firm and rivals to invest in R&D
- And why only contemporaneous effects?
  - R&D is very risky. A few big wins, many failures.
  - Economic outcomes of patents are highly skewed, lognormal
  - Difficult to catch in a regression

Comments on ICT

- Is ICT a general purpose technology that requires time to digest? Very important question!
- Software investments may cause firms to invest in complementary resources
  - Learning the software
  - Developing macros
  - Adopting other technology to best use the software
- Over the longer-run, the investments pay off

Congratulations

- And thank you!