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The Role Played by ICT Human Capital in Firm Productivity

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Overview

Research question and expectations

In Brief

Point of departure

Indications of a positive relationship between firm productivity and ICT intensive human capital in group of European countries.

Motivation

Method

Descriptive data

This influence generally stronger than from ICT maturity of firms.

Results

Concluding remarks

Impacts may differ across industries and countries as well as compared with generally skilled human capital.



Research Question and Expectations

- I. Study the effects on firm performance (productivity) of ICT intensive human capital for panels of firms in SE, FI, NO, UK and FR
- II. Test for the productivity effects of ICT maturity
- III. Distinguish between services and manufacturing firms

Relationship between ICT intensive human capital and firm productivity expected, but not necessarily similar across industries or countries. Effect possibly connected to firm ICT maturity.

Potential channels for transfer of the effects: Making better use of the real capital, increased flexibility and spillovers to colleagues.



Point of Departure

Technology recognised as driver of growth in neoclassical reasoning:
Solow (1956) and (1987)

"Computers everywhere but in the productivity statistics"

Going beneath the aggregates gives clearer picture of the relationship:
Brynjolfsson and Hitt (1995, 2000)

Caroli and Van Reenen (2001)

Draca et al (2006)

Bartelsman (2008)

Firm productivity positively affected by ICT, if GPT boost might even be larger than input

Doms et al (1997)

Galindo-Rueda and Haskel (2005)

Relationship high skills, high IT, high wages, high productivity et cetera, but causality unclear



Point of Departure

Skilled human capital important too for firm productivity, but kind of skills most often neglected:

Black and Lynch (1996)

Rao et al (2002)

Durbin (2004)

Niringiye (2010)

*Increases in the level of human capital improves firm productivity.
Services firms may respond stronger.*

Ilmakunnas and Maliranta (2005)

Iranzo (2008)

Type of education of importance

Acemoglu (1998)

Gunnarsson et al (2001, 2004)

Forth and Mason (2004)

ICT complements skills





Motivation

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Relationship between kind of human capital and growth high on political agendas

ICT intensive human capital neglected input to firm production

ICT Impacts and ESSnet on Linking of Microdata on ICT Usage Projects commissioned by Eurostat

Unique cross-country dataset



Method

Generalised Cobb-Douglas

$$\ln Y_{it} = \ln A + \alpha \ln K_{it} + \beta \ln L_{it} + \varepsilon_{it}$$

Extended by firm ICT intensive and generally skilled human capital (s^l), controlling for ICT maturity (\mathbf{x}) and firm specific (vintage (\mathbf{z}) and firm characteristics (\mathbf{d}^c)) as well as aggregate (\mathbf{d}^f) productivity shocks.

$$\ln y_{it} = \beta_0 + \beta_1 \ln k_{it} + \beta_2 \ln l_{it} + \beta_3 \ln s_{it}^l + \beta_4 \mathbf{x}_{it} + \beta_5 \mathbf{z}_{it} + \beta_6 \mathbf{d}^c + \beta_7 \mathbf{d}^f + \varepsilon_{it}$$





Method

Estimation Variables

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y	LPV	Labour productivity based on value added
s^i	HK	Firm proportion of employees with all kinds of post upper secondary education
	HKITpct	ICT intensive human capital (firm proportion of employees with post upper secondary ICT intensive education)
	HKNITpct	Generally highly skilled human capital (firm proportion of employees with general post upper secondary education)
l	E	Number of employees
x	BROADpct	Firm proportion of broadband Internet enabled employees
	MOB	Firm has mobile Internet connection
z	Age	Firm age
	Age2	Firm age squared
$s^i * x$	HKBROAD	Interaction between skilled human capital and broadband Internet enabled employees
d^c		Firm specific productivity shock (dummy variables controlling for firm characteristics; size class, international experience and affiliation)
d^f		Aggregate productivity shock (dummy variables holding changes over time and industry fixed)

* ICT human capital is equalised with post upper secondary education in mathematics, physics, engineering and information technology.



Descriptive Data

Features of ESSLimit datasets

Micro aggregated data extracted from national datasets by Distributed Microdata Method, Bartelsman et al (2001, 2004)

2009	FI	FR	NO	SE	UK
Production survey (PS)	133723	39841	271711	701033	41528
ICT usage survey (EC)	2938	9389	4041	3166	5218
Linked PSEC	2924	9389	3897	3166	2071

Source: ESSLimit dataset

Linked dataset somewhat biased towards larger firms since aim of sample surveys is to cover major amount of sales rather than as many firms as possible.

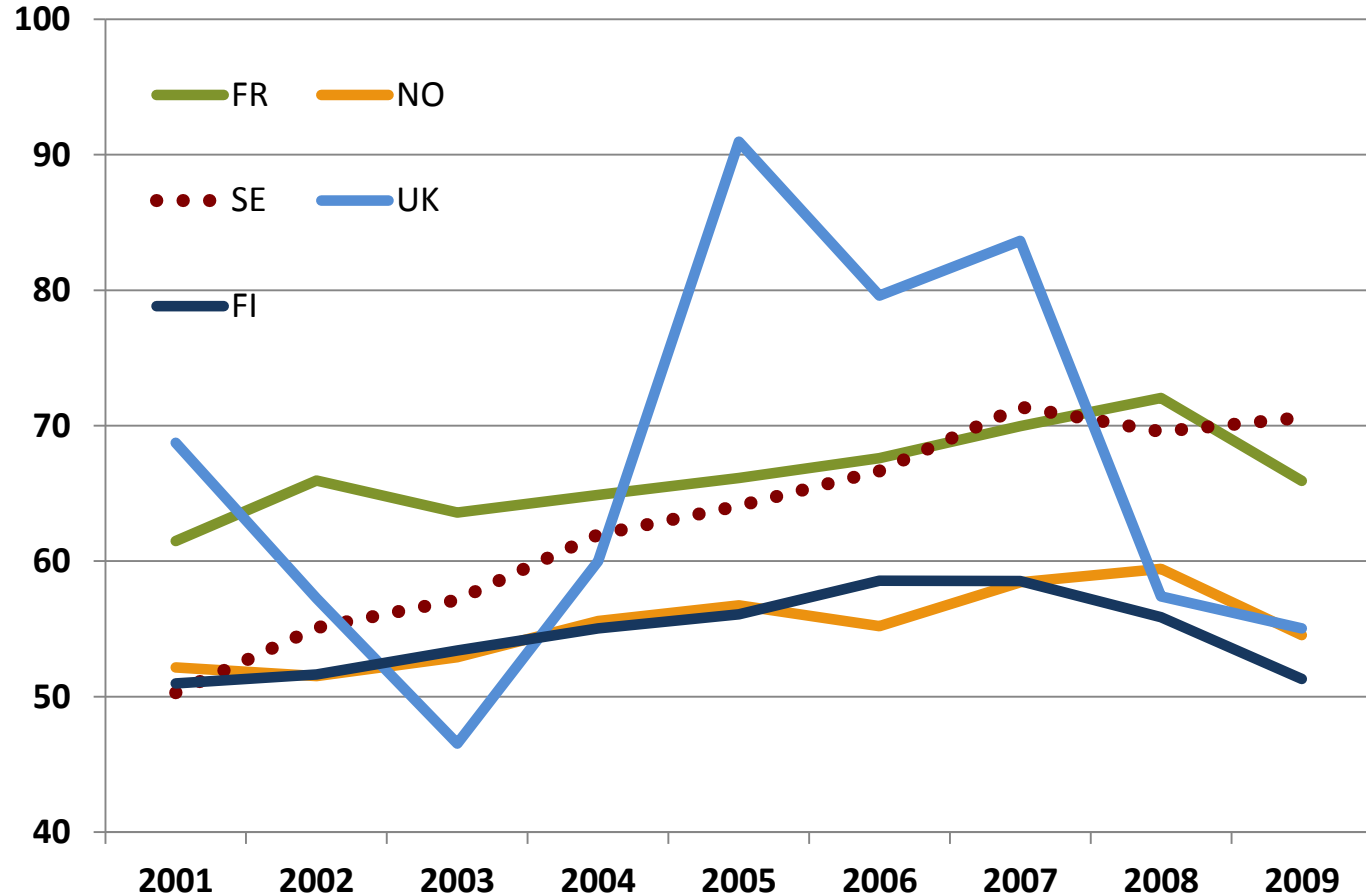
PS total surveys in some countries, EC sample survey everywhere.



Descriptive Data

Labour productivity

Euros



Weighted values

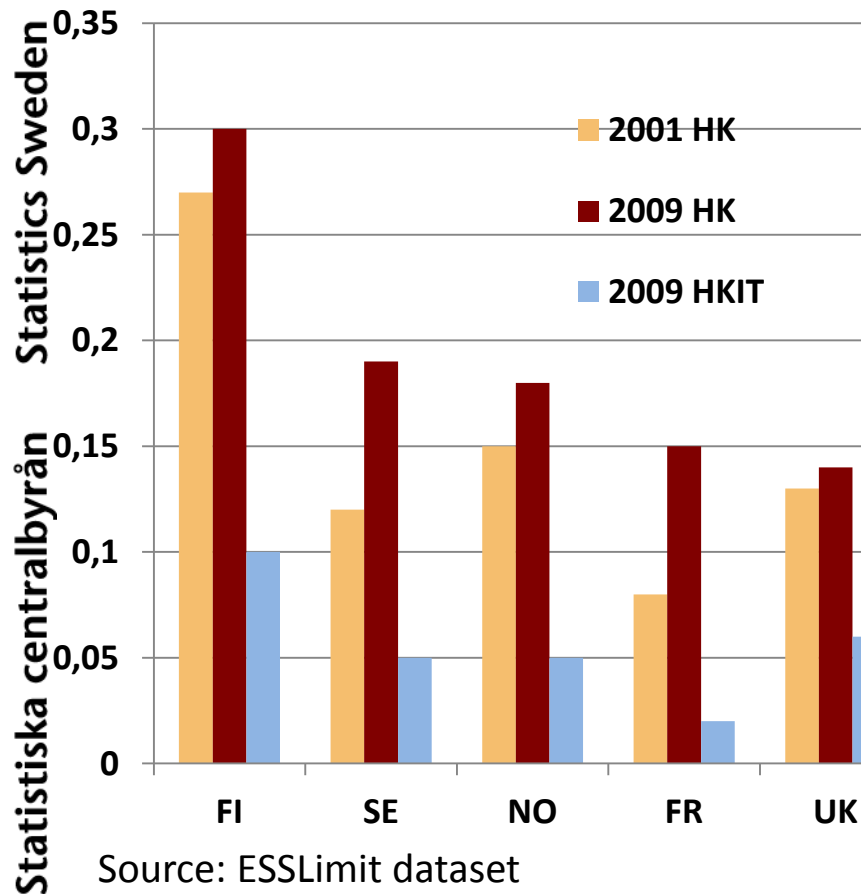
Source: ESSLimit dataset



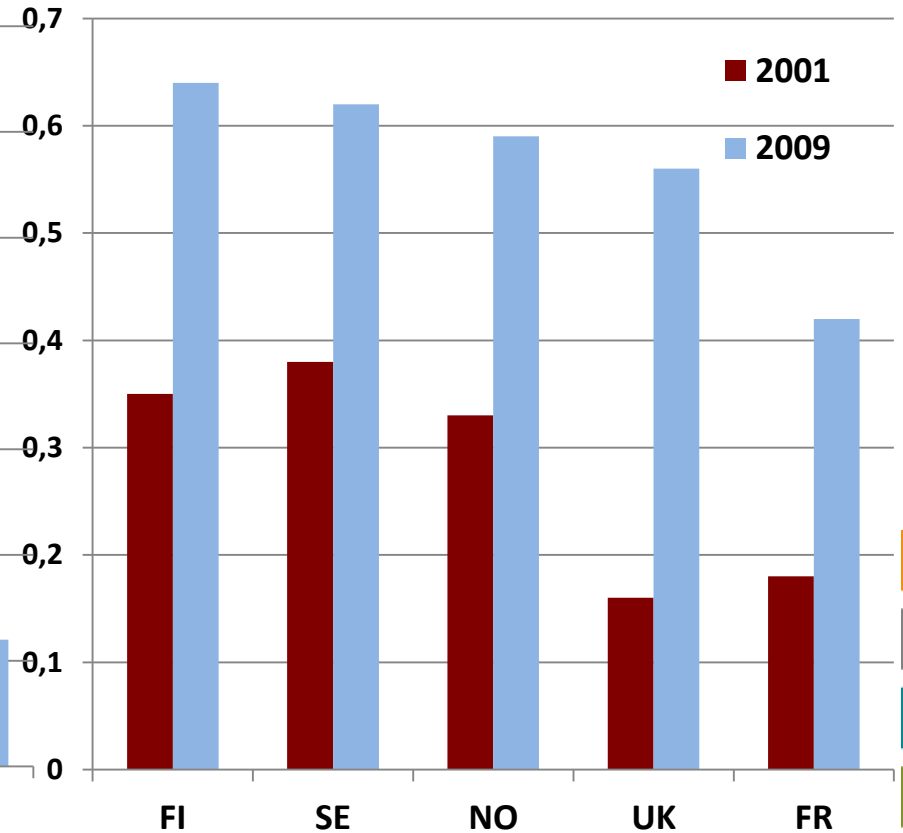


Descriptive Data: Main ICT Variables

Proportion of ICT intensive Human capital, per cent



Proportion of broad band Internet enabled employees, per cent



Source: ESSLimit dataset

Improvements over time in most countries. High in human capital also high adopter, especially so in FI.



Results: Direct Effects on Firm Productivity of ICT Human Capital

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Per cent LPV PSEC 2001-09	FI			FR			NO			SE			UK		
	1	3	5	1	3	5	1	3	5	1	3	5	1	3	5
LnE	0.862	0.857	0.856	0.907	0.899	0.894	0.980	0.975	0.975	0.952	0.949	0.947	0.977	0.985	0.976
HKITpct	0.915	0.870	0.867	0.638	0.563	0.548	0.958	0.890	0.891	0.652	0.563	0.561	0.806	0.426	0.413
HKNITpct	0.784	0.724	0.719	1.301	1.184	1.160	0.738	0.661	0.661	0.706	0.601	0.597	0.379	0.183	0.180
AGE		0.000	0.000		0.006	0.006		0.009	0.009		0.024	0.025		0.008	0.008
AGE2		0.000	0.000		0.000	0.000		0.000	0.000		0.001	0.001		0.000	0.000
BROADpct		0.068	0.064		0.212	0.198		0.120	0.119		0.173	0.168		0.830	0.802
MOB			0.023			0.085			0.021			0.026			0.130
EDF	20682	20325	20324	46441	46130	46129	15031	14685	14684	25584	24698	24697	13898	13895	13894
RSQ	0.89	0.89	0.89	0.90	0.90	0.90	0.89	0.89	0.89	0.92	0.92	0.92	0.65	0.68	0.68

Source: ESSLimit dataset

- Strongest LPV boost in FI and NO, although positive in all countries.
 - SE and FR gain more from improvements of generally skilled than ICT human capital.
 - ICT maturity deplete human capital effects slightly, except in the UK, substituted by halves.
- All estimates significant at one per cent level (except red shade not significant or yellow shade weaker significance).



Results: Direct Effects on

Firm Productivity of ICT Human Capital, by Industry



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2001-09 Per cent		Manufacturing					Services				
PSEC	LPV	FI	FR	NO	SE	UK	FI	FR	NO	SE	UK
LnE		0.974	0.938	0.933	0.988	1.102	0.787	0.877	1.002	0.953	0.962
HKITpct		0.713	0.442	1.160	0.360	0.271	0.894	0.564	0.829	0.533	0.485
HKNITpct		0.509	1.558	0.264	0.550	0.133	0.795	1.024	0.726	0.701	0.198
AGE		0.000	0.004	0.006	0.019	0.006	0.002	0.009	0.012	0.030	0.020
AGE2		0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	-0.001	-0.001
BROADpct		0.044	0.200	0.207	0.152	0.704	0.063	0.215	0.086	0.172	0.807
MOB		0.005	0.069	0.032	0.038	0.051	0.039	0.096	0.021	0.021	0.188
EDF		7744	15852	4655	7869	4381	10182	22204	8652	13499	8697
RSQ		0.90	0.92	0.89	0.93	0.73	0.88	0.88	0.89	0.91	0.66

Source: ESSLimit dataset

- Services firms drive impact on productivity. Difference s between FR and NO magnified by manufacturers.
- Weaker estimates for manufacturers (especially HKIT in FR and HKIT and HKNIT in UK).
- MOB only partly related to productivity, particularly so in UK services firms.
- Results point at importance of channels through which HKIT works.

All estimates significant at one per cent level (except red shade not significant or yellow shade weaker significance).

Results: Interaction of Highly Skilled Human Capital and ICT Maturity

2001-2009		Manufacturing					Services				
Per cent		FI	FR	NO	SE	UK	FI	FR	NO	SE	UK
PSEC	LPV										
InE		0.974	0.940	0.936	0.989	1.104	0.789	0.880	1.000	0.955	0.975
HKpct		0.708	1.658	0.596	0.887	0.293	0.753	1.102	0.522	0.534	0.214
AGE		-0.001	0.004	0.006	0.019	0.006	0.002	0.009	0.012	0.030	0.020
AGE2		0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.000	-0.001	-0.001
BROADpct		0.085	0.281	0.219	0.203	0.744	0.033	0.292	0.051	0.169	0.837
HKBROAD		-0.155	-0.486	-0.028	-0.558	-0.174	0.121	-0.331	0.268	0.098	0.104
EDF		7745	15853	4656	7870	4382	10183	22205	8653	13500	8698
RSQ		0.90	0.92	0.89	0.93	0.73	0.88	0.88	0.89	0.91	0.66

Source: ESSLimit dataset

Few indirect effects. Partly reduces productivity. Only FI and NO services firms gain.

All estimates significant at one per cent level (except red shade not significant or yellow shade weaker significance).

Concluding Remarks

- * ICT intensive human capital generally boosts firm productivity, strongest in FI and NO and among services firms (although SE and FR gain more from general skills).
- * Kind of human capital more important for manufacturers (clearly so in FR, NO and UK).
- * Channels through which ICT intensive human capital impacts productivity seem narrower than for generally skilled human capital (real capital versus flexibility and spillovers).
- * ICT maturity effect runs out of steam after a while, ICT intensive human capital does not (maybe because the level is still far lower).

High proportion		High impact	
HKIT	BROADpct	HKIT	BROADpct
FI	FI	NO	UK
UK	SE	FI	FR
SE	NO	SE	SE
NO	UK	FR	NO
FR	FR	UK	FI

- * No systematic pattern between high proportion and high impact verified except for BROADpct in UK and FR.

