Organisational Capital, ICT and Productivity in the Digital Age

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Introduction

Intangible assets play a crucial role in modern economies:

- Direct effect as production input

- Complements to new technologies and generating spillovers

The role of intangible assets has been explored both as an aggregate and as individual assets

- R&D (available in NA) and managerial skills (e.g. Bloom et al.) have received most attention in the literature.

Managerial skills are tightly related to broader investments in organisational changes, often referred to as organisational capital.

Focus of this paper
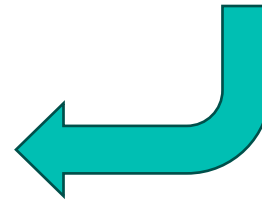
Why Organisational Capital (OC)?

1. Business management literature → OC <u>highly synergetic with new tech</u> (Bryjnolfsson and Hitt, 2000, Li et al 2006):

   - OC not only good managers but also firm's ability to manage organisational changes required by new tech

2. Broader implications on aggregate productivity growth

   - Failure to exploit OC synergies has been identified as slowing tech adoption and curbing related productivity gains

   - Tacit quality of OC may also affect productivity spillovers from intangibles

3. All this is likely to gain importance during the digital transition, chief example is ability to adapt to diffusion of AI

4. Does some of this depend on whether such OC is built up internally or acquired on the market?

Why distinguishing OC components?

1. Resourced Based View of the firm (Barney, 1991; Teece et al., 1997) gives special role to firm's <u>dynamic capabilities</u>

   - Abilities to "integrate, build, and reconfigure internal and external competences to address rapidly changing environments"→ akin to OC items covered at industry level in CHS framework

   - Can be built up internally (<u>Own-account OC</u>) or acquired on the market (<u>Purchased OC</u>)

3. Does impact on productivity depend on the source of OC acquisition?

   - Own-account and purchased OC contain qualitatively different kinds of knowledge

   - In-house firm knowledge is necessary to successfully use external knowledge and technology (Grigoriou and Rothaermel, 2015)

   - Absorptive capacity is necessary for technology adoption (Cohen and Levinthal, 1991; Griffith et al., 2003)

Empirical issue explored at industry-level

(thanks to recent CHS implementation by Bontadini et al., 2023)

Research questions and results

We exploit our OC data distinguishing between own-account and purchased OC to test the following hypotheses:

- OC is particularly important for productivity in digitalized environments
- OC built up in-house (own-account) is the key driver of productivity gains
- Own-account OC also has the strongest synergies with new technologies

We find that:

1. OC is positively associated with labour productivity growth, especially in highly-digitalized industries

2. These results are much stronger for own-account OC than for the purchased component

3. Synergies between OC and new tech are also stronger for the own-account component

Contributions to the literature

1. We provide aggregate evidence complementing a few studies using firm-level accounting data to estimate OC (Tronconi et al 2011, Papanikolau and Eisfeldt, 2009).

2. We also complement the growing firm level evidence on the synergies between OC and new tech (Van Reenen et al. 2010, Crespi et al 2007).

3. **We are the first – to the best of our knowledge – to show the key role played by own-account OC and its interplay with new technologies, digitalization and labour productivity.**

What follows

1. Data and empirical approach

2. Stylized facts

3. Main results

4. Conclusions and implications

Data: Latest release of EUKLEMS & INTANProd

Coherent set of production data embodying both NA and non-NA intangibles following the CHS framework (Bontadini et al, 2023)

- Sample of 39 manuf and non-manuf industries in 8 EU countries, UK and US over 1995-2019
- Labour productivity growth = growth of <u>adjusted</u> value added at constant prices per hour worked

Distinguish between two OC components (data not yet online but available upon request):

- Purchased OC (expenditure for legal, managerial, and accounting services)
- Own-account OC (expenditure on workers with managerial positions)

Other variables:

- industry new tech intensity = ICT assets per hour worked.
- degree of industry digitalisation → Calvino et al (2018) classification

Empirical approach

1. **Production function** estimation:

$$\Delta \ln(^Y/_H)_{ict} = \alpha_1 \Delta \ln(^{K^{I-OC}}/_H)_{ict} + \alpha_2 \, \Delta \, ln(^{K^T}/_H)_{ict} + \alpha_3 \Delta \, ln\left(^{K^{OC}}/_H\right)_{ict} + \lambda_c + \lambda_t + \lambda_i + \eta_{ict}$$

   where $^Y/_H$ = hourly labour productivity, K^{I-OC} = intangibles excluding OC, K^{OC} = OC and λ_k are industry/country/time fixed effects

2. **Augmented production function** estimation

$$\Delta \ln(^Y/_H)_{ict} = \alpha_1 \Delta \ln(^{K^{I-OC}}/_H)_{ict} + \alpha_2 \, \Delta \, ln(^{K^T}/_H)_{ict} + \alpha_3 \Delta \, ln\left(^{K^{OC}}/_H\right)_{ict} + \alpha_4 \, ln(^{K^{ICT}}/_H)_{i,avg} +$$

$$+\alpha_5 \, ln(^{K^{ICT}}/_H)_{i,avg} * \Delta \, ln\left(^{K^{OC}}/_H\right)_{ict} + \lambda_c + \lambda_t + \tau_i + \eta_{ict}$$

   where $\ln(^{K^{ICT}}/_H)_{i,avg}$ is the log of ICT intensity of each industry (averaged across countries and time)

3. For each model, we distinguish between **own-account and purchased OC** and we also estimate on **highly-digitalized industries** only

4. We test our model with both **GLS and GMM**, to reduce endogeneity and simultaneity biases

Stylized facts

- Investment in intangibles account for a rather large share of value added

- Some cross-country association between ICT and intangible investment, including OC

- Own-account and purchased OC follow different patterns across countries

Investment in intangible and ICT assets as a share of adjusted value added
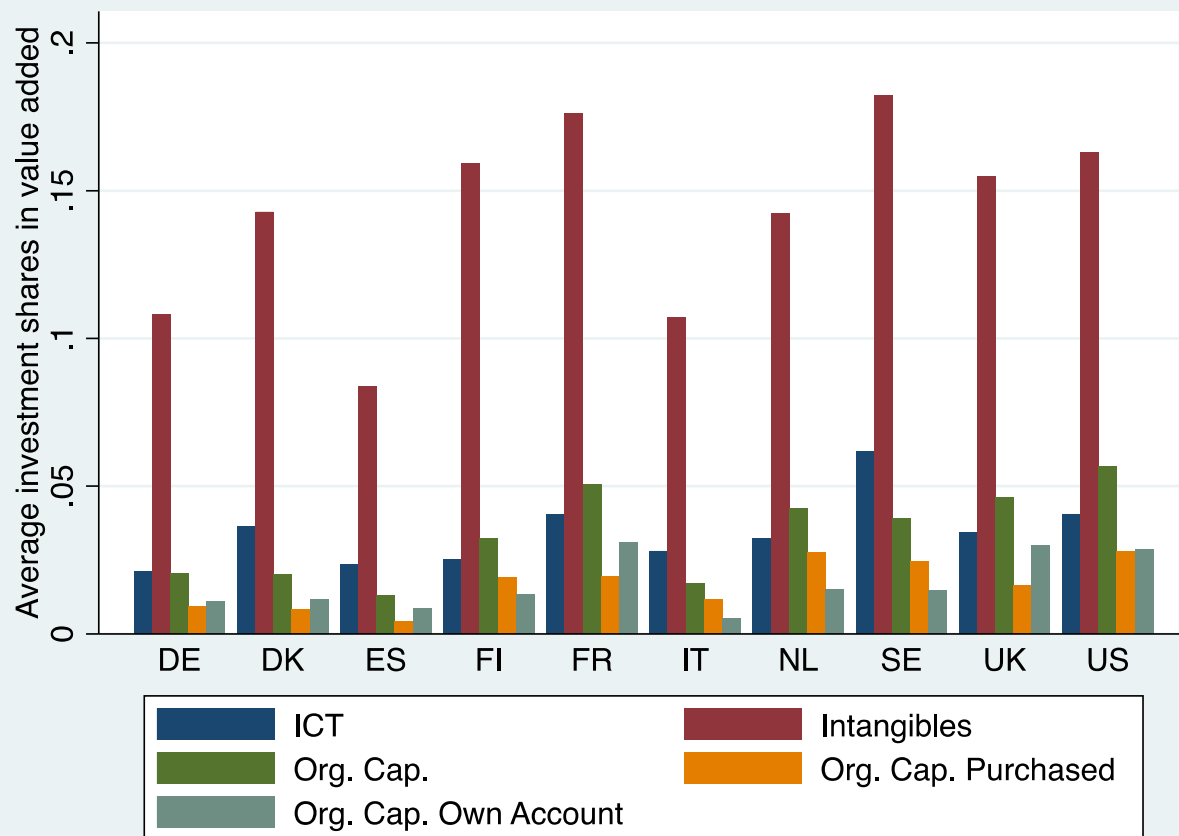
Stylized facts

- High-digital industries are more OC-intensive

- Low and medium-digital industries have similar OC-intensities

- Shares of own-account and purchased OC are similar across digital classes

OC stock across industries with low, medium and high digitalisation intensity (% of adj. VA)
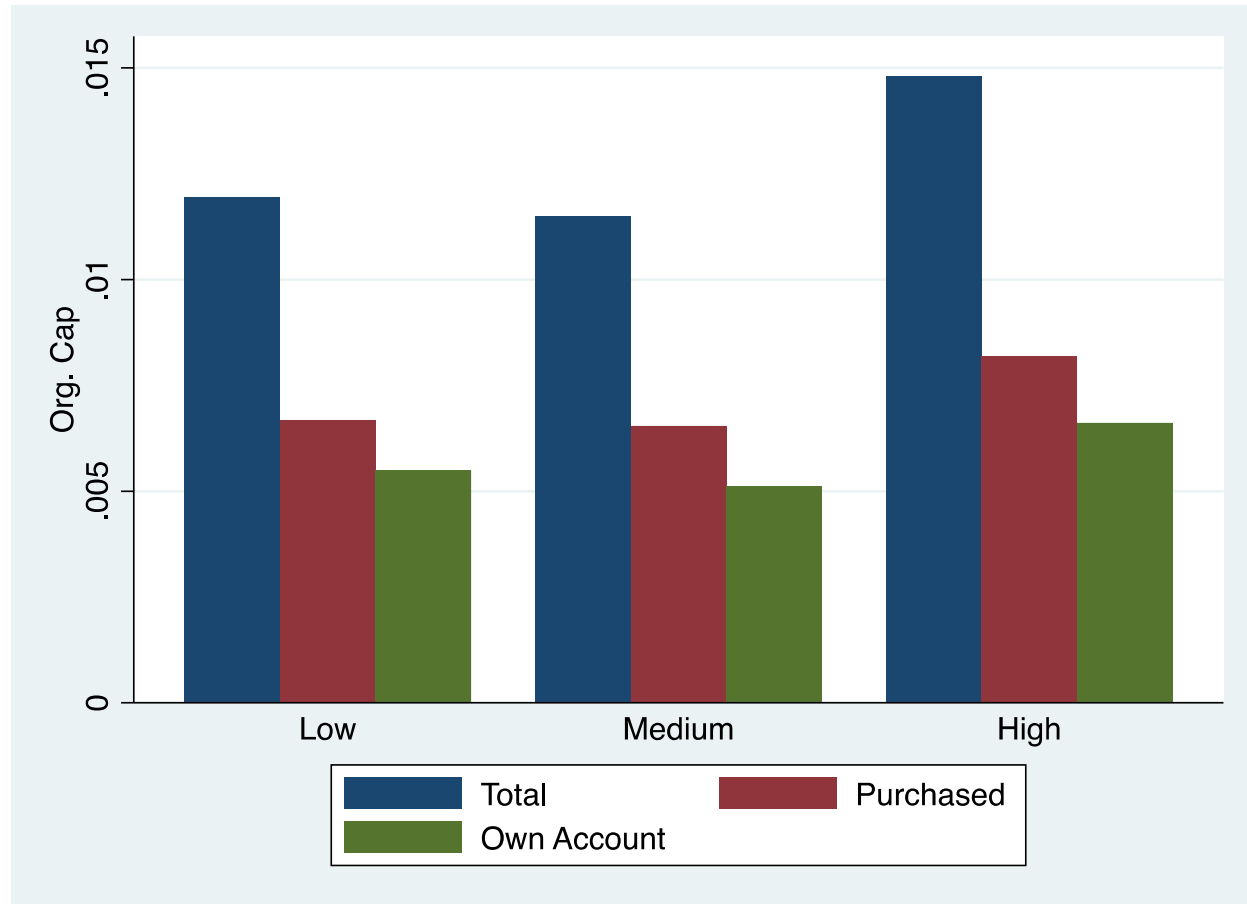
Stylized facts

- Medium-digital industries have a highest OC growth

- Low and medium-digital acquire organisational assets mostly through purchases of consultancy services

- High-digital have more balanced composition of OC acquisition
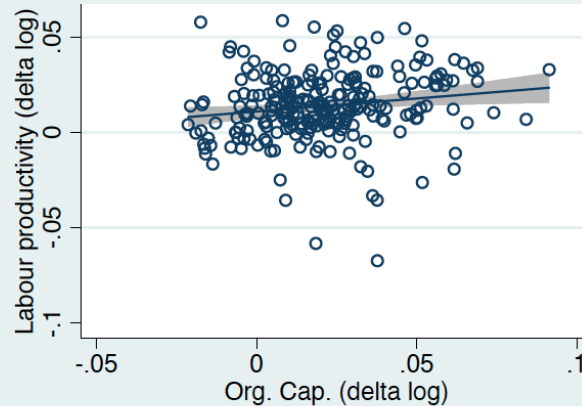
OC stock *growth* across industries with low, medium and high digitalisation intensity (% of adj. VA)
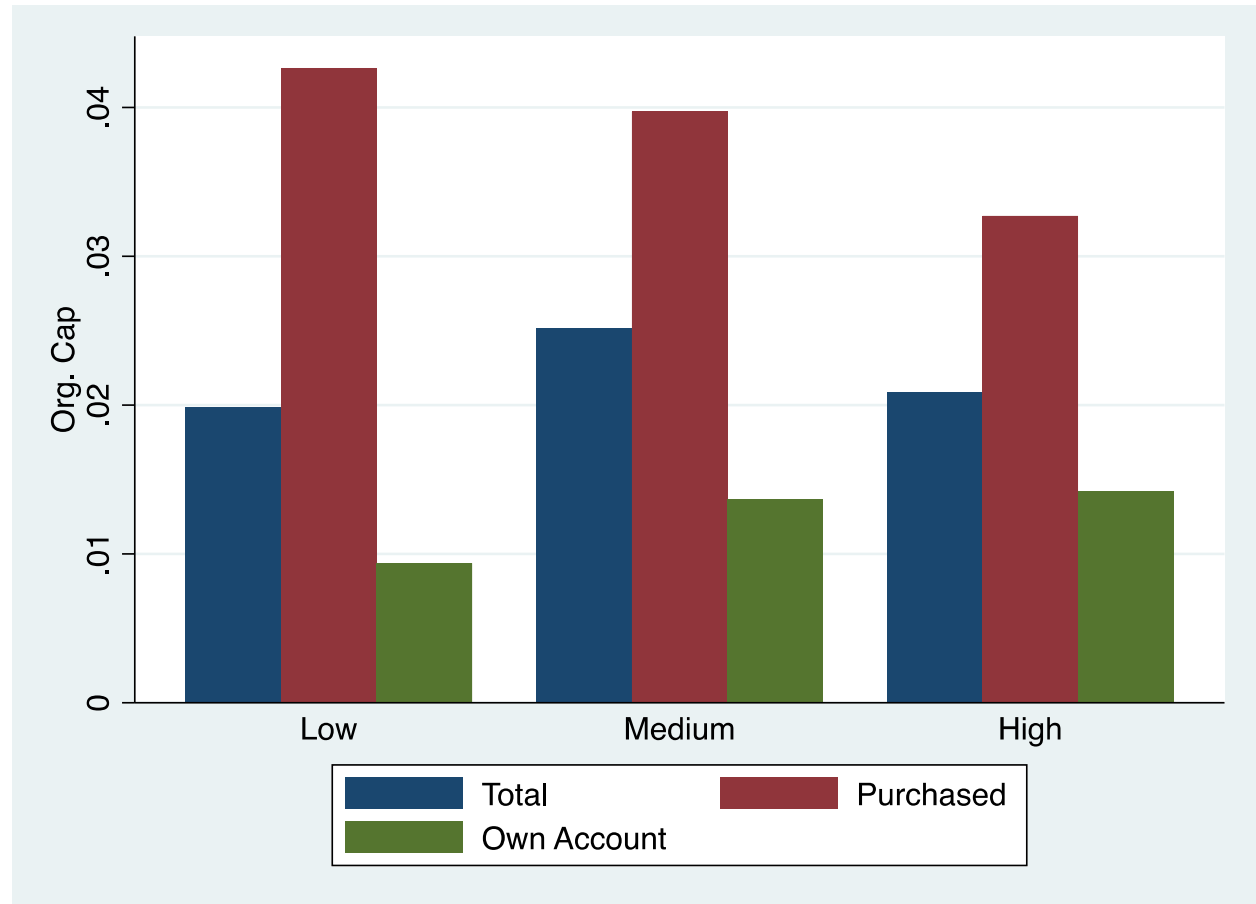
Stylized facts

- Positive relationship between productivity growth and investment in OC

- Investment in both OC components is correlated with growth

Growth in average hourly labour productivity vs investment in OC (business sector)
(country-industry obs over sample period)
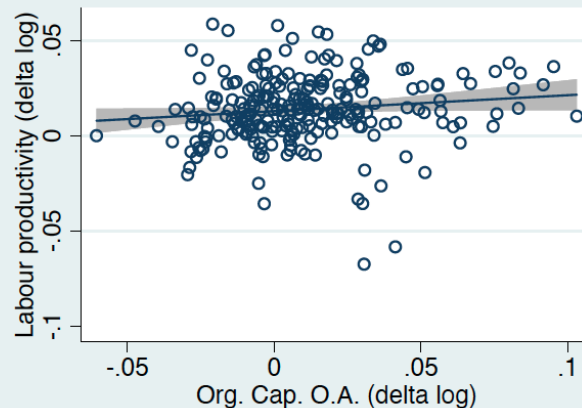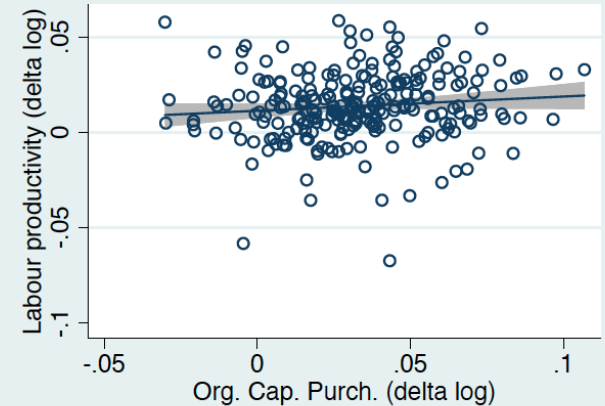
Stylized facts

- Positive relationship between productivity growth and investment in OC

- Investment in both OC components is correlated with growth…

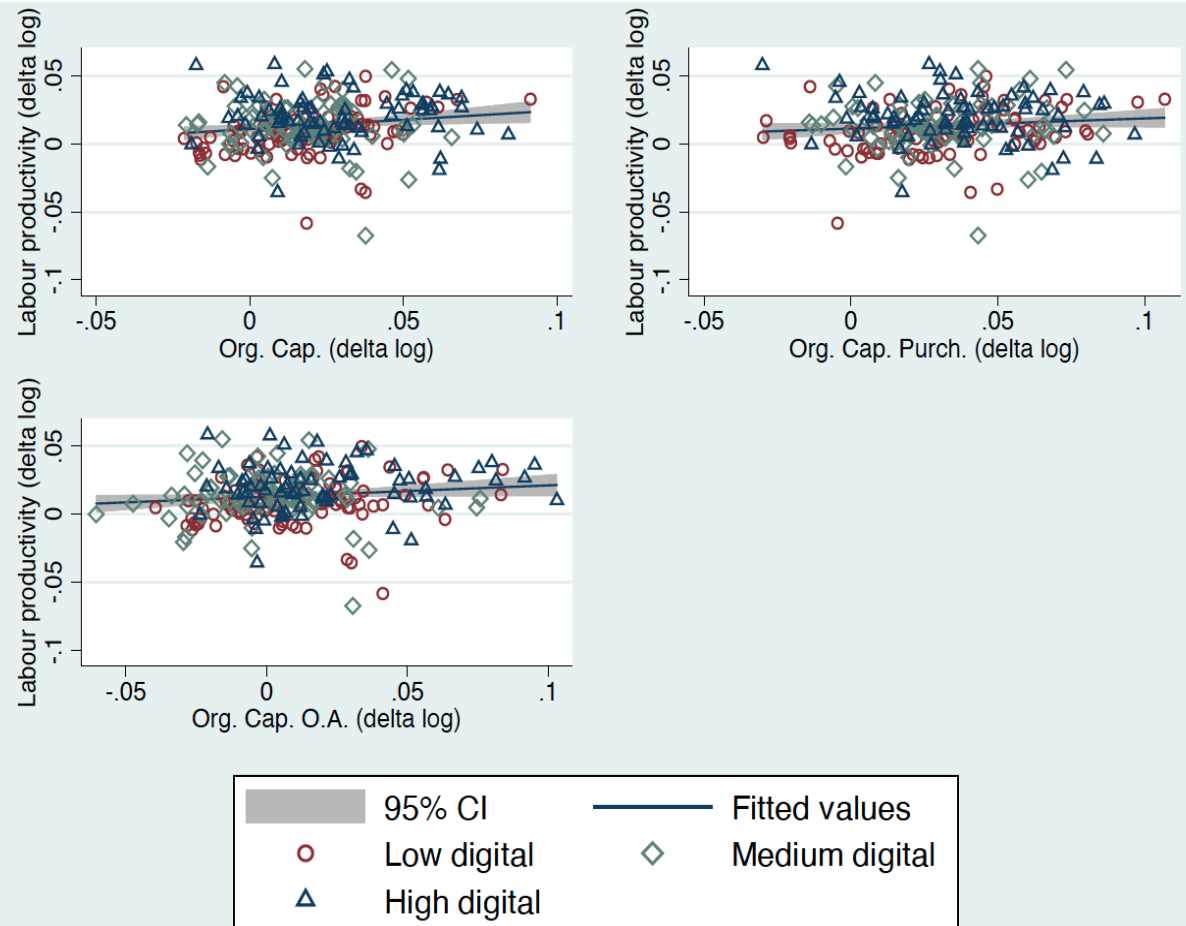- … but correlation between own-account OC and productivity growth is particularly strong in high-digital industries

**Growth in average hourly labour productivity vs investment in OC (business sector)**
(country-industry obs over sample period)

Stylized facts

- Positive relationship between productivity growth and OC endowments

- Warrants empirical exploration controlling for other possible productivity drivers

OC stock and average hourly labour productivity growth in the market sector

(country-industry obs over sample period)
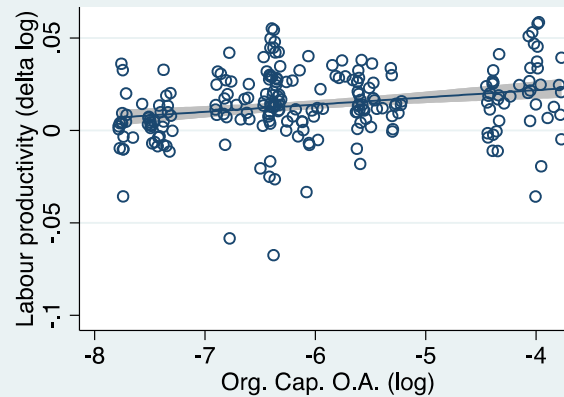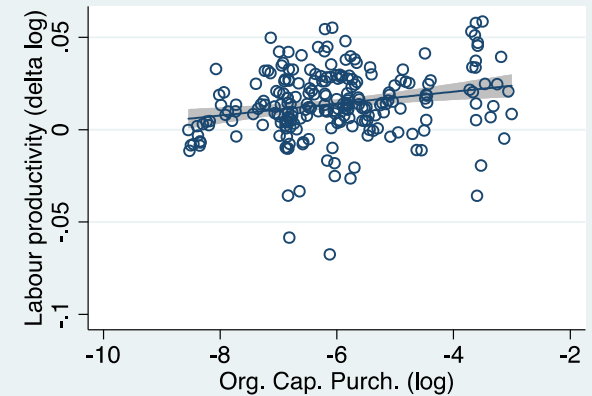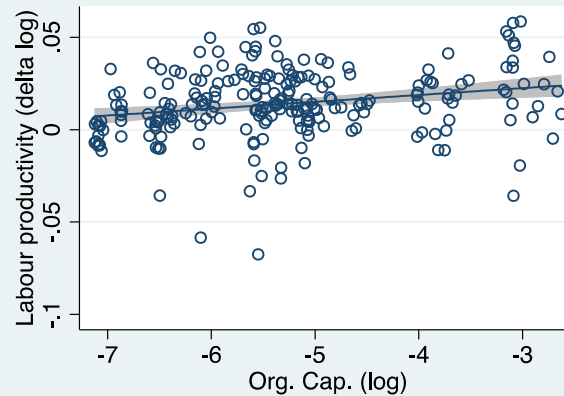
Production function results

- Intangibles have a <u>strong growth impact</u>, with plausible elasticities

- <u>OC component has the strongest impact</u> on productivity growth

- <u>Impact of own-account OC is twice stronger</u> than that of purchased OC

- Difference is <u>magnified in high-digital industries</u>

Dependent variable	*Hourly labour productivity growth*							
	Total OC **all industries**		**Total OC** <u>high digital industries</u>		**Own-acc. vs Purchased OC** **all industries**		**Own-acc. vs Purchased OC** <u>high digital industries</u>	
Explanatory variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	GLS	GMM	GLS	GMM	GLS	GMM	GLS	GMM
Growth of **intangibles** (excluding OC) per hour worked	0.0443***	0.257***	0.0527***	0.300***	0.0393***	0.155**	0.0462***	0.232***
	(0.00576)	(0.0939)	(0.00710)	(0.0523)	(0.00565)	(0.0627)	(0.00696)	(0.0425)
Growth of **tangibles** (non residential) per hour worked	0.198***	0.868***	0.193***	0.737***	0.171***	0.936***	0.167***	0.712***
	(0.0154)	(0.151)	(0.0187)	(0.0906)	(0.0156)	(0.177)	(0.0189)	(0.0887)
Growth of **organizational capital** per hour worked	0.188***	0.386***	0.220***	0.444***				
	(0.0141)	(0.127)	(0.0181)	(0.0826)				
Growth of **purchased** OCl per hour worked					0.0515***	0.237***	0.0781***	0.0848**
					(0.00806)	(0.0811)	(0.0112)	(0.0366)
Growth of **own-account** OC per hour worked					0.215***	0.540***	0.221***	0.430***
					(0.0172)	(0.154)	(0.0209)	(0.0904)
Observations	*5833*	*5158*	*3456*	*3073*	*5833*	*5158*	*3456*	*3073*
Number of geo_sec	*248*	*248*	*146*	*146*	*248*	*248*	*146*	*146*

Standard errors in parentheses; *** p<0.01, ** p<0.05, *p<0.1

All regressions include country and industry trends as well as country and year fixed effects

Augmented production function results

- Some evidence that the effect of OC is mediated by the ICT stock…

- … with the effect driven by high-digital industries…

- …perhaps reflecting that OC boosts the ability to absorb and adapt to new technologies

Dependent variable	Hourly labour productivity growth			
	Total OC			
	OC/ICT interaction		OC/ICT interaction high digital industries	
	(1)	(2)	(3)	(4)
Explanatory variables	GLS	GMM	GLS	GMM
Growth of **intangibles** (excluding organizational capital) per hour worked	0.0372***	0.0606*	0.0525***	0.0975***
	(0.00558)	(0.0363)	(0.00724)	(0.0325)
Growth of **tangibles** (non residential) per hour worked	0.181***	0.196**	0.152***	0.265***
	(0.0158)	(0.0919)	(0.0192)	(0.0595)
Growth of **organizational capital** per hour worked	0.329***	0.514**	0.421***	0.379***
	(0.0749)	(0.209)	(0.0885)	(0.136)
Cross-country average of sectoral **ICT intensity** per hour worked	0.00892***	0.0115***	0.00872***	0.0112***
	(0.000672)	(0.00136)	(0.000772)	(0.00114)
Interaction between growth of **organizational capital and average ICT intensity** per hour worked	0.0213*	0.0596*	0.0356**	0.0410*
	(0.0121)	(0.0331)	(0.0152)	(0.0236)
Observations	5833	5158	3456	2930
Number of geo_sec	248	248	146	146

Standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$

All regressions include country and industry trends as well as country and year fixed effects

Augmented production function results

- Accounting for the role of ICT intensity cancels the productivity effects of purchased OC…

- …and the mediation of ICT intensity appears to be <u>driven by own-account OC in high digital industries</u>…

- …reflecting the tendency of these industries to internalize OC skills

- …and confirming that <u>own-account OC brings highest productivity gains</u>…

- …also thanks to its <u>stronger complementarity and absorptive potential</u> vis à vis new technologies

Dependent variable	Hourly labour productivity growth				
	Own-account vs Purchased OC				
	With both ICT interactions	Own-account/ICT interaction		Own-account/ICT interaction <u>high digital industries</u>	
Explanatory variables	(5)	(6)	(7)	(8)	(9)
	GLS	GLS	GMM	GLS	GMM
Growth of **intangibles** (excluding organizational capital) per hour worked	0.0355***	0.0344***	0.0820*	0.0453***	0.0853***
	(0.00544)	(0.00546)	(0.0428)	(0.00706)	(0.0330)
Growth of **tangibles** (non residential) per hour worked	0.136***	0.137***	0.270***	0.128***	0.241***
	(0.0158)	(0.0159)	(0.0783)	(0.0195)	(0.0497)
Growth of **purchased** organizational capital per hour worked	-0.0154	0.0455***	0.0233	0.0639***	-0.0102
	(0.0449)	(0.00843)	(0.0461)	(0.0112)	(0.0291)
Growth of **own-account** organizational capital per hour worked	0.554***	0.527***	0.782***	0.476***	0.578***
	(0.0879)	(0.0860)	(0.186)	(0.0943)	(0.142)
Cross-country average of sectoral **ICT intensity** per hour worked	0.00917***	0.00896***	0.0105***	0.00891***	0.0115***
	(0.000694)	(0.000646)	(0.00128)	(0.000745)	(0.00110)
Interaction between growth of **purchased organizational capital and average ICT intensity** per hour worked	-0.0104				
	(0.00740)				
Interaction between growth of **own-account organizational capital and average ICT intensity** per hour worked	0.0543***	0.0500***	0.103***	0.0418***	0.0662***
	(0.0145)	(0.0142)	(0.0284)	(0.0162)	(0.0243)
Observations	*5833*	*5833*	*4917*	*3456*	*2930*
Number of geo_sec	*248*	*248*	*248*	*146*	*146*

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

All regressions include country and industry trends as well as country and year fixed effects

Conclusions and ways forward

- Using a unique set of cross-country data, we find a robust positive link between OC and productivity growth at industry level

- The link is driven by the own-account component of OC and is particularly strong in digitalized environments

- Moreover, the link gets stronger when ICT endowments are large, especially for the own-account component

- All this points to key synergies between in-house OC and new technologies, consistent with both the RBV view of the firm and theories of absorption capacity

- It also suggests that firm-level build up of in-house OC may have spillovers at aggregate level

- This lends support to policies aimed at increasing economies' endowment of OC – especially so that developed within companies

- Further research:

  - Explore the interaction between OC and other intangibles, e.g. R&D, Brand, Data

  - Investigate which public policies are most effective to promote OC formation within firms