

Dynamique de la productivité après la crise  
Banque de France  
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# POLICIES, ADOPTION AND THE DIGITAL- PRODUCTIVITY NEXUS: MICRO-LEVEL EVIDENCE FROM EU COUNTRIES

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By Giuseppe Nicoletti

A summary of

***Going digital: What determines technology diffusion among firms?***

By Dan Andrews, Giuseppe Nicoletti, Christina Timiliotis

***Decoding the digital-productivity nexus? Micro-level evidence from EU countries***

By Peter Gal, Giuseppe Nicoletti, Theodore Renault, Stephane Sorbe & Christina Timiliotis

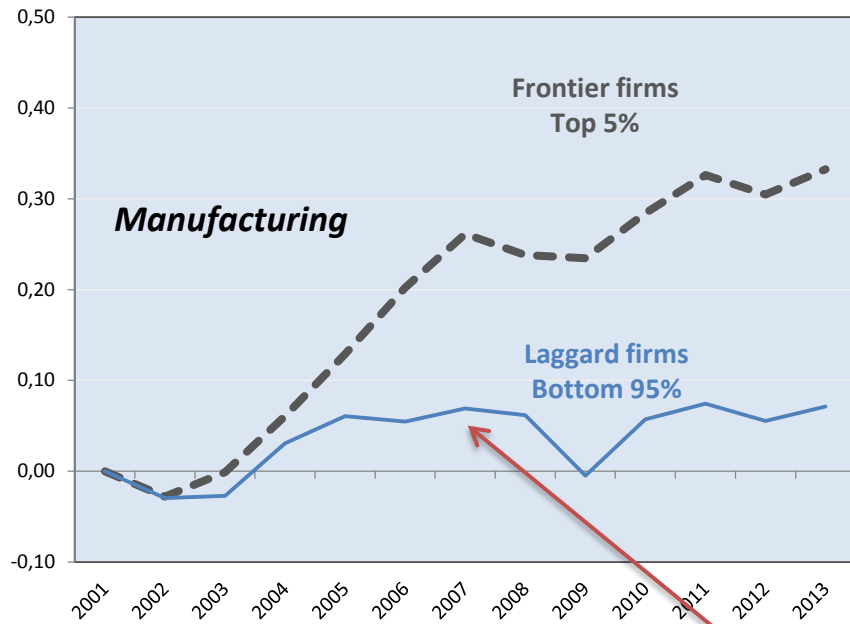
# Motivation and summary

# Has the diffusion machine broken down?

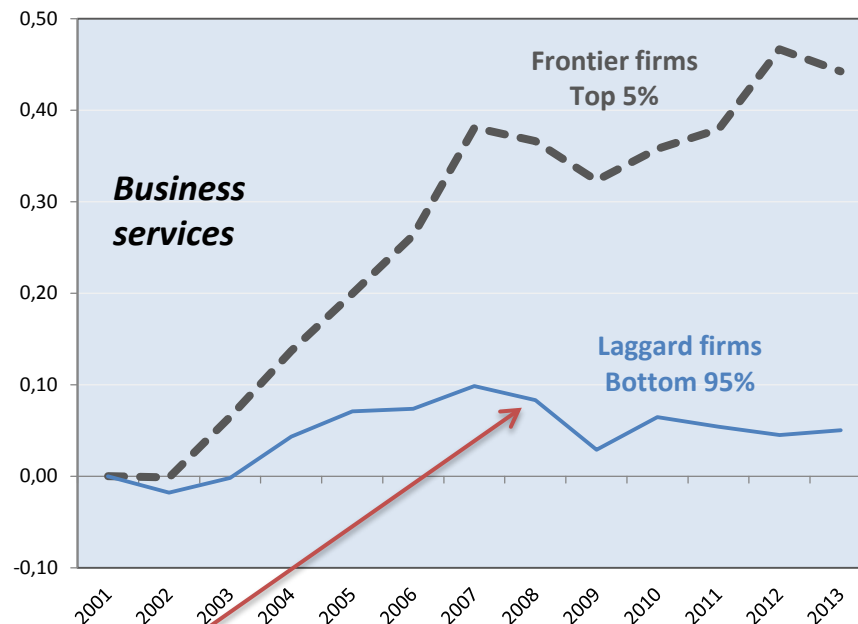
Dispersion in multifactor productivity (MFP) has widened, with the best firms taking off and the rest stagnating

Evolution of MFP of frontier and other firms, 2001-13  
(cross-firm, cross-sector averages)

Logs, 2000=0

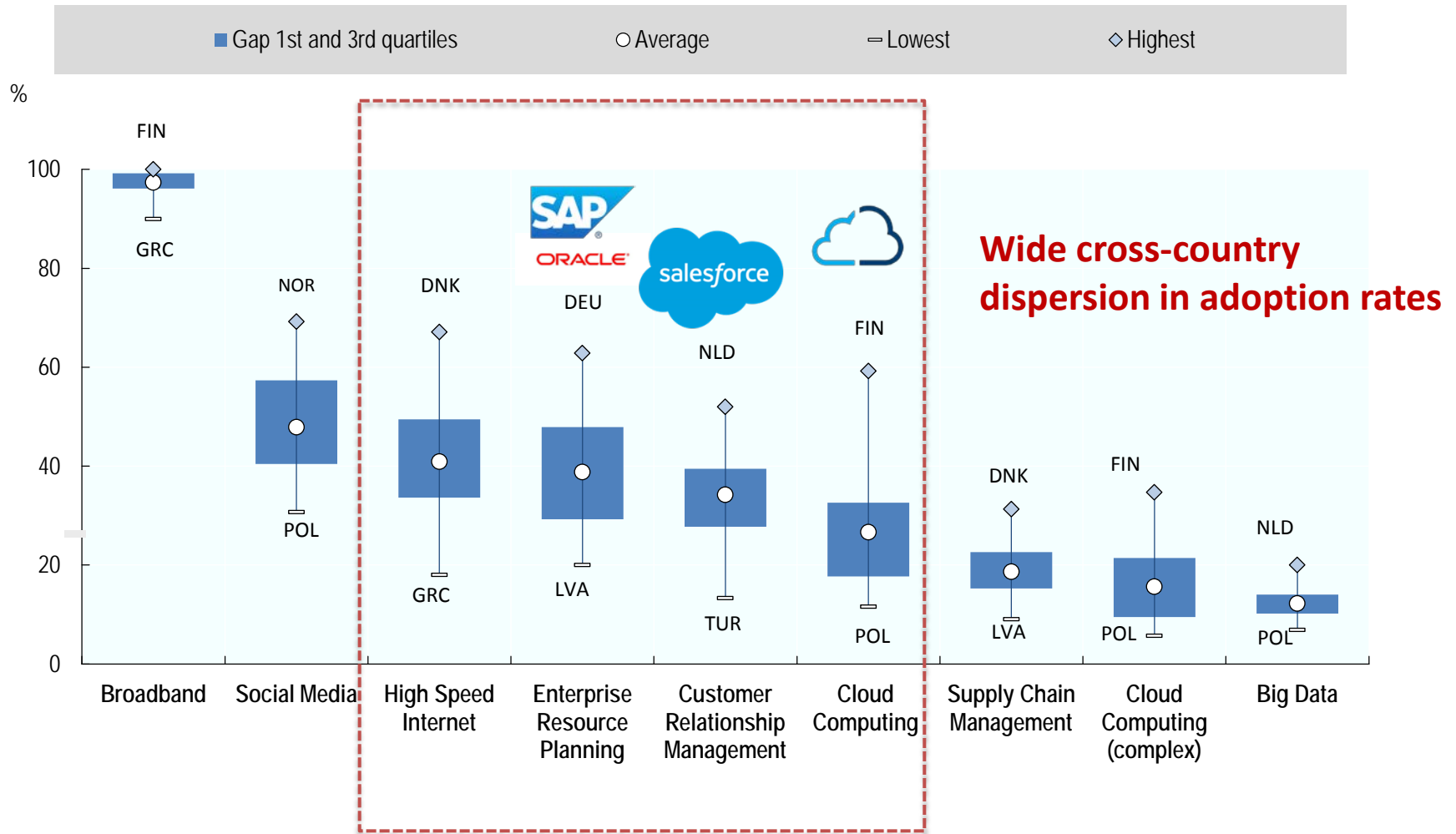


Source: Andrews et al. (2016)



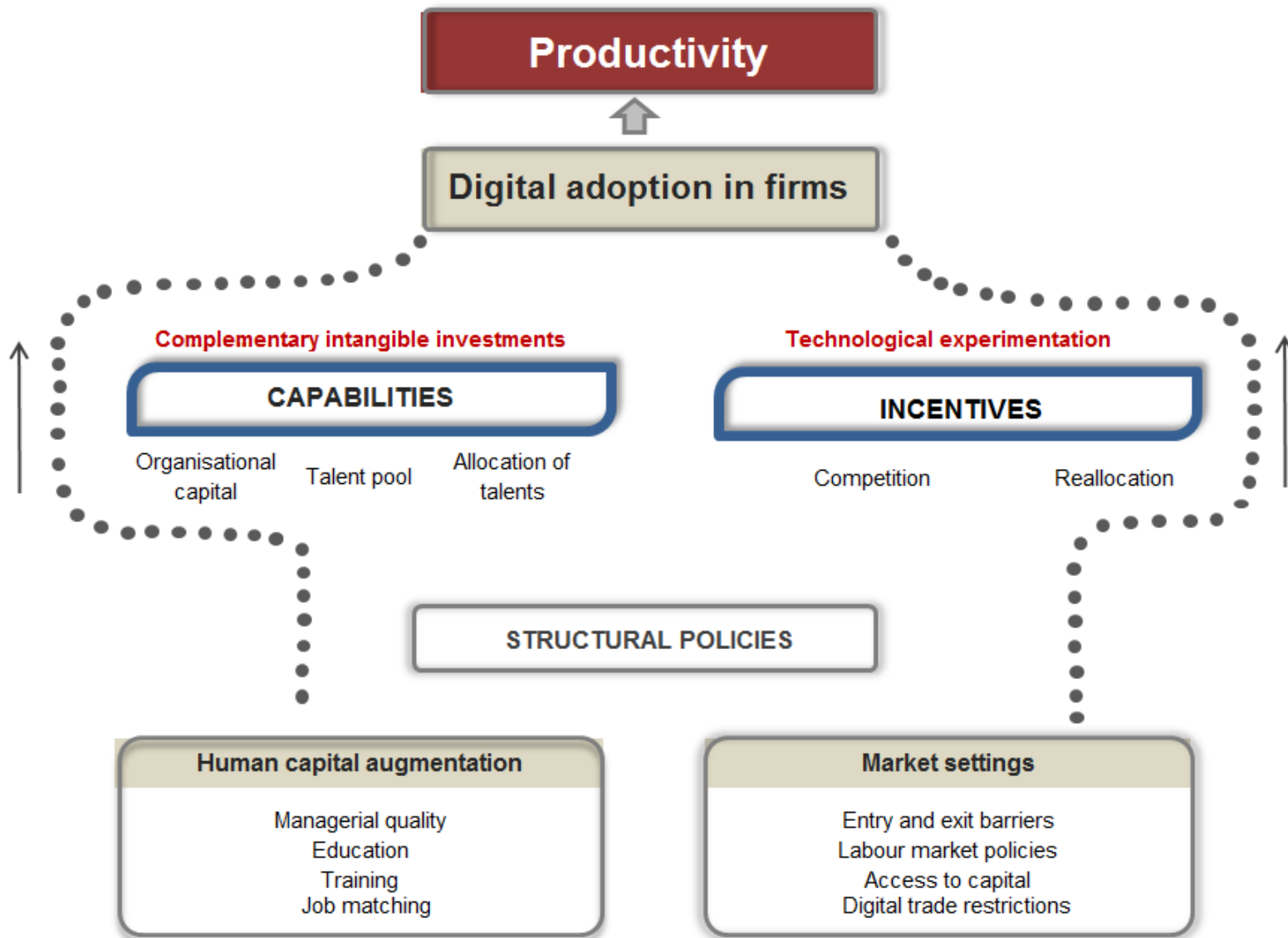
A reflection of structural weaknesses that could be addressed by structural policies?

# How spread out are digital technologies?



**Many firms still lack 'basic' technologies**

# Structural channels influencing digital adoption



# Summary of main findings

## Part I: Structural drivers of digital adoption

- ✓ **Strong complementarity among technologies :**
  - digital infrastructure (high-speed internet) is a key enabler of digital adoption
- ✓ **Adoption is related to complementary knowledge-based investment in:**
  - organisational capital (management, work organisation)
  - ICT skills of working-age population and their good match
  - training (especially of low-skilled and non-ICT workers)
- ✓ **Significant complementarities among structural factors**
  - the effects of capabilities on digital adoption are stronger in the presence of the right market incentives

## Part II: The productivity benefits from digital adoption

- ✓ **The benefits are significant**
- ✓ **But heterogeneous across groups of firms**
  - Low productive and small and medium sized firms reap greater productivity benefits
  - Effects are stronger in sectors more integrated into GVCs and with a high share of routine tasks

# Drivers of digital adoption

## The digital

- Sou
- Agg
- tech
- Cov
- Onl

## The capa

- Vari
- Bot
- wor
- No

### Variables measuring capabilities

#### Management

Share of jobs with  
performance

#### Talent Po

Percentage of adults with no  
ICT skills

Share of high-and low skilled in  
training

Share of workers in lifelong  
training

Skill mismatch

Principal Component Analysis

fic digital

verage

formance  
urdens)



# Empirical approach

## Focus on enablers and productivity-enhancers

- High-speed internet, cloud computing (simple/complex), back-office integration (ERP, CRM)
- Use high-speed broadband internet access as control (complementarity + difficult to disentangle supply/demand factors)

## Use Rajan-Zingales diff-in-diff approach

- Industry exposure assumptions (knowledge intensity, firm turnover, financial dependency) to overcome lack of sector dimension.


$$Adopt_{c,s}^j = \alpha + \beta_1 BB_{c,s} + [Policy * Exposure] + \delta_c + \delta_s + \varepsilon_{c,s}$$

- *Policy (1):*  $Inc_c$  *or*  $Cap_c$  (one by one)
- *Policy (2):*  $Cap_c$  *and*  $Inc_c$  (pairwise)
- *Policy (3):*  $Cap_c$  *and*  $Cap_c * Inc_c$  (interaction)

## Limitations

- Cross-section only
- Differential effects across high and low exposed industries
- Max pairwise RHS variables due to multicollinearity
- Endogeneity/omitted variables/causality issues

**Robustness:** different exposure variables, drop country/sector, PCA

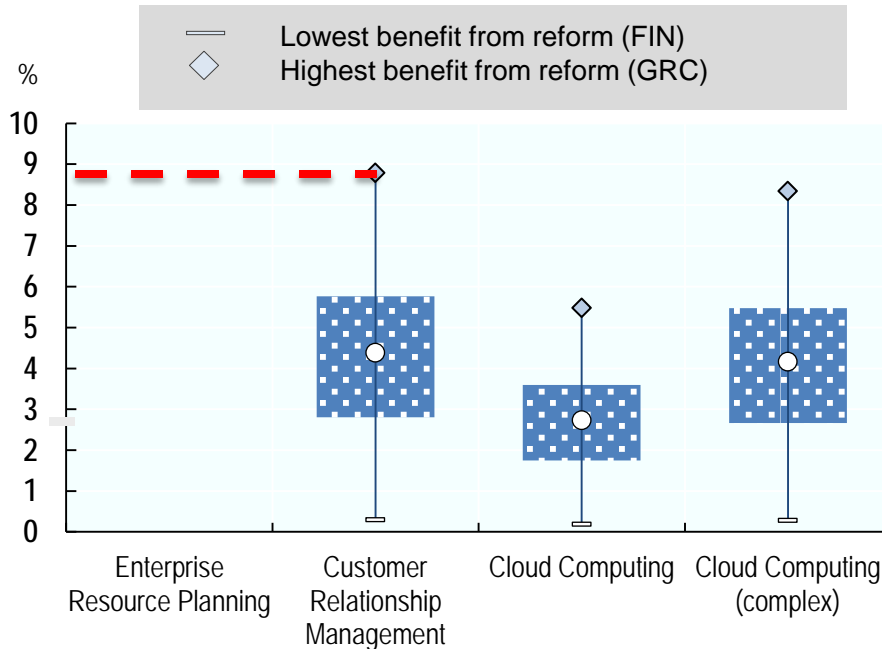
# Results: univariate (capabilities)

	PCA (digital technologies)	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)
<b>Capabilities</b>					
<b>1<sup>st</sup> principal component (skills) x knowledge intensity</b>	<b>0.535***</b>	<b>-0.00893</b>	<b>0.0330***</b>	<b>0.0448***</b>	<b>0.0578***</b>
High-speed broadband access (>30Mbit/s)	3.172***	0.269***	0.316***	0.247***	0.146**
Observations	223	246	246	248	227
<b>High performance work practices x knowledge intensity</b>	<b>0.00857***</b>	<b>0.0807***</b>	<b>-0.00219</b>	<b>0.00987***</b>	<b>0.00552**</b>
High-speed broadband access (>30Mbit/s)	0.117**	2.797***	0.353***	0.251***	0.171**
Observations	343	338	384	385	364
<b>Incentives</b>					
Entry and competition					
PMR Administrative burdens on start-ups x Turnover	-0.0473***	0.00235	-0.00158	-0.00330**	-0.00630***
High-speed broadband access (>30Mbit/s)	2.685***	0.209***	0.251***	0.186***	0.127***
Observations	429	477	477	456	435
Digital Trade Restrictiveness Index X Share of Computer services as input into sector x	-0.607**	-0.0371**	-0.0769***	-0.0323*	-0.0497**
High-speed broadband access (>30Mbit/s)	2.447***	0.204***	0.228***	0.174***	0.102**
Observations	429	477	477	456	435
Exit and reallocation					
Employment Protection Legislation x Turnover	-0,0648***	-0.00556*	-0.00649***	-0.00423**	-0.00439***
High-speed broadband access (>30Mbit/s)	2.669***	0.225***	0.260***	0.186***	0.119***
Observations	429	477	477	456	435

# Increases in digital adoption rates from...

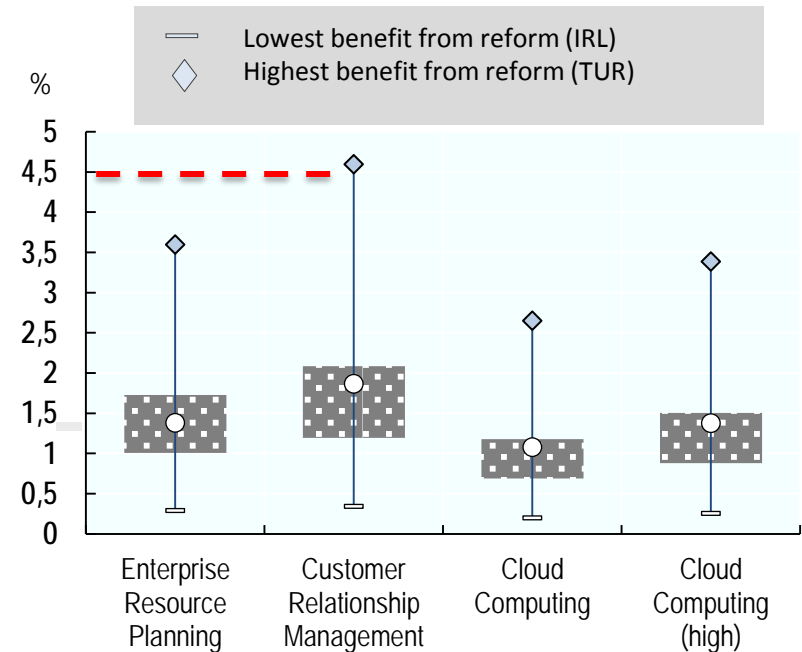
## Capabilities

... increasing the diffusion of high performance work practices to sample maximum level (DNK)



## Incentives

... decreasing digital trade restrictions to sample minimum level (ISL)



**Most conservative estimates based on smallest coefficients from pairwise regressions**

# More accessible and flexible markets enhance the effects of capabilities on adoption

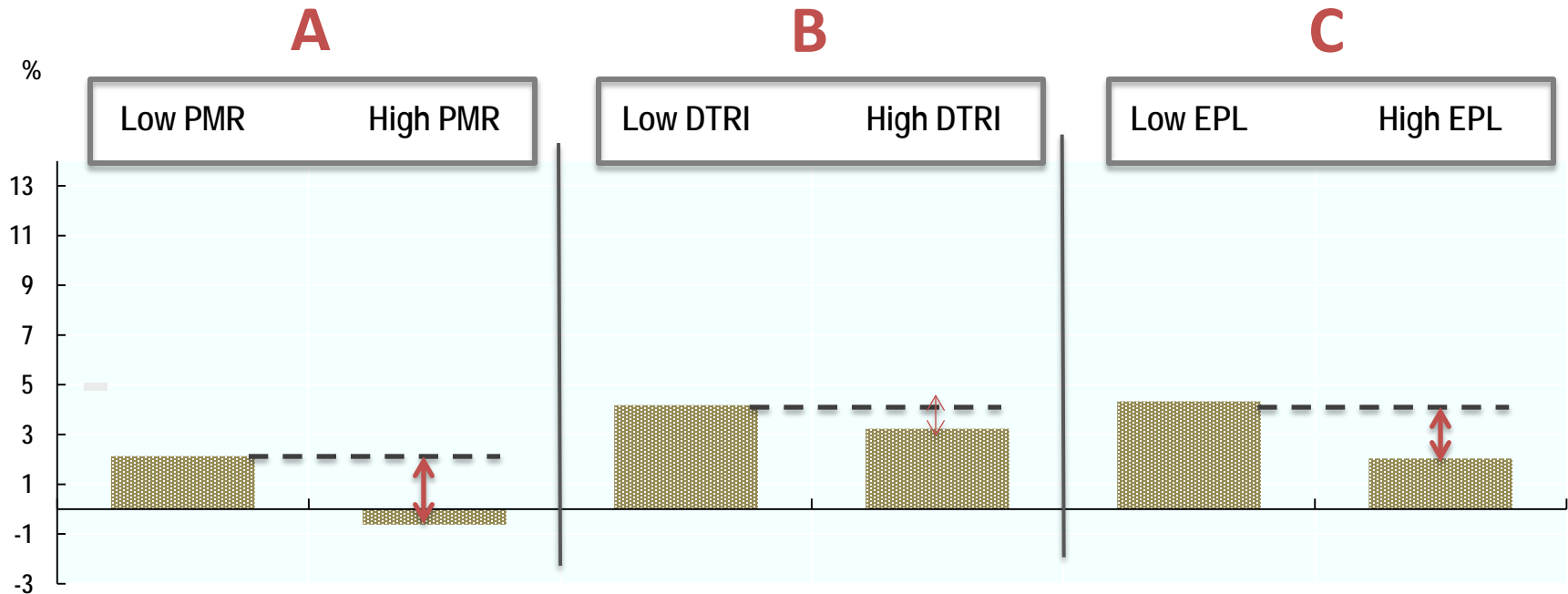
$$Adopt_{c,s}^j = \alpha + \beta_1 BB_{c,s} + \beta_2 Cap_c * Exp_s + \beta_4 Cap_c * Inc_c * Exp_s + \delta_c + \delta_s + \varepsilon_{c,s}$$

	PCA	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)
<b>A: Administrative Burdens to Startups</b>				
HPWP* Knowledge Intensity	0.156*** (0.0308)	0.0116*** (0.00256)	<b>0.0121***</b> (0.00297)	0.0163*** (0.00282)
HPWP* Knowledge Intensity* Administrative Burdens to Startups (PMR)	-0.0684*** (0.0197)	-0.00164 (0.00234)	<b>-0.00583***</b> (0.00211)	-0.00696*** (0.00186)
<b>B: Digital Trade Restrictions</b>				
HPWP* Knowledge Intensity	0.142*** (0.0408)	0.0160*** (0.00374)	<b>0.0102***</b> (0.00306)	0.0170*** (0.00318)
HPWP* Knowledge Intensity * Digital Trade Restrictiveness Index	-0.327* (0.174)	-0.0368** (0.0169)	<b>-0.0254**</b> (0.0123)	-0.0453*** (0.0143)
<b>C: Employment Protection</b>				
HPWP* Knowledge Intensity	0.244*** (0.0532)	0.0225*** (0.00536)	<b>0.0200***</b> (0.00575)	0.0230*** (0.00510)
HPWP* Knowledge Intensity * Employment Protection Legislation	-0.0691*** (0.0206)	-0.00525** (0.00238)	<b>-0.00616***</b> (0.00234)	-0.00611*** (0.00199)

# Higher bang-for-the-buck of packaging reforms for adoption

## Example of cloud computing

Increasing **managerial quality (HPWP)** to sample maximum (DNK) in different market environments



NB: all differences are statistically significant

**The positive effect of managerial quality on adoption is boosted by easier access to markets and reallocation**

# The digital-productivity nexus

We have shown that

- ✓ digital adoption is boosted by the right skills
- ✓ especially under the right incentive framework



But does it affect firm-level productivity and if so, are all firms/sectors equally affected?

# Digital adoption and productivity: a firm-level analysis

## References/Literature: evidence on the granular (firm-level) impact of ICT

### Single-country studies



Netherlands: Polder et al. (2009). "Productivity effects of innovation modes"



Italy: Hall et al. (2012), "Evidence on the impact of R&D and ICT investment on innovation and productivity in Italian firms"



Chile: Álvarez R. (2016), 'The impact of R&D and ICT. Investment on innovation and productivity in chilean firms',



Belgium: Dhyne et al. (2017), "IT and Productivity"



New Zealand: Fabling and Grimes (2016), "Does ultrafast broadband increase firm productivity"

### Cross country study



Bartelsman, et al. (2016) "CDM using a cross-country micro moments database"

## Data

- Bureau van Dijk (ORBIS) → firm-level MFP according to Gal (2013)
- Coverage: 2009-2015, 21 EU countries, 25 industries
- Firms with >10 employees only to match adoption data

# Modelling productivity growth, conditional on catch-up and firm characteristics

Following Aghion, P. and P. Howitt (1998), “Endogenous Growth Theory” and Acemoglu, D., P. Aghion and F. Zilibotti (2006), “Distance to the Frontier, Selection and Economic Growth”

$$\Delta MFP_{isct} = \beta_1 \Delta MFP_{st}^{Leader} + \beta_2 Gap_{isct} + \beta_3 Age_{isct} + \beta_4 LogL_{isct} + \beta_5 Digital_{cs} + \delta_{ct} + \delta_s + \varepsilon$$

MFP growth (Wooldridge)      Growth of global leader      Gap to global frontier      Firm-level controls      Digital adoption      Fixed effects

## Interpretation from combining industry-level adoption with firm level MFP growth not obvious

- **Two possible channels:** intensive/extensive margin (spillovers from adoption in other firms or gains from within-firm adoption)

However, may help addressing endogeneity issues



# Are there productivity benefits and who benefits most from adoption?

PCA: high speed broadband access, ERP , CRM , Cloud Computing

	By productivity quartile (1=least productive)					By size class (10-20; 20-49; 50-250; 250+)			
	Full	1quart	2quart	3quart	4quart	1quart	2quart	3quart	4quart
Frontier growth	0.236*** (0.0393)	0.251*** (0.0513)	0.188*** (0.0510)	0.206*** (0.0455)	0.306*** (0.0460)	0.245*** (0.0371)	0.248*** (0.0389)	0.200*** (0.0591)	0.185*** (0.0565)
Lagged gap	0.107*** (0.0126)	0.0989*** (0.0286)	0.0961*** (0.00965)	0.0716*** (0.00799)	0.154*** (0.00818)	0.133*** (0.0143)	0.106*** (0.0132)	0.0798*** (0.0117)	0.0984*** (0.0169)
<b>PCA (digital technologies)</b>	<b>0.0161***</b> (0.00391)	<b>0.0167**</b> (0.00683)	<b>0.0142***</b> (0.00463)	<b>0.0145***</b> (0.00318)	<b>0.0113***</b> (0.00393)	<b>0.0206***</b> (0.00522)	<b>0.0184***</b> (0.00413)	<b>0.0136***</b> (0.00408)	<b>0.00999**</b> (0.00452)
Observations	1,348,670	328,032	349,700	357,784	264,437	515,195	486,135	262,438	91,678
R-squared	0.064	0.055	0.035	0.033	0.057	0.078	0.063	0.054	0.063
Country-Time FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Sector FE	YES	YES	YES	YES	YES	YES	YES	YES	YES
Firm controls (age, size)	YES	YES	YES	YES	YES	YES	YES	YES	YES

While all firms benefit from higher digital adoption, the effect is stronger for **low productive, small and medium-sized enterprises.**

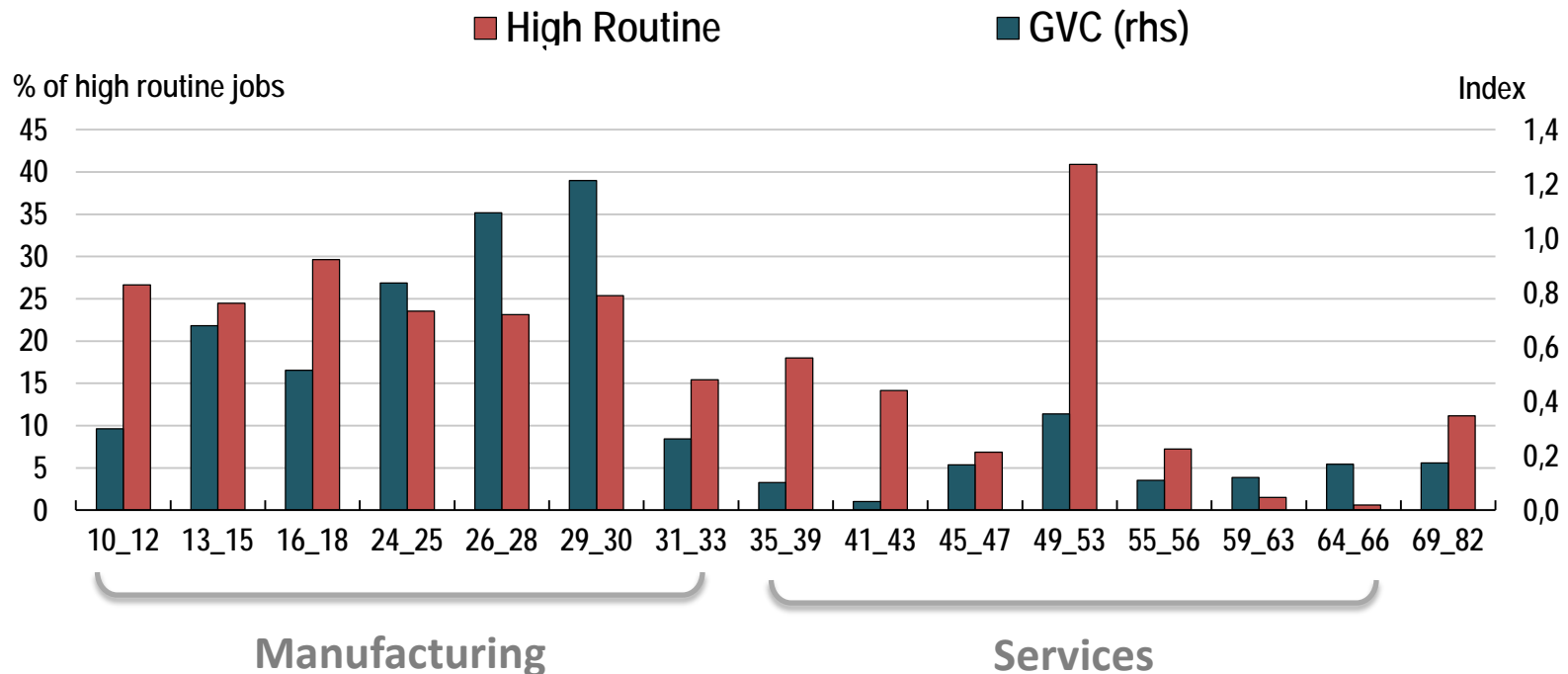
# Which sectors are behind these results?

	Manufacturing	Non-manufacturing	Services
Frontier growth	0.152*** -0.0461	0.172*** -0.0391	0.134** -0.0531
Lagged gap	0.152*** -0.00774	0.0956*** -0.0123	0.118*** -0.00574
<b>PCA (digital technologies)</b>	<b>0.0162**</b>	<b>0.0125***</b>	<b>0.0108**</b>
	-0.00753	-0.00417	-0.00465
Observations	397898	1174058	943434
R-squared	0.09	0.06	0.071
Country-Time FE	YES	YES	YES
Sector FE	YES	YES	YES
Firm controls (age, size)	YES	YES	YES

**Q:** What characteristics of the manufacturing sector lead firms to benefit more from digital adoption?

# Distinctive features of the manufacturing sector

## 1. Share of high-routine jobs    2. GVC participation



**Because the manufacturing sector is more integrated in GVCs**

- It is more exposed to digital technologies (spillovers)
- It may have greater use for organisational technologies (e.g. ERP/CRM)

**A greater share of high-routine jobs may indicate**

- More scope to reorganise production to take advantage of digital technologies

# Productivity effects are boosted by GVCs and high-routine jobs

$$\Delta MFP_{isct} = [Baseline] + \beta_4 Digital_{cs} + \beta_5 Digital_{cs} * GVC \text{ or } HR_{cs} + \delta_{ct} + \delta_s + \varepsilon$$

	GVC participation	Share of high-routine jobs
PCA	<b>0.0299***</b> (0.00822)	<b>0.0226***</b> (0.00617)
PCA*GVC participation	<b>0.0104**</b> (0.00492)	<b>0.0391</b> (0.0246)

Blue = standalone statistically significant

Red = interaction term statistically significant

## By technology

High speed broadband	<b>0.168***</b> (0.0633)	<b>0.121***</b> (0.0408)
High speed broadband * GVC	-0.0180 (0.0564)	-0.236 (0.164)
ERP	<b>0.160***</b> (0.0488)	<b>0.120***</b> (0.0430)
ERP * GVC	0.0220 (0.0426)	<b>0.541*</b> (0.297)
Cloud Computing	0.0897 (0.0883)	0.104 (0.0652)
Cloud Computing * GVC	<b>0.111**</b> (0.0550)	0.130 (0.196)
CRM	<b>0.230***</b> (0.0655)	<b>0.188***</b> (0.0436)
CRM * GVC	<b>0.104**</b> (0.0483)	0.278 (0.271)

Effect is particularly strong for ERP and CRM

# Policies to enhance digital diffusion

## Part I: Structural policies and digital adoption

- **Roll-out of broadband** high-speed internet is a key enabler of digital adoption
  - **Capabilities:** Upgrading ICT skills via **education and training** system (**school, on and out of the job, LL learning**) is a prerequisite for digital adoption
  - **Incentives:** **Streamlining administrative burdens and easing access to services markets** can enhance digital adoption through competitive pressures
  - **Reducing barriers to digital trade** to ensure the availability of digital products and complementary services
- ➔ **Package policies for largest adoption benefits!**

## Part II: The digital-productivity nexus

- Benefits from higher digital adoption spread to all firms
- But, the effect is stronger for **low productive, small and medium-sized enterprises**  
➔ **could help close the gap between laggards and frontier**
- Results are driven by sectors more integrated in **Global Value Chains** and with a higher share of **routine jobs** (i.e. manufacturing)
- **Channels** yet to be explored...

Was Solow too pessimistic after all...?

**Thank you!**

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**Spare**

# References

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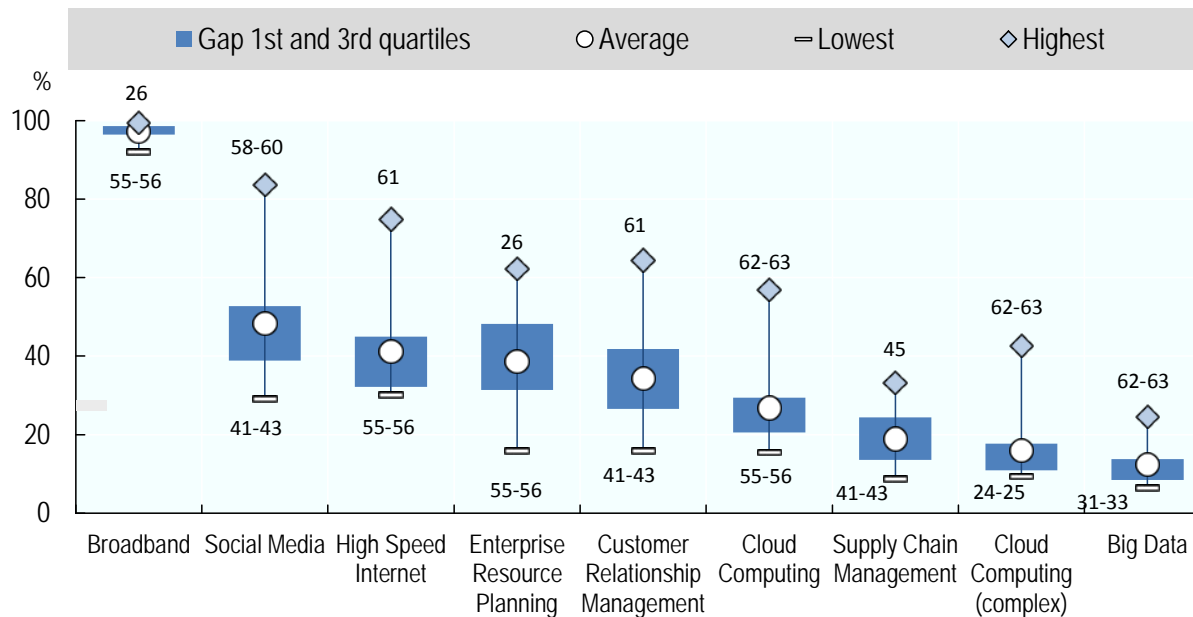


# Sectors

NACE Rev 2	Description
10-12	Manufacture of beverages, food and tobacco products
13-15	Manufacture of textiles, wearing apparel, leather and related products
16-18	Manufacture of wood & products of wood & cork, except furniture; articles of straw & plaiting materials; paper & paper products; printing & reproduction of recorded media
19-23	Manufacture of coke, refined petroleum, chemical & basic pharmaceutical products, rubber & plastics, other non-metallic mineral products
24-25	Manufacture of basic metals & fabricated metal products excluding machines & equipments
26	Manufacture of computer, electronic and optical products
27-28	Manufacture of electrical equipment, machinery and equipment n.e.c.
29-30	Manufacture of motor vehicles, trailers and semi-trailers, other transport equipment
31-33	Manufacture of furniture and other manufacturing; repair and installation of machinery and equipment
35_39	Electricity, gas, steam, air conditioning and water supply
41_43	Construction
45	Trade of motor vehicles and motorcycles
46	Wholesale trade, except of motor vehicles and motorcycles
47	Retail trade, except of motor vehicles and motorcycles
49_53	Transportation and storage )
55_56	Accommodation and Food and beverage service activities
58-60	Publishing activities; motion picture, video & television programme production, sound recording & music publishing; programming & broadcasting
61	Telecommunications
62-63	Computer programming, consultancy and related activities, information service activities
64	Other monetary intermediation, other credit granting
65	Insurance, reinsurance
66	Security and commodity contracts brokerage, other activities auxiliary to financial services, except insurance and pension funding
68	Real estate activities
69-74	Professional, scientific and technical activities
77-82	Administrative and support service activities

# Diffusion across industries

Panel B: Diffusion across industries (NACE Rev 2, codes 10-83)



*Note:* For Panel B, sector 24-25 corresponds to *Manufacture of basic metals & fabricated metal products excluding machines & equipment*; sector 26 to *Manufacture of computer, electronic and optical products*; sector 31-33 to *Manufacture of furniture and other manufacturing; repair and installation of machinery and equipment*; sector 41-43 to *Construction services*; sector 55-56 to *Accommodation and Food and beverage service activities*; sector 58-60 to *Publishing activities; motion picture, video & television programme production, sound recording & music publishing; programming & broadcasting*; sector 61 to *Telecommunications*; and sector 62-63 to *Computer programming, consultancy and related activities, information service activities*.

*Source:* based on Eurostat, Digital Economy and Society (database)

# Summary statistics

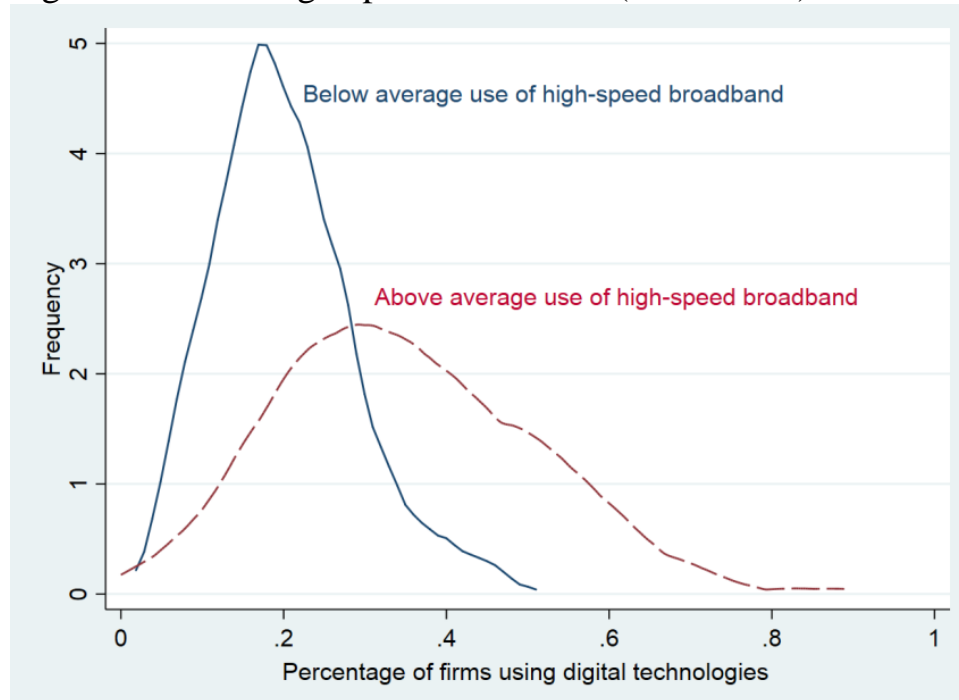
Table 1. Summary statistics of policy and structural factors

		Obs	Mean	Std. Dev.	Min	Max
<b>Capabilities</b>						
I. Organisational capital	Quality of Management school	626	4.883414	0.716024	3.687408	6.099314
	High performance work practices	500	26.05715	9.044642	10.17509	41.6223
II. Skilled labour	Percentage of adults with no ICT skills	425	20.15593	11.16819	7.243739	43.25481
	Lifelong learning	425	50.72941	12.42818	24.3	66.8
	Percentage of low skilled in training	450	35.06356	11.61629	15.84475	51.69505
	Percentage of high skilled in training	450	63.76499	13.37589	31.32726	80.72747
	E-Government	551	55.817.1	17.1	24.1	85
III. Allocation of talent	Skill mismatch	525	25.57619	5.604652	18.1	38.3
<b>Incentives</b>						
I. Entry and competition	Administrative barriers to start-ups	630	2.00624	0.479206	1.121914	3.080247
	Barriers in services sectors	630	3.480308	0.67593	1.365741	4.615741
	Digital trade restrictions	626	0.2152077	0.0634429	0.11	0.38
II. Exit and reallocation	EPL	625	2.529961	0.343966	1.721089	3.204082
	Venture Capital	401	0.0311	0.020665	0.002556	0.075
	Tax incentives	551	0.7306	0.07	0	0.26
	Insolvency regimes	550	0.486888	0.118902	0.130769	0.7

# Smoking guns



Figure 1. Use of high-speed broadband (>30 Mbit/s) is associated with higher digital



*Note:* Average adoption rate across 4 technologies (ERP, CRM, Cloud Computing, Cloud Computing (high)) for a sample of 25 countries and 25 sectors (see Appendix 1 for more details).

*Source:* Authors' calculations, based on Eurostat, Digital Economy and Society Statistics, Comprehensive Database and national sources, September 2017.

# Proxies for capabilities and incentives

**Table 1. Proxies for capability and incentive factors**

	Policy variable	Source of policy variable	Exposure variable
<b>Capabilities</b>			
Organisational capital	Quality of management schools	World Economic Forum	Knowledge intensity
	High performance work practices (HPWP)	OECD Programme for the International Assessment of Adult Competencies (PIAAC)	Knowledge intensity
Skilled labour	Percentage of adults with no ICT skills	OECD Programme for the International Assessment of Adult Competencies (PIAAC)	Knowledge intensity
	The share of (low and high-skilled) workers receiving training	OECD Programme for the International Assessment of Adult Competencies (PIAAC)	Knowledge intensity
	The share of adults participating in lifelong learning	OECD Programme for the International Assessment of Adult Competencies (PIAAC)	Knowledge intensity
	E-Government	OECD Science, Technology and Industry Scoreboard 2017	Knowledge intensity
Allocation of talent	Skill mismatch	Adalet McGowan and Andrews (2015) based on the OECD Programme for the International Assessment of Adult Competencies (PIAAC)	Knowledge intensity
<b>Incentives</b>			
Entry and competition	Administrative burdens on start-ups	OECD Product Market Regulation Index	Firm turnover
	Barriers to entry in services	OECD Product Market Regulation Index	Firm turnover
	Digital Trade Restrictiveness Index	European Centre for International Political Economy	Share of computer service (ISIC Rev4 sector C72: Computer and related activities) purchases, in total purchases of intermediates.
Exit and reallocation	The OECD indicator of employment protect legislation (EPL)	OECD Indicators of Employment Protection	Firm turnover
	The share of venture capital in GDP	Eurostat	External financial dependency
	Indirect government support through R&D tax incentives	OECD Science, Technology and Industry Scoreboard 2015 - © OECD 2015	Knowledge intensity
	OECD indicator of the efficiency of insolvency regimes	OECD Insolvency Regime Indicator	External financial dependency

# Bivariate results

**Table 5. The joint effects of incentives and capabilities**

Pairwise regression results

Incentives	ENTRY AND COMPETITION											
	Administrative barriers for start-ups x Turnover				Barriers to the services sector x Turnover				DTRI X share of comp services			
	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)
<i>Incentive</i>	0.00227	-0.00120	-0.00274*	-0.00576***	0.00142	-0.00170	-0.00184**	-0.00370***	-0.0398**	-0.0691***	-0.0334**	-0.0486**
Quality of management schools x knowledge intensity	-0.0249	0.113***	0.169***	0.160***	-0.0252	0.113***	0.170***	0.160***	-0.0346	0.101***	0.172***	0.163***
<i>Incentive</i>	0.00297	-0.00143	-0.00271	-0.00614***	0.00165	-0.00163	-0.00182*	-0.00383***	-0.0261	-0.0616***	-0.0333*	-0.0659***
High Performance Work Practices x knowledge intensity	-0.00198	0.00976***	0.00532**	0.00814***	-0.00195	0.00963***	0.00523**	0.00799***	-0.00315	0.00766***	0.00484**	0.00737***
<i>Incentive</i>	0.000410	-0.00297	-0.00322	-0.00600***	0.000707	-0.00177	-0.00185*	-0.00358***	-0.0424**	-0.0765***	-0.0356**	-0.0561***
Percentage of adults with no ICT skills x knowledge intensity	0.00175	-0.00680***	-0.00831***	-0.00990***	0.00170	-0.00677***	-0.00829***	-0.00984***	0.00216	-0.00627***	-0.00816***	-0.00942***
<i>Incentive</i>	0.00330	-0.000244	-0.00202	-0.00589***	0.00167	-0.00101	-0.00144	-0.00349***	-0.0289*	-0.0508***	-0.00923	-0.0305*
Percentage of low skilled in training x knowledge intensity	0.000191	0.00745***	0.00600***	0.00939***	0.000222	0.00733***	0.00592***	0.00928***	-0.00110	0.00555***	0.00586***	0.00883***
<i>Incentive</i>	0.00327	-0.000370	-0.00225	-0.00608***	0.00164	-0.00116	-0.00162*	-0.00362***	-0.0297*	-0.0585***	-0.0203	-0.0427**
Percentage of high skilled in training x knowledge intensity	-0.000256	0.00496***	0.00346**	0.00722***	-0.000238	0.00485***	0.00338**	0.00712***	-0.00132	0.00325*	0.00319**	0.00651***
<i>Incentive</i>	0.000502	-0.00287	-0.00328	-0.00591***	0.000756	-0.00165	-0.00183*	-0.00347***	-0.0471**	-0.0638**	-0.0225	-0.0336*
Lifelong learning x knowledge intensity	-0.000750	0.00690***	0.00654***	0.00902***	-0.000686	0.00686***	0.00650***	0.00893***	-0.00197	0.00544***	0.00616***	0.00843***
Incentives	0.00186	-0.00166	-0.00219	-0.00594***	0.00117	-0.00200	-0.00107	-0.00360***	-0.0490***	-0.0674***	-0.0133	-0.0333*
E-Government x knowledge intensity	0.000214	0.00505***	0.00510***	0.00456***	0.000234	0.00498***	0.00508***	0.00448***	-0.000736	0.00383***	0.00497***	0.00426***
<i>Incentive</i>	0.00323	-0.00155	-0.00273	-0.00640***	0.00166	-0.00183*	-0.00197**	-0.00400***	-0.0230	-0.0786***	-0.0410**	-0.0821***
Skill mismatch x knowledge intensity	0.00118	-0.0156***	-0.00847***	-0.00796***	0.00112	-0.0154***	-0.00835***	-0.00781***	0.00120	-0.0162***	-0.00884***	-0.00901***

# Bivariate results

**Table 5. (continued)**

Incentives	REALLOCATION AND EXIT											
	Venture Capital x Financial Dependency				BERD indirect X knowledge intensity				EPL x Turnover			
	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)
<i>Incentive</i>	0.0714	0.444***	0.158	0.394***	-0.0186	0.252	0.0295	-0.306	-0.00564*	-0.00613***	-0.00380*	-0.00396***
Quality of management schools x knowledge intensity	-0.0581	0.0644	0.149***	0.120***	-0.0309	0.106***	0.162***	0.158***	-0.0282	0.112***	0.170***	0.162***
<i>Incentive</i>	0.129	0.418***	0.414***	0.595***	-0.0753	0.792***	0.705***	0.424**	-0.00515*	-0.00680***	-0.00282	-0.00342*
High Performance Work Practices x knowledge intensity	-0.00437	0.00476	-0.00199	-0.00124	-0.00220	0.00961***	0.00534**	0.00818***	-0.00241	0.00957***	0.00539**	0.00843***
<i>Incentive</i>	0.0715	0.439***	0.181	0.351***	-0.0483	0.597**	0.588***	0.117	-0.00592**	-0.00769***	-0.00318	-0.00306*
Percentage of adults with no ICT skills x knowledge intensity	0.00160	-0.00281	-0.00463**	-0.00534***	0.00207	-0.00858***	-0.00842***	-0.0102***	0.00193	-0.00677***	-0.00842***	-0.0102***
<i>Incentive</i>	0.00492	0.401***	0.235	0.327***	0.103	0.620**	0.634***	0.308	-0.00711*	-0.00589**	-0.00261	-0.00334
Percentage of low skilled in training x knowledge intensity	-5.96e-05	0.00434*	0.00358	0.00635***	-6.05e-05	0.00781***	0.00560***	0.00900***	-0.000189	0.00729***	0.00604***	0.00964***
<i>Incentive</i>	0.0724	0.541***	0.326**	0.373***	0.105	0.662**	0.660***	0.321	-0.00715*	-0.00612**	-0.00286	-0.00353
Percentage of high skilled in training x knowledge intensity	-0.00203	0.000671	0.00127	0.00554***	-0.000491	0.00499***	0.00316*	0.00682***	-0.000574	0.00482***	0.00350**	0.00744***
<i>Incentive</i>	0.0376	0.382***	0.214	0.328***	-0.0950	0.839***	0.803***	0.431**	-0.00589**	-0.00748***	-0.00306	-0.00280
Lifelong learning x knowledge intensity	-0.000609	0.00363	0.00320*	0.00508***	-0.000750	0.00806***	0.00658***	0.00884***	-0.000970	0.00682***	0.00663***	0.00926***
<i>Incentive</i>	-0.649**	0.114	0.143	0.316	-0.0646	0.651**	0.563***	0.285	-0.00418	-0.00604***	-0.00450**	-0.00433**
E-Government x knowledge intensity	0.00303	0.00522***	0.00609***	0.00566***	0.000426	0.00622***	0.00593***	0.00524***	0.000124	0.00503***	0.00509***	0.00462***
<i>Incentive</i>	0.0631	0.378***	0.279**	0.596***	-0.0403	0.534*	0.516**	0.161	-0.00494*	-0.00691***	-0.00298	-0.00368**
Skill mismatch x knowledge intensity	0.00379	-0.0121***	-0.00570	0.00250	0.00213	-0.0144***	-0.00842**	-0.0107***	0.00155	-0.0153***	-0.00849***	-0.00817***

# The role of broadband access

Technology	ERP	CRM	CC	CC High
High Speed Internet (>30 Mbit/s)	0.214*** (0.0477)	0.248*** (0.0425)	0.178*** (0.0378)	0.110*** (0.0343)
Constant	0.372*** (0.0303)	0.385*** (0.0264)	0.112*** (0.0204)	0.0504** (0.0196)
Observations	477	477	456	435
R-squared	0.850	0.876	0.906	0.845

**Table A.6. High-speed broadband connections are critical to the adoption of all digital**

Dependent variable: percentage of firms >10 employees adopting the digital technology

*Note:* The results show estimates for the percentage of firms adopting ERP, CRM or CC technologies regressed on the percentage of firms using high-speed internet, country and industry fixed effects; \*\*\*, \*\* and \* represent  $p < 0.01$ ,  $p < 0.05$  and  $p < 0.1$  respectively.



# Robustness check



	ERP	CRM	Cloud Computing	Cloud Computing (high)
High-speed internet	0.205*** (0.0624)	0.236*** (0.0648)	0.161*** (0.0543)	0.102** (0.0465)
EPL * Job turnover	-0.00197** (0.000806)	-0.00119* (0.000659)	-0.000594 (0.000562)	-0.000790* (0.000417)
Constant	0.576*** (0.0927)	0.503*** (0.0728)	0.181*** (0.0623)	0.139*** (0.0476)
Observations	413	413	394	376
R-squared	0.854	0.881	0.915	0.853

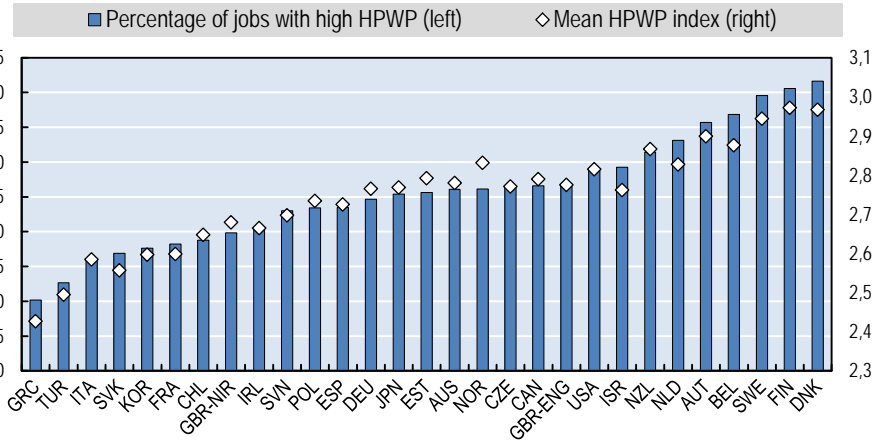
**Table B.2. EPL interacted with job turnover**

Dependent variable: percentage of firms >10 employees adopting the digital technology

# Capabilities across countries

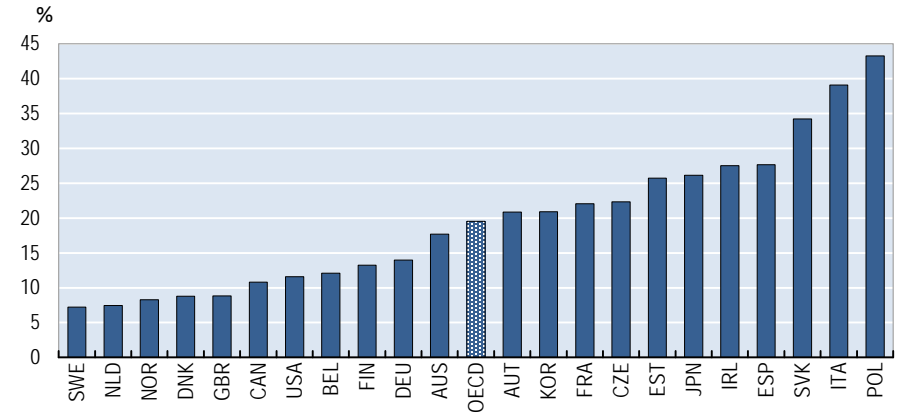
## High-Performance Work Practices (HPWP)

Share of jobs with high and mean HPWP score  
(average value, across jobs, of the HPWP index), 2012, 2015



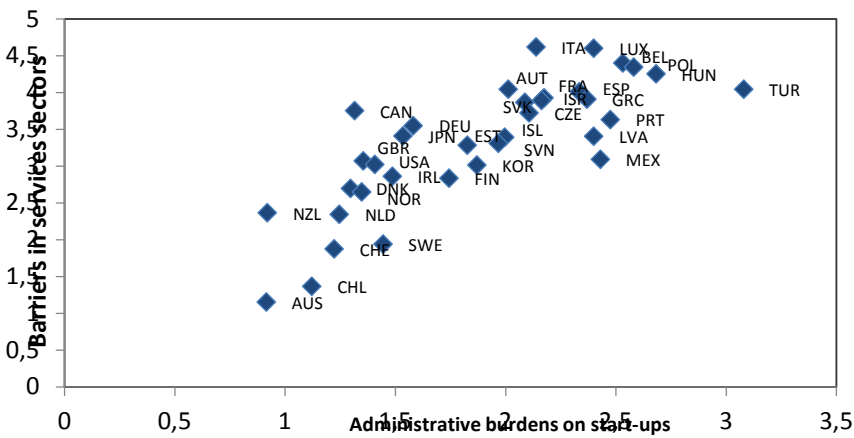
## Familiarity with ICT

Percentage share of adults (15-65) with insufficient or no ICT experience



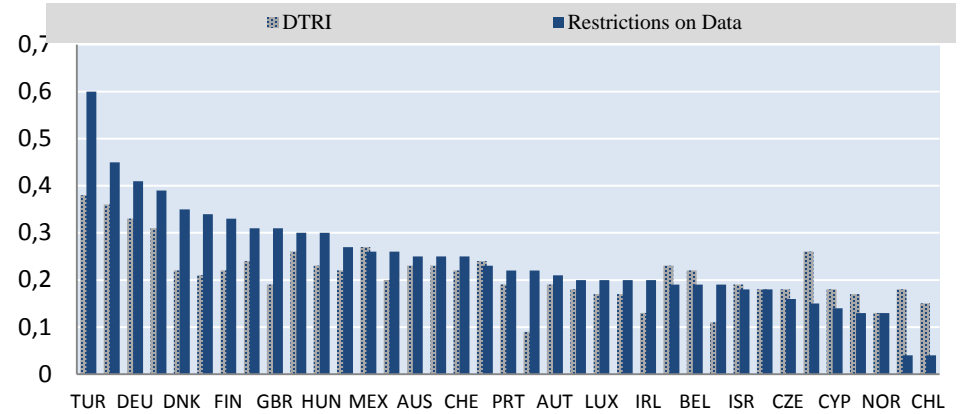
## Barriers to market access

Higher values indicate higher barriers to entry



## Barriers to digital trade

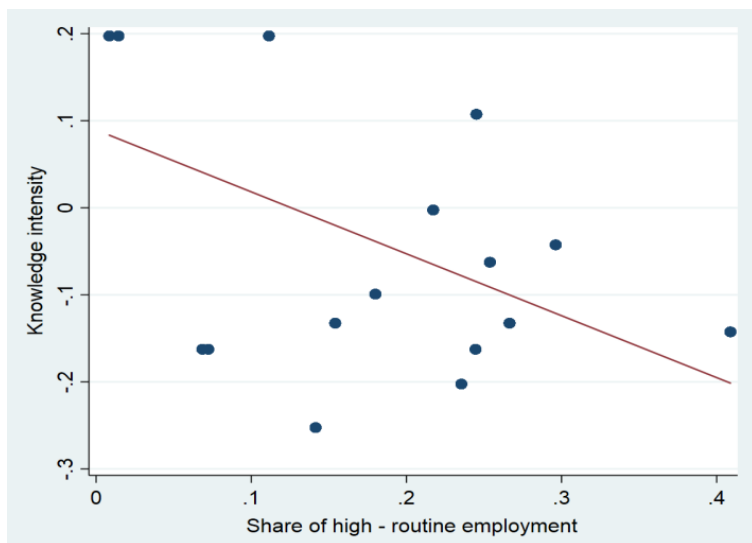
Indicator increasing in barriers to digital trade



# HR and knowledge intensity



**Figure B.1. The correlation between knowledge intensity and the share of high-routine employment**



**Table B.3. Capabilities and digital adoption – robustness to a different exposure variable**

Exposure variable: share of high routine employment

	Enterprise Resource Planning	Customer Relationship Management	Cloud Computing	Cloud Computing (complex)
<b>I. Organisational capital</b>				
Quality of Management school x share of routine tasks	0.0840*	-0.116***	-0.131***	-0.147***
High-speed broadband access (>30Mbit/s)	0.216***	0.207***	0.134**	0.0365
Observations	369	368	352	336
High performance work practices x share of routine tasks	0.00492	-0.00823**	-0.00995***	-0.0117***
High-speed broadband access (>30Mbit/s)	0.367***	0.247***	0.141*	0.0669
Observations	296	296	280	264
<b>II. Talent Pool</b>				
Percentage of adults with no ICT skills x share of routine tasks	-0.00670*	0.00222	0.00971***	0.00993***
High-speed broadband access (>30Mbit/s)	0.334***	0.210**	0.161**	0.0784
Observations	247	247	248	232
Low skilled in training x share of routine tasks	0.00103	-0.00577**	-0.00875***	-0.00996***
High-speed broadband access (>30Mbit/s)	0.338***	0.333***	0.209***	0.114
Observations	271	271	256	240
High skilled in training x share of routine tasks	0.00107	-0.00388	-0.00735***	-0.00873***
High-speed broadband access (>30Mbit/s)	0.339***	0.329***	0.205***	0.109
Observations	271	271	256	240
Lifelong learning x share of routine tasks	0.00339	-0.00245	-0.00832***	-0.00897***
High-speed broadband access (>30Mbit/s)	0.344***	0.208**	0.149*	0.0655
Observations	247	247	248	232
Skill mismatch x share of routine tasks	-0.00591	0.0130**	0.0108**	0.00825**
High-speed broadband access (>30Mbit/s)	0.319***	0.222**	0.139**	0.0650
Observations	314***	365***	0.0979***	0.0426**
E-Government x share of routine tasks	0.000298	-0.00329	-0.00363**	-0.00289*
High-speed broadband access (>30Mbit/s)	0.211**	0.205**	0.116*	0.0383
Observations	318	317	301	285