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Intangible Investments and Productivity Performance

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The views expressed are those of the authors and do not necessarily reflect the views of the European Investment Bank



1. Motivation



2. Objective and Research Questions

OBJECTIVE:

- **Assessing the impact of different types of intangible investment on productivity**

RESEARCH QUESTIONS:

- **How intangible investments affect productivity?**
- **Which types of intangible investments contribute most to productivity gains?**
- **Is the productivity of manufacturing firms differently affected by intangible investments compared to services ones?**
- **In which EU countries/regions can companies expect higher productivity returns of their intangible investments?**

3. Data



EIB Investment Survey (EIBIS)

- Annual survey
- Information about investment and financing activities
- EU 28 Member states
- Period: 2015-2017

Bureau van Dijk ORBIS database

- Financial accounting data

Our sample

- Repeated cross-sectional data
- 24,126 firm-year observations:
 - SMEs (83%) and large firms
 - Manufacturing (30%), Construction (22%), Services (23%) and Infrastructure (24%)

3. Data



Figure 1. Distribution of investment activities (% of total)

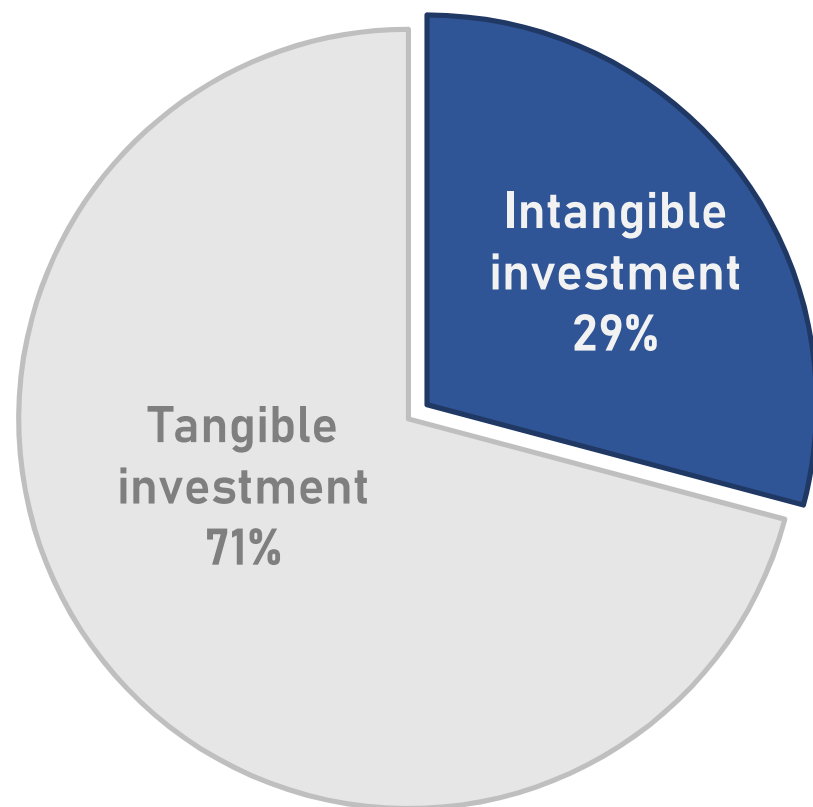
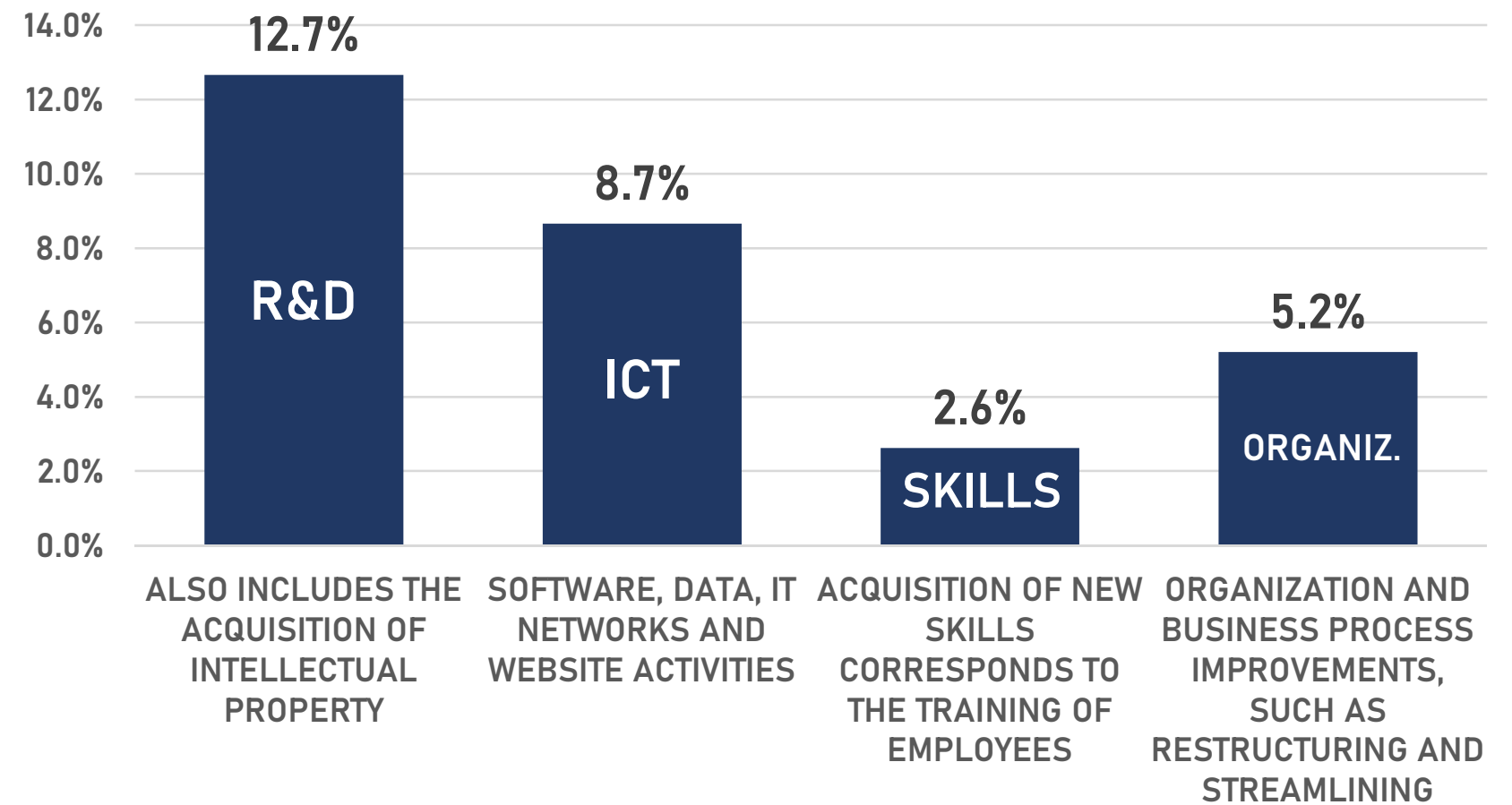


Figure 2. Intangible investments (% of total)



3. Data



Table 1. Mean of major obstacles, innovation and productivity, by investment decision

Variables	Intangible Yes		Intangible No		Diff (Yes-No)
	Mean	Std. Dev.	Mean	Std. Dev.	
N° of major obstacles	2.27	2.06	2.38	2.14	-0.11 ***
Innovation (Yes/No)	0.40	0.49	0.08	0.26	0.32 ***
Turnover per employee (€)	408,929	4,062,712	293,026	3,530,824	115,902 *

Note: N° of observations: Intangible Yes = 20,162; Intangible No = 3,964. Significance level: *** p<0.01, * p<0.1.

MAIN CONCLUSIONS:

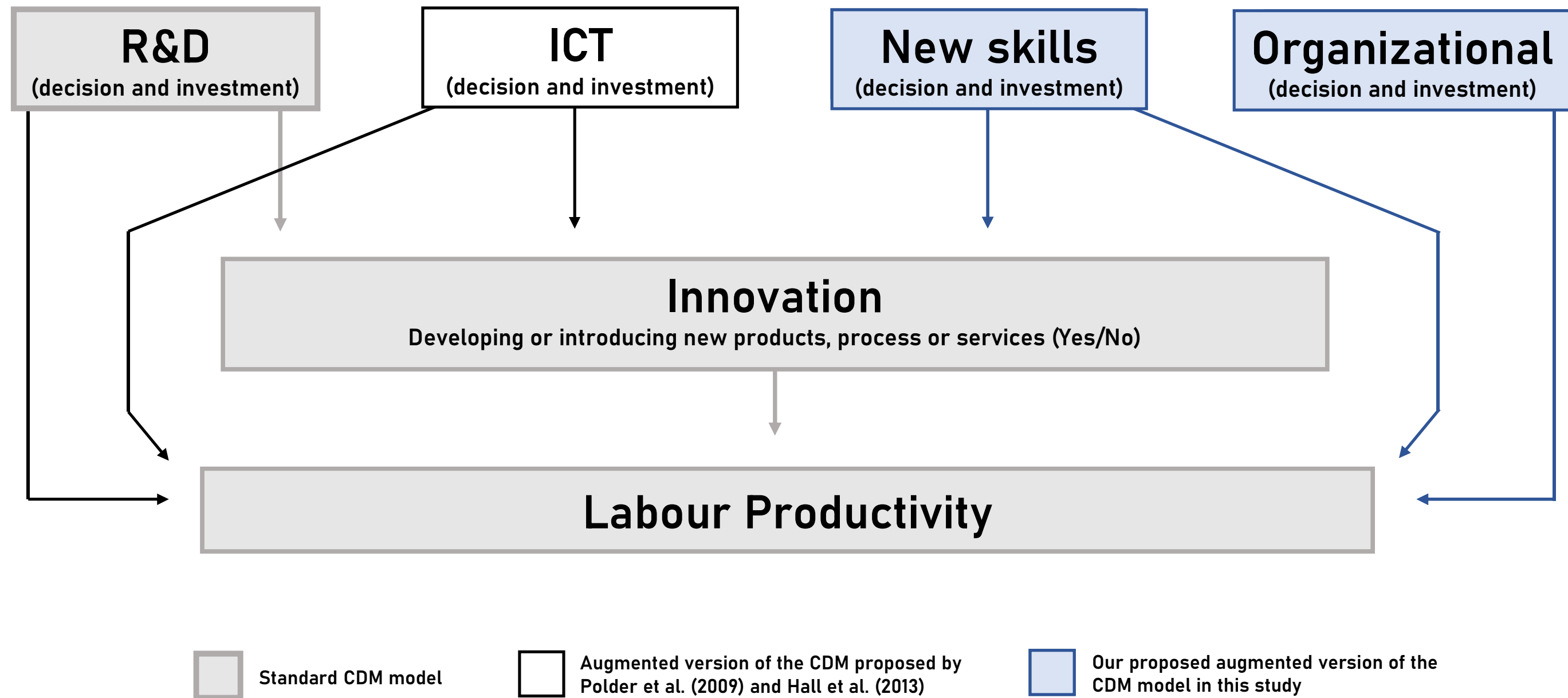
Firms investing in intangibles

➔ Face fewer major obstacles

➔ Are more innovative and more productive

4. Methodology and conceptual framework

Figure 3. Framework of the study: 3-step model



Motivation

Objective

Data

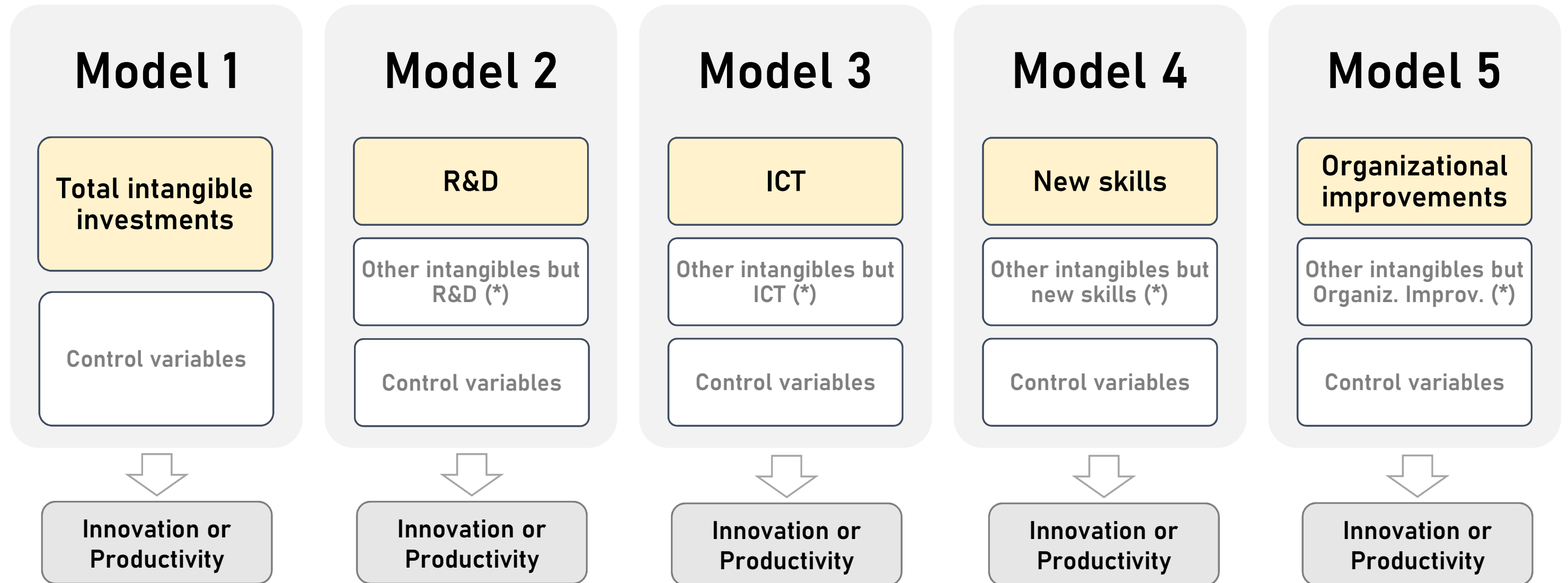
Methodology

Results

Conclusion

4. Methodology and conceptual framework

Figure 4. Framework of the study



Note: (*) corresponds to the predicted value expressed per employee (intensity of investment). Control variables in the innovation equation include tangible investment, firm size, age, exporter status, ownership, year, sector and country dummies. Control variables in the productivity equation include physical capital stock, firm size, age, export status, ownership, year, sector and country dummies.

5. Results | Step 1: Investment Decision and Intensity

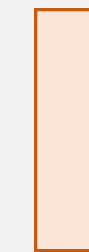
Table 2. Results of OLS regression, intensity of investment:
 $Y = \text{Log}(\text{investment in } j \text{ per employee})$

Intangible investment j:	Total Intangible		R&D		ICT		New skills		Organiz.
Inverse Mills Ratio - (invest. j) *	-2.993	***	-2.423	***	-3.723	***	-1.581	***	-1.208
Obstacle: Demand	0.005		0.046		-0.028		0.003		-0.060
Obstacle: Staff with the right skills	0.071	***	-0.014		0.035		0.101	***	-0.016
Obstacle: Energy costs	-0.134	***	-0.249	***	-0.114	***	-0.101	***	-0.017
Obstacle: Digital infrastructure	0.226	***	0.085		0.206	***	0.103	***	0.093
Obstacle: Labour market regul.	-0.060	**	-0.038		-0.092	***	-0.020		-0.049
Obstacle: Business regulations	0.110	***	0.086		0.072	**	0.032		-0.087 *
Obstacle: Transport infrastructure	0.005		0.007		0.042		0.025		0.053
Obstacle: Availability of finance	-0.010		0.051		-0.065	**	-0.058	***	0.018
Obstacle: Uncertainty	-0.075	***	-0.045		-0.068	*	-0.047	***	0.061
Firms characteristics	YES		YES		YES		YES		YES
Year, sector and country dummy	YES		YES		YES		YES		YES
N° of observations	20,162		5,904		15,151		16,573		7,575
R-Squared	0.2533		0.2913		0.2743		0.3021		0.1953

Note: Regressions include a constant. Regressions only include firms that invested in each category j . Reference category for major obstacles: minor or not an obstacle at all. Robust standard errors in parentheses. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

MAIN CONCLUSIONS:

➔ Identification of two different barriers (*) to investment activities:



DETERING BARRIERS

- Energy costs
- Labour market regulations
- Availability of finance
- Uncertainty



REVEALING BARRIERS

- Staff with right skills
- Digital infrastructure
- Business regulation

➔ ICT and new skills investments are affected by a higher number of major obstacles

(*) For more detail see D'Este et al. (2012)

5. Results | Step 2: Innovation decision

Table 3. Results of Probit regression for innovation (Yes/No), by sectors

Variables	All firms	By sectors	
		Manuf.	Services
Predicted Log intangible investment per employee	0.480 *** (0.045)	0.444 *** (0.079)	0.167 * (0.090)
Marginal effect intangible investment ($\Delta 1\%$ intangible investment $\Rightarrow \Delta$ probability to innovate)	0.163 ***	0.163 ***	0.057 *
Log (Tangible investment per employee)	0.011 ** (0.006)	0.039 *** (0.010)	0.027 ** (0.012)
No investment in tangible (Yes/No)	-0.338 *** (0.050)	-0.246 ** (0.098)	-0.251 ** (0.104)
Firms characteristics	YES	YES	YES
Year, sector and country dummy	YES	YES	YES
N° of observations	24,126	7,295	5,635

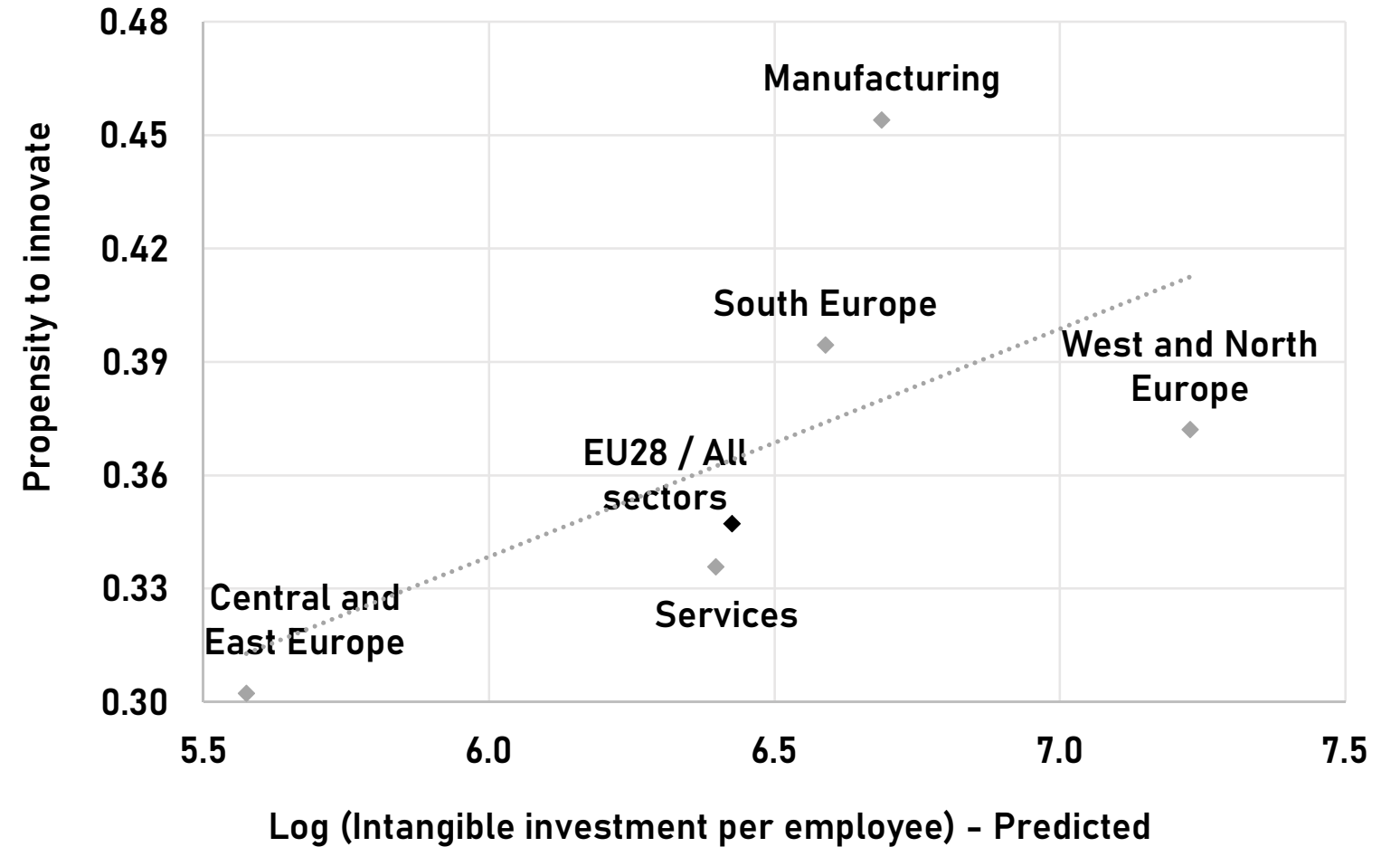
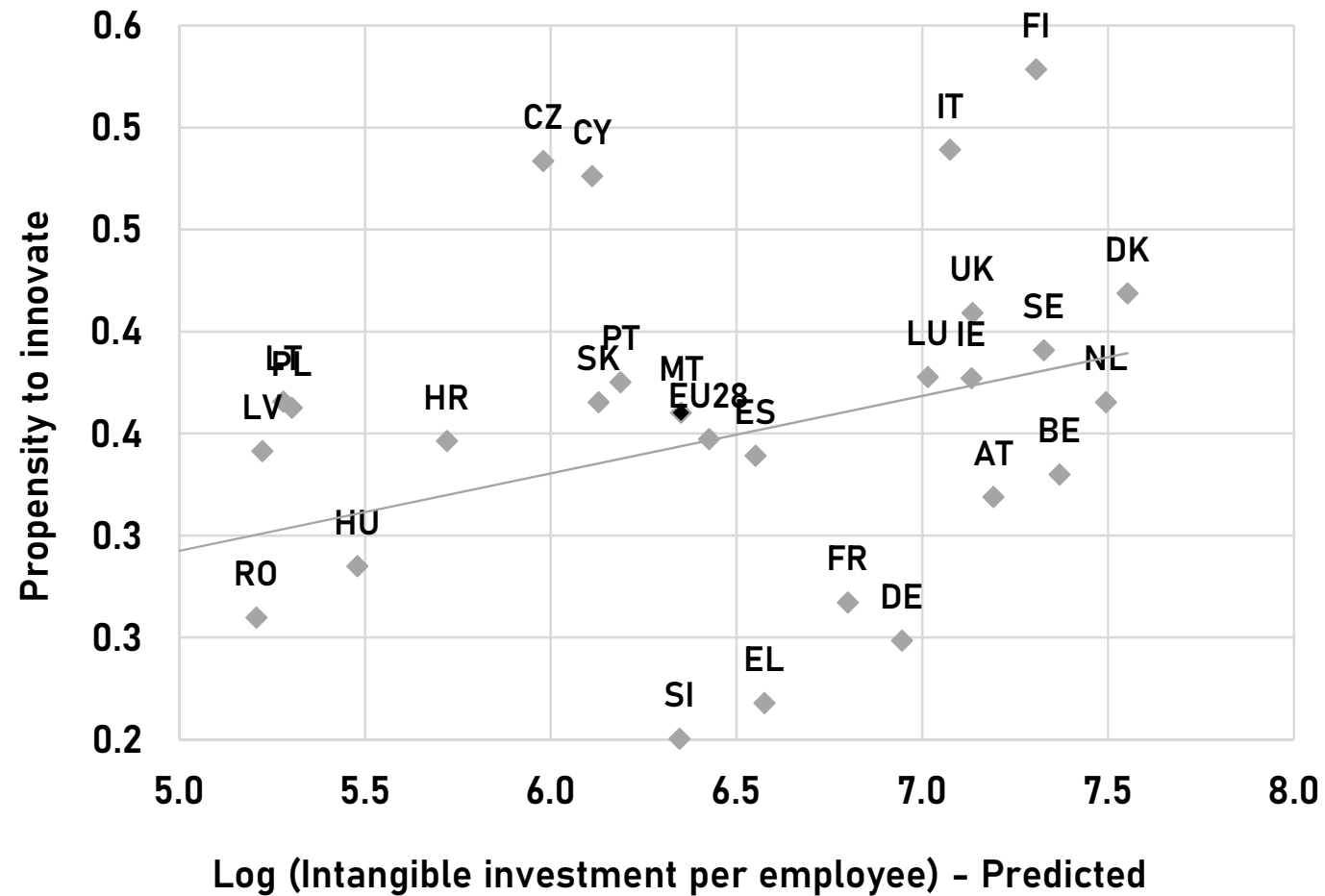
Note: Innovation = developing or introducing new products, processes or services. Firms characteristics include size (n° of employees), age, belonging in a group (Yes/No) and being exporter (Yes/No). Regressions include a constant. Robust standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

MAIN CONCLUSIONS:

- ➔ The intensity of intangible investment has a positive effect on the likelihood to innovate
- ➔ Marginal effect is higher in the manufacturing sector (0.163) than in services (0.057)

5. Results | Step 2: Innovation decision

Figure 5. Intangible investment-innovation relationship



Note: Values refer to country, European regions or sectors average.

5. Results | Step 2: Innovation decision

Table 4. Results of Probit regression model for innovation (Yes/No), by intangible investment categories

Variables	(1)	(2)	(3)	(4)
Predicted log R&D per employee	0.353 ***	-	-	-
	(0.025)	-	-	-
Predicted log ICT per employee	-	0.336 ***	-	-
	-	(0.057)	-	-
Predicted log new skills per employee	-	-	-0.082	-
	-	-	(0.094)	-
Predicted log organiz. Improv. per employee	-	-	-	-0.260 ***
	-	-	-	(0.096)
Marginal effect intangible investment	0.119 ***	0.114 ***	-0.028	-0.088 ***
Predicted Log remaining intangible investment per employee	0.227 ***	0.233 ***	0.482 ***	0.441 ***
	(0.069)	(0.064)	(0.044)	(0.043)
Tangible investment	YES	YES	YES	YES
Firms characteristics	YES	YES	YES	YES
Year, sector and country dummy	YES	YES	YES	YES
N° of observations	24,126	24,126	24,126	24,126

MAIN CONCLUSIONS:

- ➔ R&D and ICT: positive effect on the probability to innovate
- ➔ The acquisition of new skills, through employee training: no significant effect
- ➔ Organizational and business process improvements: negative effect

Note: Marginal effect of intangible investment = Δ 1% intangible investment \Rightarrow Δ probability to innovate. Innovation = developing or introducing new products, processes or services. Firms characteristics include size (n° of employees), age, belonging in a group (Yes/No) and being exporter (Yes/No). Regressions include a constant. Robust standard errors in parentheses. Significance level: *** p<0.01, ** p<0.05, * p<0.1.

5. Results | Step 3: Productivity

Table 5. Results of labour productivity equation (OLS), by sectors:
 $Y = \text{Log}(\text{turnover per employee})$

Variables	All firms	By sectors	
		Manuf.	Services
Predicted Innovation propensity	0.095 ** (0.046)	0.575 *** (0.085)	-0.151 * (0.091)
Predicted Log Intangible investment per employee	0.358 *** (0.044)	0.117 * (0.071)	0.806 *** (0.087)
Log(Stock capital per employee)	0.112 *** (0.005)	0.152 *** (0.011)	0.093 *** (0.009)
Firms characteristics	YES	YES	YES
Year, sector and country dummy	YES	YES	YES
N° of observations	24,126	7,295	5,635
R-Squared	0.360	0.423	0.313

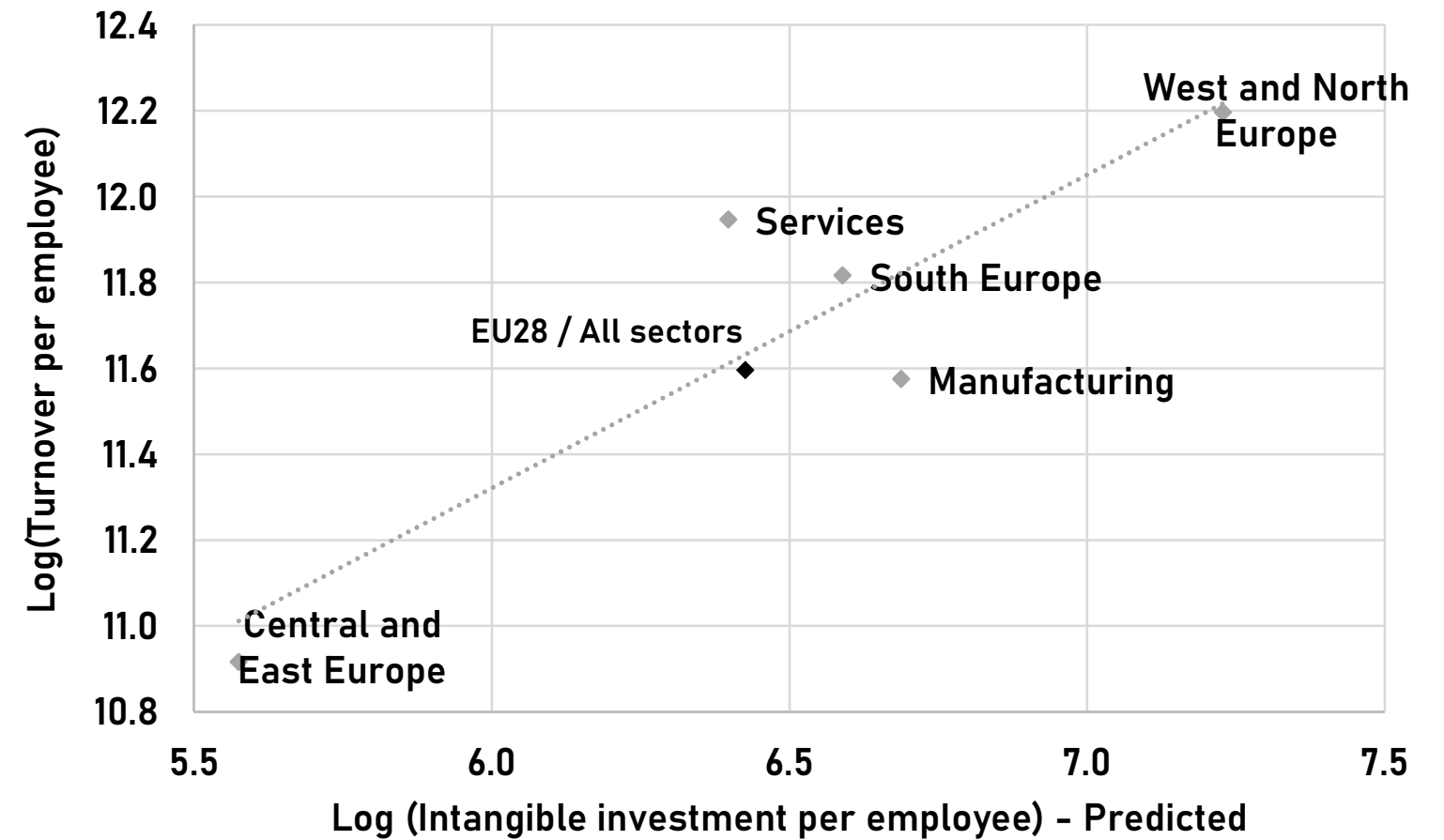
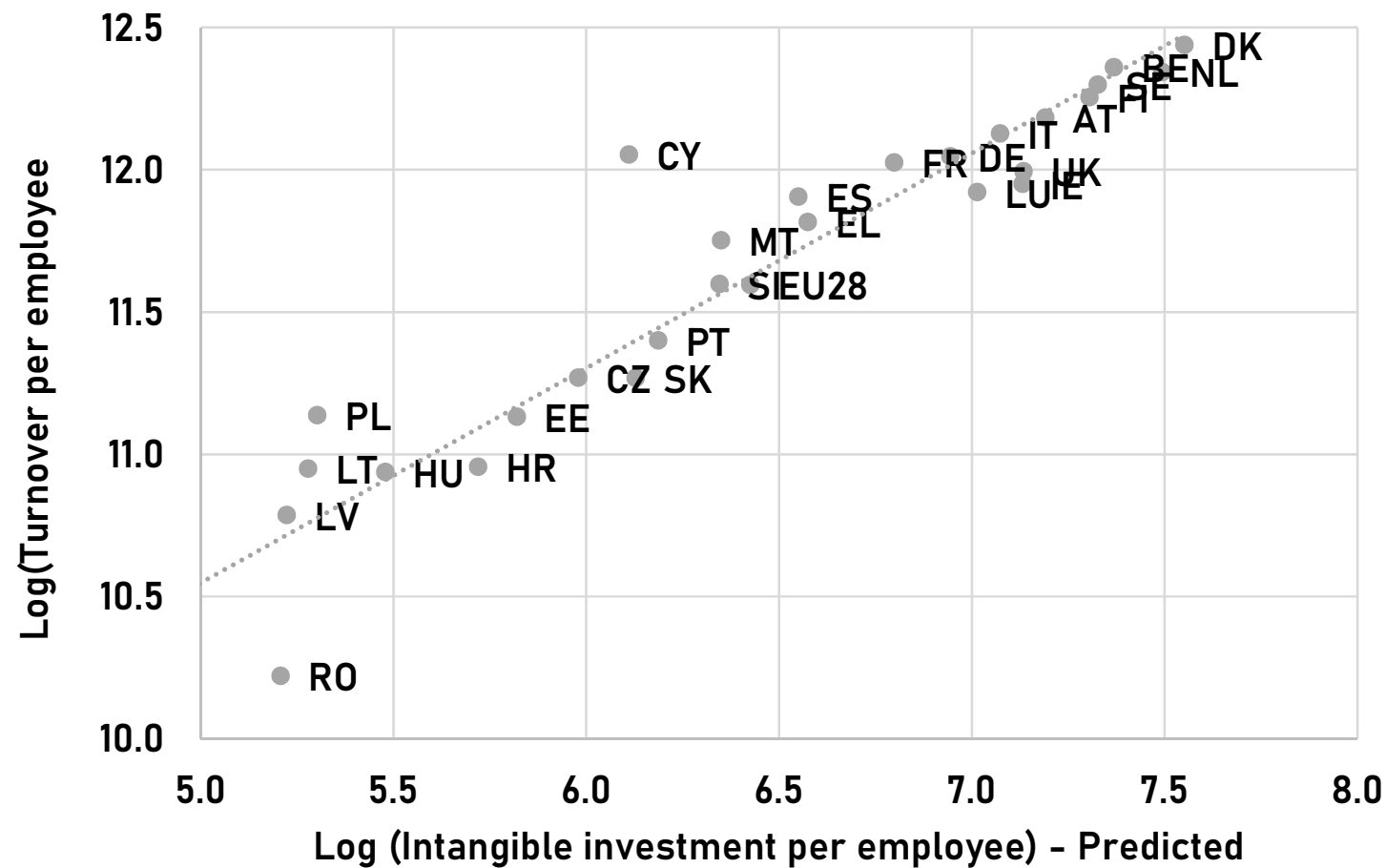
Note: Firms characteristics include size (n° of employees), age, belonging in a group (Yes/No) and being exporter (Yes/No). Regressions include a constant. Robust standard errors in parentheses.
 Significance level: *** p<0.01, ** p<0.05, * p<0.1.

MAIN CONCLUSIONS:

- ➔ Positive effect of intangible investment on productivity in all sectors
- ➔ Innovation propensity has a negative effect in Services sectors (⇒ direct effect is more important in explaining productivity gains)

5. Results | Step 3: Productivity

Figure 6. Intangible investment-productivity relationship



Note: Values refer to country, European regions or sectors average.

5. Results | Step 3: Productivity

Table 6. Results of labour productivity equation (OLS), by intangible investment categories: $Y = \text{Log}(\text{turnover per employee})$

Variables	(1)	(2)	(3)	(4)
Predicted value – Innovation propensity	0.137 *** (0.044)	0.128 *** (0.045)	0.116 *** (0.045)	0.107 ** (0.046)
Predicted log R&D per employee	0.046 * (0.025)	-	-	-
Predicted log ICT per employee	-	0.505 *** (0.047)	-	-
Predicted log new skills per employee	-	-	0.592 *** (0.078)	-
Predicted log organiz. Improv. per employee	-	-	-	0.252 *** (0.081)
Predicted Log remaining intangible investment per employee	0.458 *** (0.058)	-0.138 ** (0.054)	0.067 (0.041)	0.307 *** (0.041)
Capital stock and firms characteristics	YES	YES	YES	YES
Year, sector and country dummy	YES	YES	YES	YES
N° of observations	24,126	24,126	24,126	24,126
R-Squared	0.360	0.363	0.362	0.361

MAIN CONCLUSIONS:

- ➔ Direct and indirect effects of intangible investments on productivity
- ➔ ICT and new skills are more important in explaining productivity than R&D and organizational improvements

Note: Robust standard errors in parentheses. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Regressions include a constant. Firms characteristics include size (n° of employees), age, belonging in a group (Yes/No) and being exporter (Yes/No).

6. Conclusion

How intangible investments affect productivity?

- **Intangible investments affect labour productivity directly and indirectly through innovation**
- **The effect of intangible investments on innovation and productivity doesn't appear to be different across different EU regions**
- **Differences in terms of impact are more visible across sectors:**
 - **Manufacturing sector: the effect on productivity appears to be more indirect (through innovation)**
 - **Services sector: the effects on productivity is more direct**

6. Conclusion

Which types of intangible investments contribute most to productivity gains?

- **R&D investment seems to be more associated with innovation than productivity and its effect on productivity is less important in comparison to ICT and new skills**
- **ICT investment has a decisive effect on both the propensity to innovate and productivity gains**

POLICY RECOMENDATIONS:

- **More supportive ecosystem for investments in ICT and the acquisition of new skills ➡ enhance productivity growth, and to ensure higher competitiveness**

Thank you for your attention

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APPENDIX

4. Methodology and conceptual framework

Step 1: Investment Decision and Intensity

$$\begin{cases} \Pr\{INV_{j,i,t}\} = f(FC_{i,t}, MC_{i,t}, CAP_{i,t}, Z_{j,i,t}) \\ INV_{j,i,t} = f(\widehat{IMR}_{j,i,t}, FC_{i,t}, MC_{s,t}, CAP_{i,t}, OB_{i,t}) \end{cases}$$

where:

- $INV_{j,i,t}$: intangible investment j , with $j = RD, ICT$, new skills or organisational improvements
- $FC_{i,t}$: firm characteristics (size, age, ownership - belonging to a group, and export status)
- $MC_{s,t}$: market conditions in sector s (competition level - HHI)
- $Z_{j,i,t}$: percentage of firms in each industry-year investing in intangible j
- $\widehat{IMR}_{j,i,t}$: inverse Mills ratio intangible investment j
- $CAP_{i,t}$: production capacity (to be above maximum capacity production - Yes/No)
- $OB_{i,t}$: obstacles to investment activities in general

4. Methodology and conceptual framework

Step 2: Innovation decision

$$\Pr\{\text{INNO}_{j,i,t}\} = f(\text{FC}_{i,t}, \text{TANG}_{i,t}, \sum \widehat{\text{INV}}_{j,i,t})$$

where:

- $\text{INNO}_{j,i,t}$: aim of firms' investment - developing or introducing new products, processes or services
- $\text{FC}_{i,t}$: firm characteristics (size, age, ownership - belonging to a group, and export status)
- $\text{TANG}_{i,t}$: non-intangible investment per employee
- $\sum \widehat{\text{INV}}_{j,i,t}$: sum of predicted value of intangible investment per employee

4. Methodology and conceptual framework

Step 3: Productivity

$$LP_{i,t} = f(FC_{i,t}, K_{i,t}, \widehat{INNO}_{j,i,t}, \sum \widehat{INV}_{j,i,t})$$

where:

- $FC_{i,t}$: firm characteristics (size, age, ownership - belonging to a group, and export status)
- $K_{i,t}$: capital stock per employee (tangible fixed assets)
- $\widehat{INNO}_{j,i,t}$: predicted innovation decision/probability
- $\sum \widehat{INV}_{j,i,t}$: sum of predicted value of intangible investment per employee

5. Results | | Step 1: Investment Decision

Table A1. Results of Probit regression: $Y = \text{Investing in intangible } j$

Variables	$j = \text{Total intangible}$		$j = \text{R\&D}$		$j = \text{ICT}$		$j = \text{New skills}$		$j = \text{Organiz.}$	
	(1)		(2)		(3)		(4)		(5)	
% of firms investing in j (1)	1.758	***	2.035	***	1.282	***	1.136	***	0.319	*
	(0.181)		(0.090)		(0.133)		(0.152)		(0.193)	
Average wage per employee in the sector (2)	-		-		-		0.0381		-	
	-		-		-		(0.027)		-	
Log(n° employees)	0.476	***	0.114	***	0.301	***	0.731	***	0.298	***
	(0.035)		(0.030)		(0.030)		(0.028)		(0.027)	
Log(n° employees) - Squared	-0.032	***	0.003		-0.016	***	-0.064	***	-0.017	***
	(0.004)		(0.003)		(0.003)		(0.003)		(0.003)	
Belonging to a group (Y/N)	-0.016		-0.090	***	-0.172	***	0.030		-0.075	***
	(0.027)		(0.023)		(0.021)		(0.022)		(0.021)	
Exporter (Y/N)	0.203	***	0.436	***	0.223	***	0.098	***	0.193	***
	(0.023)		(0.022)		(0.019)		(0.020)		(0.020)	
Above maximum capacity (Y/N)	0.133	***	0.093	**	0.110	***	0.083	**	0.162	***
	(0.050)		(0.041)		(0.039)		(0.041)		(0.038)	
Competition	-1.318	***	0.660		-0.039		-0.487		-0.147	
	(0.506)		(0.438)		(0.402)		(0.425)		(0.395)	
Competition - Squared	0.755	**	-0.561	*	-0.085		0.242		0.109	
	(0.357)		(0.313)		(0.287)		(0.302)		(0.283)	
Firm age	YES		YES		YES		YES		YES	
Year, sector and country dummy	YES		YES		YES		YES		YES	
N° of observations	24,126		24,126		24,126		24,126		24,126	
Pseudo R2	0.111		0.151		0.079		0.098		0.061	

Note: Robust standard errors in parentheses. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. (1) Different in each equation and estimated at NACE 2-digits. (2) Refers to the mean log wage per employee in the NACE 2-digit sector. Regressions include a constant.

MAIN CONCLUSIONS:

- ➔ Exclusion restrictions (percentage of firms in the industry-year that invest in intangible j and excluding the firm i decision) are relevant in explaining the different investment decisions
- ➔ Exclusion restriction was selected following Alvarez (2016)

5. Results | Step 2: Innovation decision

Table A2. Results of Probit regression for innovation (Yes/No) by European regions

Variables	Central and East	South	West and North
Predicted Log intangible investment per employee	0.432 *** (0.064)	0.539 *** (0.103)	0.762 *** (0.084)
Marginal effect intangible investment	0.138 ***	0.188 ***	0.267 ***
Log (Tangible investment per employee)	0.030 *** (0.009)	0.022 * (0.012)	-0.006 (0.009)
No investment in tangible (Yes/No)	-0.354 *** (0.080)	-0.354 *** (0.112)	-0.315 *** (0.080)
Firms characteristics	YES	YES	YES
Year, sector and country dummy	YES	YES	YES
N° of observations	10,013	4,386	9,727

Note: Marginal effect of intangible investment = $\Delta 1\%$ intangible investment $\Rightarrow \Delta$ probability to innovate. Innovation = developing or introducing new products, processes or services. Firms characteristics include size (n° of employees), age, belonging in a group (Yes/No) and being exporter (Yes/No). Regressions include a constant. Robust standard errors in parentheses. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

MAIN CONCLUSIONS:

➔ Marginal effect in West and North Europe (0.267) is higher and statistically different compared to other regions (0.138 and 0.188)

5. Results | Step 3: Productivity

Table A3. Results of labour productivity equation (OLS), by European regions: $Y = \text{Log}(\text{turnover per employee})$

Variables	Central and East	South	West and North
Predicted Innovation propensity	0.187 ** (0.074)	0.238 ** (0.106)	-0.073 (0.071)
Predicted Log Intangible investment per employee	0.318 *** (0.069)	0.249 ** (0.104)	0.427 *** (0.072)
Log(Stock capital per employee)	0.145 *** (0.007)	0.118 *** (0.011)	0.081 *** (0.007)
Firms characteristics	YES	YES	YES
Year, sector and country dummy	YES	YES	YES
N° of observations	10,013	4,386	9,727
R-Squared	0.283	0.177	0.122

Note: Firms characteristics include size (n° of employees), age, belonging in a group (Yes/No) and being exporter (Yes/No). Regressions include a constant. Robust standard errors in parentheses.
Significance level: *** p<0.01, ** p<0.05, * p<0.1.

MAIN CONCLUSIONS:

➔ Innovation propensity has no significant effect in West and North Europe