S3, artificial Intelligence and regional disparities

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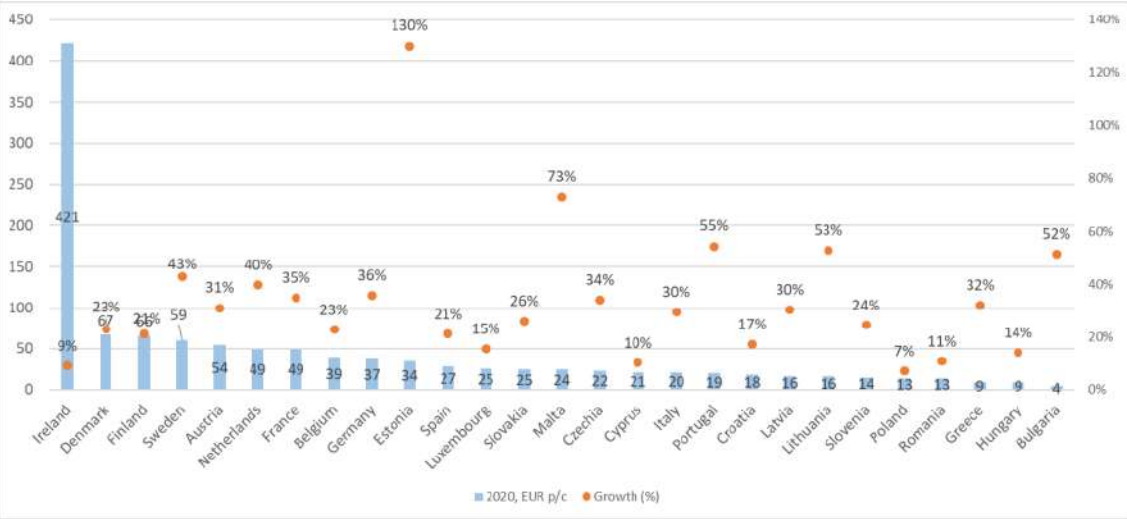
European Commission

1. Context 

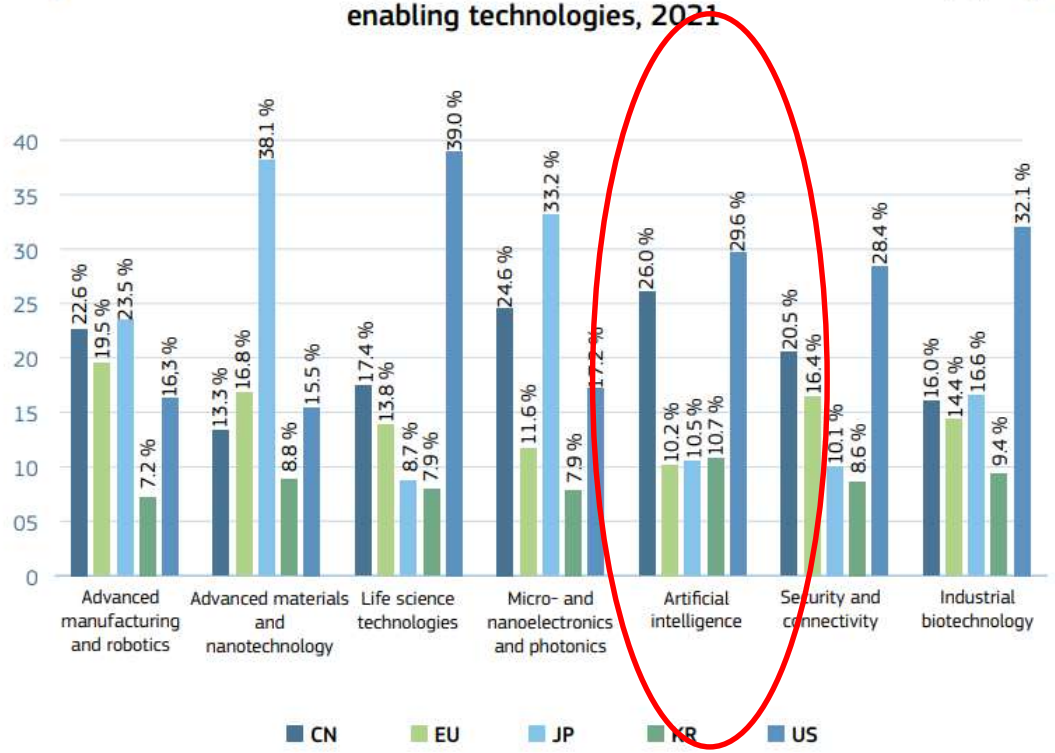
AI: world and EU's laggards

Figure 10: AI investments per capita by country (EUR) in 2020 and growth between 2019 and 2020



Source: JRC based on EUROSTAT, Spintan and Intan-Invest. Note: max scenario (see Annex I).

Figure 2.2-2 World share (%) of patent applications filed under PCT[1], by key enabling technologies, 2021



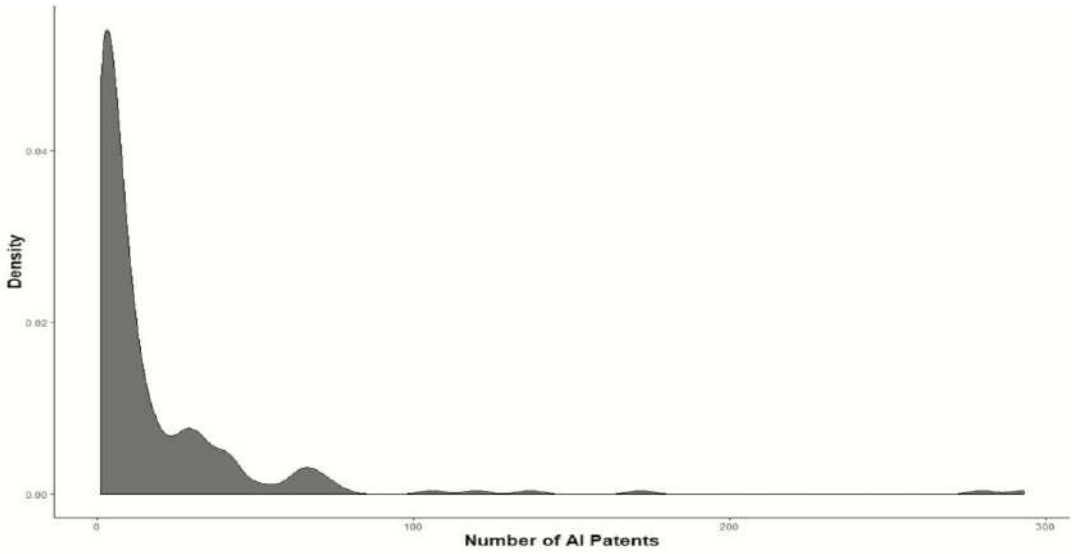
Science, research and innovation performance of the EU 2024

Source: DG Research and innovation, Common R&I Strategy and Foresight Service, Chief Economist Unit, based on Fraunhofer ISI, using PATSTAT.

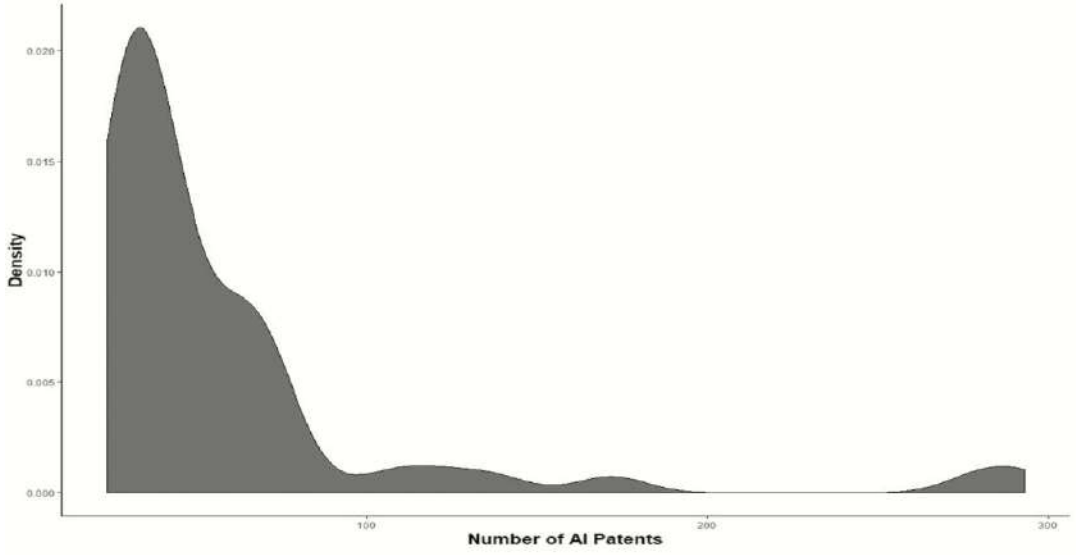
Notes: [1] Patent Cooperation Treaty (PCT) patents. Fractional counting method, inventor's country of residence and priority date used.

An uneven geography

- The distribution of AI patents across regions is highly skewed
- A mere 23 regions account for 39.9% of all patented AI knowledge production



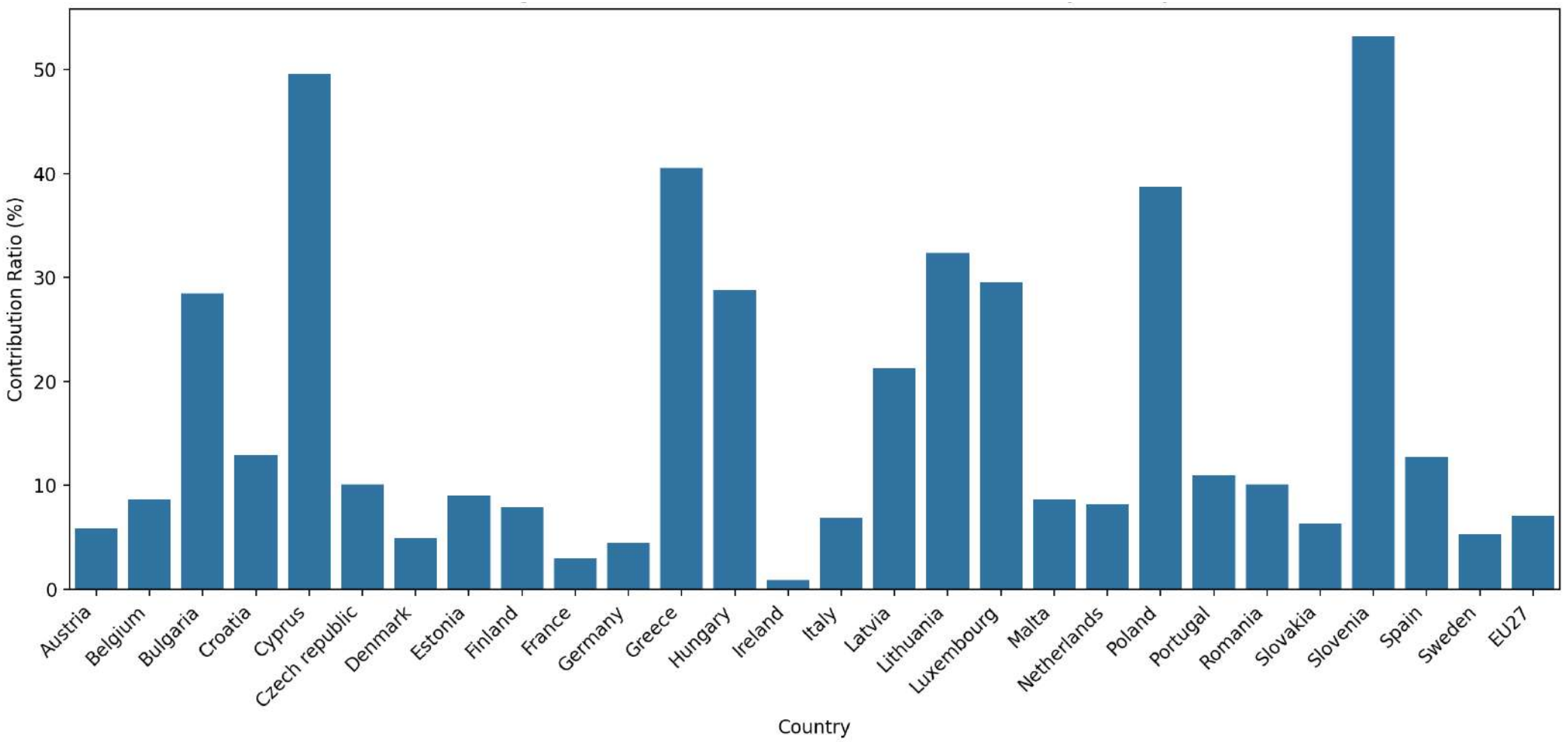
(a) All regions



(b) 75th percentile

Source/figures: Buarque, B. S., Davies, R. B., Hynes, R. M., & Kogler, D. F. (2020). OK Computer: the creation and integration of AI in Europe. Cambridge Journal of Regions, Economy and Society, 13(1), 175-192.

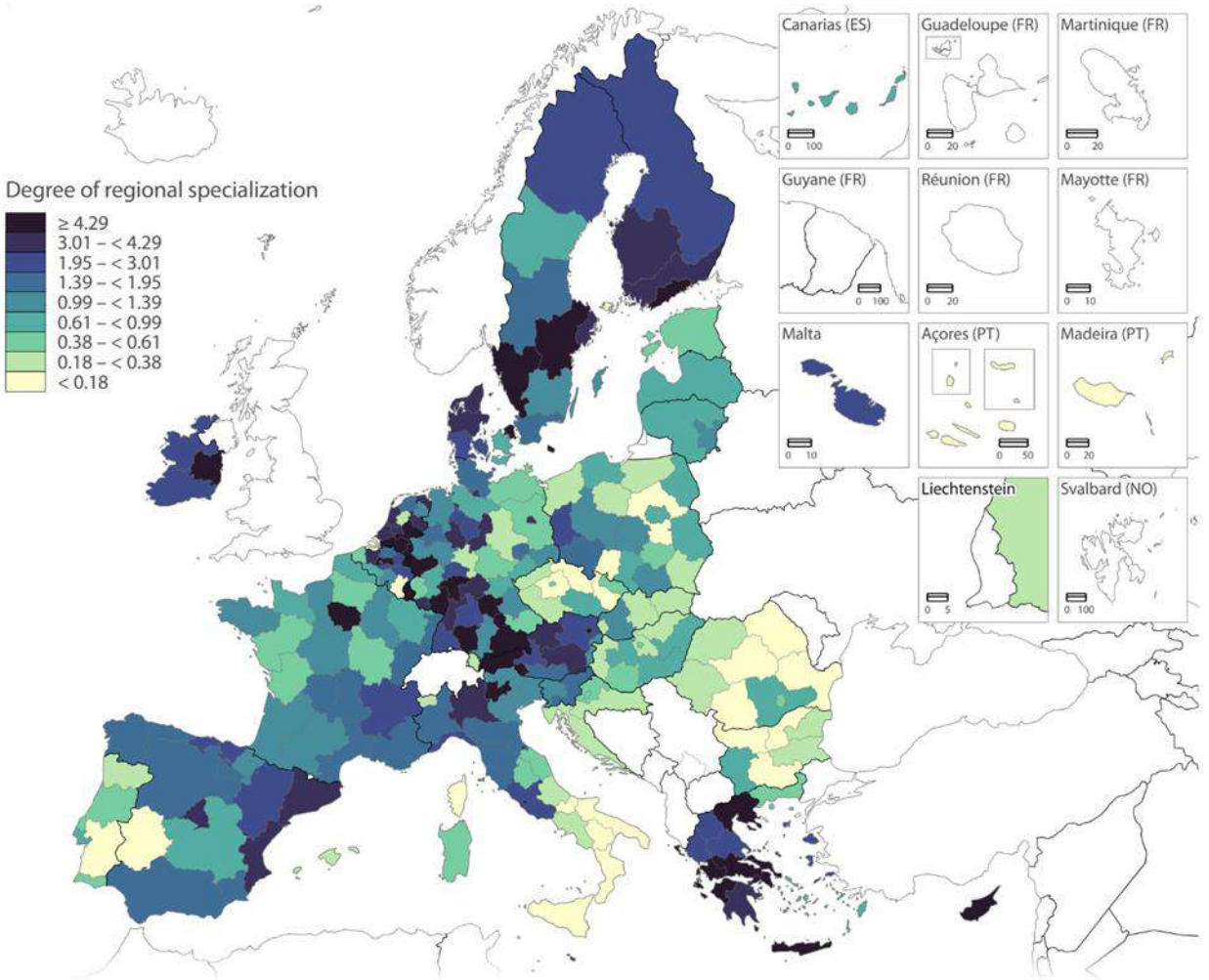
Average contribution of EU funds to domestic investment in AI



Source: Marques Santos, A., Molica, F., & Torrecilla Salinas, C. (2024). EU-funded investment in Artificial Intelligence and regional specialization (No. 181). Gabinete de Estratégia e Estudos, Ministério da Economia.

Uneven geography of EU investment in AI

Degree of EU funds specialization in AI (by region): defined as the ratio between share of EU-funded allocated AI projects (over total ERDF + H2020) at regional level (NUTS2) and share of AI projects at EU level



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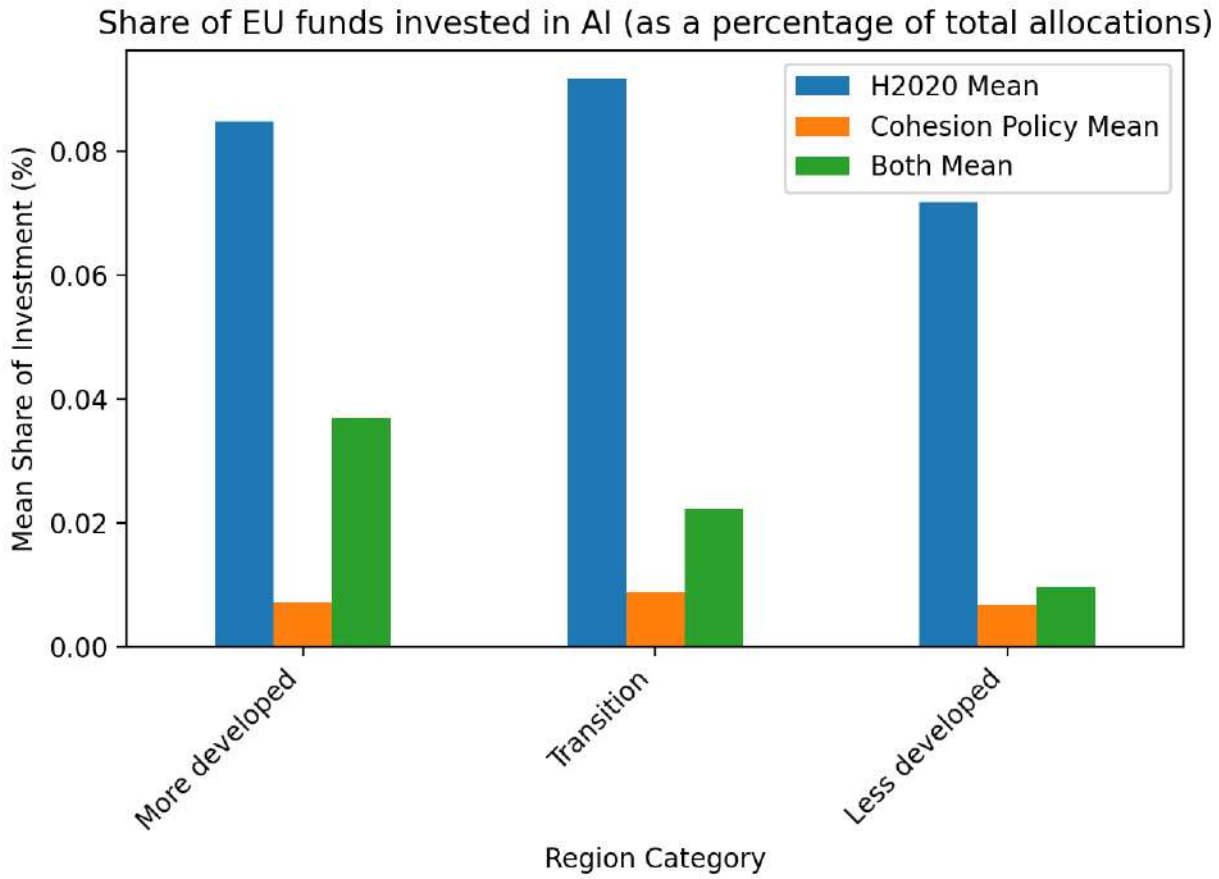

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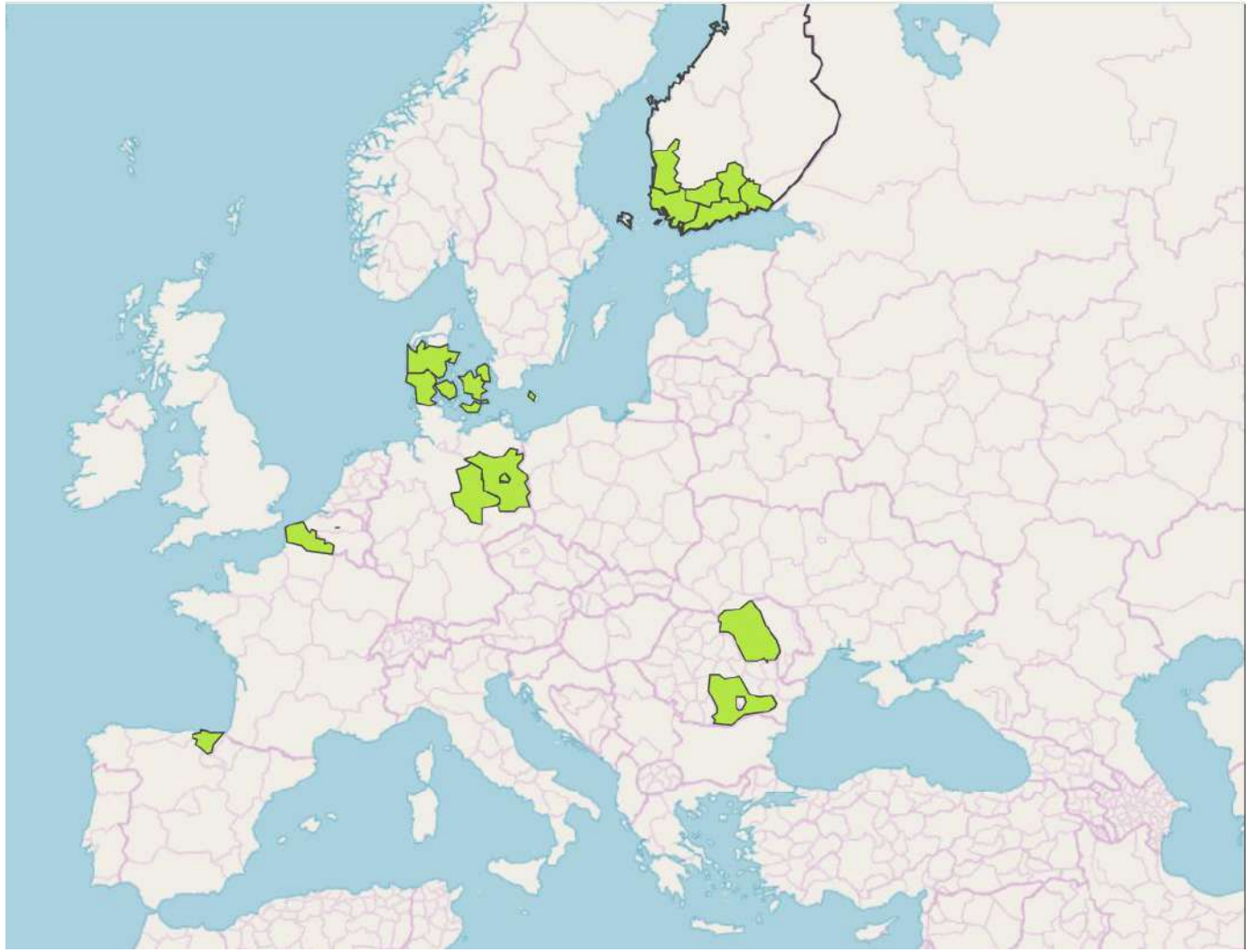
Research gaps

- Empirical literature on the determinants of AI specialization/uptake is in its early stages (Igna and Venturini, 2023)
- Literature on the “geography of AI” is very limited and focuses on AI patent (Buarque et al., 2020; Cicerone et al., 2023)
- There are no analyses (bar Santos et al., 2024) focusing on the distribution of AI-related investment at regional level and the contribution of EU funding

2. S3 and AI

AI in Smart Specialization Strategies



2014-2020 period: 17 regions

2021-2027: 33 regions

Italy: Sicily, Calabria, Emilia Romagna, Lombardy

Can S3 be a critical framework to encourage AI development/uptake?

- Extensive body of research on the theoretical underpinnings and implementation of S3s, including from a critical perspective (e.g. Molica, 2024; Capello and Kroll, 2016; Radosevic, 2017; Hassink and Gong, 2019)…but little empirical work on the actual impact of S3

- That the choice to include AI in S3 results cannot be taken for grated: gaps between the selection of S3 priorities and actual regional specializations (or specialization potentials) (Di Cataldo et al., 2021) + discrepancies between these priorities and the subsequent allocation of EU funds or capacity to attract them (D'Adda et al., 2019).

- This indicates that a government's commitment to support an innovation area does not necessarily imply the existence of adequate local conditions (knowledge specialization, skilled labour, etc) to generate sufficient demand for funding in that area, nor does it guarantee the government's ability or willingness to promote these conditions effectively.

JRC study on EU investment in AI and S3*

- Investigate the spatial distribution (“specialization”) of AI-related (public) investment in Europe using EU funds data as a proxy
- Explore the territorial determinants of (EU) investment in AI
- **Ascertain if investment in AI are the result of specific economic objectives and sectoral and technological preferences formulated in the frame of S3s**

**Marques Santos, A., Molica, F., & Torrecilla Salinas, C. (2024). EU-funded investment in Artificial Intelligence and regional specialization (No. 181). Gabinete de Estratégia e Estudos, Ministério da Economia.*

Research hypotheses

1. *A higher concentration of ICT activities tend to drive a higher specialisation of public investment in AI-related activities*

2. *More developed regions (more productive and/or more innovative) tend to be more specialised in public investment in AI*

3. *Investment specialisation in AI and market competition display an inverted U-shaped relationship*

4. *Investment specialization in AI is higher in regions who have identified it as a priority area in their Smart Specialization Strategies*

3.Data and methodological approach 

Methodological approach and data sources

- Degree of regional specialization is defined as the ratio between share of EU-funded AI projects (ERDF + H2020) at regional level (NUTS2) and share of AI projects at EU level

$$DRS_i = \frac{S_i}{S_{EU}} = \frac{\frac{AI_i}{TT_i}}{\frac{AI_{EU}}{TT_{EU}}}$$

- Data sources: Beneficiaries of cohesion policy funds is Kohesio platform and the list of H2020 projects from the Horizon dashboard.

- AI-related projects are identified using text-mining techniques to projects' title and description. The list of keywords are extracted from the European Commission's report on the definition of AI (Samioli et al., 2020).

Model description (1/2)

A **spatial autoregressive (SAR) model** is used to avoid biased and inconsistent estimates by ignoring spatial effects (given the use of NUTS2 data)

$$DRS_i = \alpha + \rho WDRS_j + \beta X_i + u_i$$

Xi: exploratory variables region i

$\rho WDRS_j$: degree of specialization in neighboring regions

Model description (2/2)

Explanatory variables	Description
Regional specialization in ICT services	Concentration of employment in ICT services: Ratio of the share of employment in ICT services in region i over the share of employment in ICT services in the EU
Market competition at regional level	Inverse of Herfindahl (1950) and Hirschman (1945) Index (HHI) using the sectorial concentration of employment of 56 economic activities.
Degree of innovativeness of a region	Measured by the stock of patent applications estimated using the perpetual inventory method and a depreciation rate of 5% following Cicerone et al. (2023).
Level of regional development	GVA per capita
Government's commitment to invest in AI	Dummy variable equal 1 if the AI-related investment is considered an innovation priority in the Smart Specialisation Strategy

3. Key results 

Econometric model

Table 5. Results of spatial autoregressive (SAR) model, dependent variable: degree of regional specialization in AI (DRS_i)

Variables	Pooled OLS	SAR	
		Maximum likelihood	Generalized spatial two-stage least squares
	(1)	(2)	(3)
Regional specialisation in ICT services	0.277	0.461**	0.482**
	(0.216)	(0.193)	(0.215)
Competition	6.624***	6.290***	6.253***
	(1.419)	(1.868)	(1.399)
Competition – Squared	-0.0380***	-0.0359***	-0.0357***
	(0.00807)	(0.0106)	(0.00795)
Smart Specialisation (Yes/No)	0.344*	0.344**	0.344**
	(0.180)	(0.169)	(0.169)
Stock of patents	0.0418***	0.0371***	0.0365***
	(0.0152)	(0.0113)	(0.0117)
GVA per capita	0.0581***	0.0336**	0.0309*
	(0.0128)	(0.0133)	(0.0168)
W.Y	-	0.304***	0.338**
	-	(0.0702)	(0.133)
var(u.Y)	-	1.545***	-
	-	(0.185)	-
Constant	-288.8***	-275.4***	-273.9***
	(62.26)	(82.14)	(61.45)
Observations	235	235	235
R-squared / Pseudo R-squared	0.3338	0.3502	0.3501
Log pseudolikelihood	-	-387.18	-
Joint significance (p-value)	0.0000	0.0000	0.0000
Wald test of spatial terms (p-value)	-	0.0000	0.0113
Ramsey test for omitted variables (p-value)	0.0585	0.2327	0.2212

Results

- Regional specialization of investment in AI in neighboring regions is positively and significantly interlinked
- The degree of regional specialization of EU-funded investment in AI is positively correlated with a region specialization in ICT services, as well as the degree of innovativeness and level of development of the region
- Regions with a higher level of competition tend to exhibit a higher specialization of funds in AI, although when faced with higher competition pressure this specialization patterns tend to decrease
- Having AI as a priority in the innovation policy of a region is positively associated with a higher specialization on EU-funded projects related to AI.

4. Conclusions

Some final reflections

- AI-related activities (and investment) are already highly spatially concentrated, which might deepen existing territorial disparities given the growing economic relevance of the technology
- Public policies at EU, national and regional level should address this risk by continuing to target the root causes of Europe's innovation divide: education, demography and quality of institutions, among others.
- Role of AI in S3s geared at societal challenges under the so-called third paradigm of innovation policies

Thank you

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