AI and Firm Turnover in the EU

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Why This Study?

- In economic terms, AI is increasingly viewed as a **transformative general-purpose technology (GPT)** that can reshape how firms operate, compete, and innovate.
- However, when we look at the data — especially for Europe — the picture becomes less clear.
  - The empirical literature tells us little about what AI actually does at the **firm level**.
  - Evidence is particularly scarce for **commercial outcomes**, such as turnover.
- The main reason is the lack of **systematic, comparable firm-level data** on AI adoption.
  - Some aggregate country-level indicators exist, but firm-level data are limited.
  - Traditional innovation surveys (e.g., CIS) did **not** include AI questions and offer no panel structure.
  - They are less detailed to capture AI applications.

Research Questions

Overall aim: To understand whether AI creates real commercial value for European firms, and under which conditions these gains emerge.

We focus on four main questions:

1. Is AI positively associated with higher firm turnover in the EU?
2. How important are **complementary digital technologies** (e.g. big data, cloud, robotics)?
   - AI's benefits often depend on these complements, which provide the data, infrastructure, and automation required for AI to generate meaningful performance gains.
3. Does the AI–turnover relationship follow a **non-linear / J-curve** pattern?
   - AI investments may initially reduce measured productivity due to adjustment costs and organizational restructuring.
   - Over time, as firms optimize AI use, productivity should increase significantly.
4. Is broader AI adoption linked to a wider set of **innovations**?
   - Broader AI use is often associated with richer innovation activity, including product, process, organizational, or even environmental innovations etc.

The European Context

- Historically, the EU has consistently lagged behind the United States in capturing the productivity gains of ICT.
- Today, this gap is not only with the U.S.—Europe is also falling behind **China**, which is rapidly advancing in digital technologies and AI.
- AI adoption within Europe is highly uneven:
  - Only a few Northwestern European regions specialize strongly in AI.
  - Southern and Eastern European regions lag significantly behind.
- This creates a clear **core–periphery** structure in AI capabilities.
- As a result, Europe faces a risk of **double divergence**:
  - A **digital divide** — uneven adoption and investment in AI
  - A **productivity divide** — widening economic performance gaps
- Therefore, understanding how AI translates into **firm-level performance** is crucial to assess whether AI will help bridge these gaps — or widen them.

Data in One Slide

- Source: **Flash Eurobarometer 486** – SMEs, Start-ups, Scale-ups and Entrepreneurship.
- Coverage:
  - EU-27 countries,
- Year: **2020**.
- Sample used in this study:
  - 6,328 SMEs (we exclude large firms, 250+ employees).
  - CEOs, general managers or similar decision-makers as respondents.
- We include sector and country fixed effects to account for structural differences.
- Control for key firm characteristics (size, age, location, financial health, innovation history).

Three Ways We Measure Digital Adoption

1. **AI (narrow):** dummy for firms reporting use of AI (e.g. machine learning, image recognition).
2. **AI adoption (broad):** dummy for using at least one among
   - AI, big data, or robotics.

   $\Rightarrow$ proxy for **digital maturity**.
3. **AI breadth:** intensity measure combining
   - number of AI-related technologies (AI, big data, robotics),
   - and the number of innovation types they stimulate (product, process, organizational, environmental, social, marketing, other).

- These broader AI measures help mitigate endogeneity by capturing digital maturity and complementary innovation patterns rather than treating AI adopters and non-adopters as two comparable groups.

Result 1: AI Alone Has a Weak Effect

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
AI	0.124**					0.0637
	(0.0593)					(0.0655)
Robotics		0.0504				0.00135
		(0.0564)				(0.0591)
Bigdata			0.167***			0.127**
			(0.0513)			(0.0544)
Smartdevices				0.103**		0.0709*
				(0.0393)		(0.0414)
Cloudcomputing					0.118***	0.0933**
					(0.0414)	(0.0412)
Constant	11.99***	11.98***	11.99***	11.97***	11.95***	11.95***
	(0.334)	(0.336)	(0.332)	(0.333)	(0.329)	(0.328)
Observations	6,460	6,460	6,460	6,460	6,460	6,460
R-squared	0.595	0.595	0.595	0.595	0.595	0.596
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
CV	Yes	Yes	Yes	Yes	Yes	Yes

- Digital technologies are **positively associated** with turnover, but the magnitude differs across tools: the largest effects come from big data, AI, cloud computing, and smart devices.
- AI's effect weakens and becomes insignificant once other digital technologies are added, indicating that AI's performance impact depends on complementary technologies rather than AI alone.
- Robotics shows no significant association with turnover, reflecting its capital-intensive, manufacturing-oriented nature and limited applicability across EU SMEs.

Result 2: Complementarities Matter

VARIABLES	(1)
AI_Adoption (AI/Bigdata/Robotics)	0.186***
	(0.0337)
AGE*AI	0.186**
	(0.0883)
AGE*Cloud	0.116**
	(0.0560)
Constant	11.99***
	(0.329)
Observations	6,460
R-squared	0.596
Sector FE	Yes
Country FE	Yes
CV	Yes

- AI adoption variable (=1 if the firm uses AI, big data, or robotics) has a large and highly significant effect (0.186***), indicating that integrated digital use—rather than isolated tools—drives firm gain.
- The effect size exceeds that of any individual technology in Table 1, showing that complementary across technologies generate stronger gains.
- Robotics alone offers limited improvement, but combining it with AI and data leads to higher turnover.
- Stronger effects for older firms support the J-curve hypothesis: experienced firms are better positioned.
- Takeaway: moving from experimental/isolated adoption to a broader digital ecosystem yields visible and substantial performance gains.

Result 3: Non-linear (J-curve) Pattern and Innovation

VARIABLES	(1)	(2)
AI_Breadth	0.304**	0.925***
	(0.125)	(0.273)
AI_Breadth_squared		-1.671**
		(0.633)
AGE×AI	0.188*	0.185***
	(0.0926)	(0.0885)
AGE×Cloud	0.112*	0.113*
	(0.0577)	(0.0571)
Constant	11.99***	10.35***
	(0.334)	(0.223)
Observations	6,460	6,460
R-squared	0.595	0.595
Sector FE	Yes	Yes
Country FE	Yes	Yes
CV	Yes	Yes

- AI Breadth shows a strong positive effect: adopting multiple AI-related technologies boosts turnover.
- Results support AI as an **emerging GPT:** broader use stimulates product, process, organizational, and environmental innovations.
- It does not only affect one outcome, but shapes a wide innovation ecosystem in firms.
- Adding the squared term reveals an **inverted-U** shape: gains increase from low to medium breadth but diminish at high levels.
- Pervasiveness has limits for now—very high adoption.

Result 4: Threshold Effects in AI Breadth

VARIABLES	(1) Base = No AI	(2) Base = Low (0–5%)	(3) Base = Medium (5–15%)	(4) Base = High (>15%)
AI_Breadth		-0.135	-0.268***	-0.0482
		(0.0852)	(0.0483)	(0.0548)
AI_Breadth	0.135		-0.133	0.0872
	(0.0852)		(0.0954)	(0.0756)
AI Breadth	0.268***	0.133		0.220**
	(0.0483)	(0.0954)		(0.0830)
AI Breadth	0.0482	-0.0872	0.220**	
	(0.0548)	(0.0756)	(0.0830)	
Constant	10.33***	10.47***	10.60***	10.38***
	(0.220)	(0.222)	(0.235)	(0.219)
Observations	6,460	6,460	6,460	6,460
R-squared	0.596	0.596	0.596	0.596
Sector FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
CV	Yes	Yes	Yes	Yes

- Table 4 compares firms at different AI-breadth levels and reveals a clear **threshold pattern**.
- Low adopters (0–5%) perform similarly to non-adopters—early experimentation does not yet translate into gains.
- Medium adopters (5–15%) show the strongest improvement (+0.268), indicating an **optimal adoption zone**.
- High adopters (>15%) show no significant additional gain, consistent with diminishing returns.
- Together, results confirm the inverted-U pattern: firms benefit most from **moderate AI breadth**, where complementarities peak and complexity remains manageable.

What Does This Mean for the EU?

- AI is not just another software tool
- Simply increasing the number of AI adopters is not a strategy.
- Firms seem to benefit most at **intermediate** levels of AI breadth:
  - early adopters face problems, such as adjustment costs.
  - very advanced adopters face another problems, such as coordination and complexity.
- Shift focus from "adopting AI" to **building digital maturity**:
- Support firms through the **implementation-lag** phase.

Policy challenge: AI can help EU firms increase turnover, but only when embedded in a broader digital and organizational transformation.

Limitations

- Cross-sectional data (2020): we cannot fully observe dynamic adjustment.
- Self-reported turnover and technology use.
- Potential reverse causality: more successful firms may adopt more AI.
- More specific attention to the innovation types.

Thank you.

Comments and suggestions are very welcome.

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