AI and Regional Growth

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Extended Abstract

Artificial intelligence (AI) has become a strategic priority for governments, firms, and international organisations across the world. In Europe, the conviction that AI will reshape productivity, industrial competitiveness, and labour markets has translated into substantial public investment in research infrastructure, digital capabilities, and human capital, alongside an increasingly elaborate regulatory architecture. The Draghi Report on the future of European competitiveness adds further urgency, casting AI as central to closing the continent's productivity gap with the United States and China. Yet despite the confident rhetoric, systematic evidence on how AI is shaping regional economic growth in Europe —and, crucially, through which channels— remains remarkably thin. This paper addresses that gap by drawing an explicit conceptual and empirical distinction between two pathways through which AI may affect economic outcomes: AI generation, defined as the creation of AI-related innovations, and AI adoption, defined as the diffusion and productive deployment of AI technologies. These are connected but fundamentally different processes, obeying different economic logics and following different spatial footprints. Conflating them, as much of the existing literature does, obscures the mechanisms that matter most for regional prosperity.

The theoretical framework builds on several established literatures. From the economics of diffusion, we take the insight that it is the application of innovations —not their mere creation— that most directly delivers economic gains. From the general-purpose technology (GPT) literature, we draw the expectation that the benefits of transformative technologies materialise only after extended periods of organisational adaptation and complementary investment, producing the so-called "J-curve" pattern in which measured productivity initially stalls before higher-growth phases emerge. From the absorptive capacity literature, we adopt the principle that the ability to recognise, assimilate, and apply externally developed knowledge depends on local capabilities — particularly human capital, R&D intensity, and institutional quality— that vary substantially across regions. AI fits many of the GPT criteria: it is pervasive, subject to sustained improvement, and generates innovational complementarities. But it also has features that sharpen the divide between where it is created and where it can be used. AI generation is unusually data-intensive, computationally demanding, and subject to scale economies that concentrate inventive activity in a small number of metropolitan hubs. AI adoption, by contrast, is increasingly decoupled from generation through cloud-based delivery, pre-trained models, and "AI-as-a-service" platforms that lower the costs of productive deployment for regions without frontier research capacity.

The descriptive evidence confirms this disjuncture at both the global and European scales. Globally, AI patent activity is dominated by a small group of countries —above all, the United States and China— while Europe collectively accounts for approximately two per cent of global AI patent grants despite producing scientific publications at rates comparable to other major economies. The gap appears at the point where research is converted into commercial activity: US venture capital investment in AI reached $194 billion in 2025, compared with $16 billion in the EU-27. Within Europe, AI generation is even more lopsided. A handful of metropolitan regions —Northern Brabant, Île-de-France, Upper Bavaria, and a few Nordic capitals— dominate inventive activity, with the richest quartile of regions accounting for 69 per cent of all AI patents and the bottom two quartiles together accounting for just 8 per cent. AI adoption, by contrast, is markedly more dispersed. A latent measure of regional AI adoption, constructed using an anchoring regression that relates observable regional ICT characteristics to firm-level AI uptake data, reveals a pattern far less polarised than patenting: the top-to-bottom ratio across income quartiles is roughly 5:1 for adoption, compared with 69:1 for patents. Regions that are outsiders in AI generation can nonetheless show meaningful adoption capacity, signalling a decoupling of productive use from inventive activity.

The empirical strategy exploits panel data for European NUTS-2 regions over 2013–2023. AI generation is measured using AI patent applications from the OECD REGPAT database. AI adoption is captured through a latent measure derived from a composite ICT index — aggregating broadband coverage, high-tech employment, household internet access, and internet usage intensity— anchored to observed firm-level AI adoption rates from Eurostat surveys. The anchoring regression, estimated with country and year fixed effects, yields a positive and statistically significant coefficient on the ICT index (R^2 = 0.569), supporting the measure's validity as a proxy for regional AI adoption propensity. The main econometric specifications are fixed-effects panel regressions with GDP per capita growth as the dependent variable, estimated at annual, three-year, and five-year horizons. All explanatory variables are lagged one period to reduce simultaneity concerns. Region fixed effects absorb time-invariant confounders; year fixed effects capture common shocks. The models are augmented with interaction terms between each AI measure and two proxies for absorptive capacity —tertiary education attainment and R&D intensity— to test whether returns to AI vary with complementary regional capabilities.

The results reveal a stark asymmetry between the two AI channels. The coefficient on lagged AI adoption is positive and statistically significant across all three time horizons: 0.210 in the annual specification (significant at the one per cent level), 0.281 over three years, and 0.198 over five years. The pattern is consistent with cumulative gains that build as firms integrate AI into routines and processes, peaking at the three-year window before moderating slightly at five years. AI generation tells a different story. The coefficient on lagged AI patent intensity is only marginally significant in the annual specification (0.327

at the ten per cent level) and statistically indistinguishable from zero at longer horizons. The increasingly negative point estimates at longer horizons are consistent with a spatial disconnect between where AI inventions are recorded and where their economic value is ultimately realised, particularly if patented innovations are commercialised through global value chains, licensing, or deployment outside the region of origin.

The interaction estimates deepen the picture. Both interaction terms —AI adoption × education and AI adoption × R&D— are positive and statistically significant, indicating that regions with higher R&D intensity and more educated workforces extract larger growth benefits from a given increase in AI adoption. R&D emerges as the stronger moderator, pointing to an "applied capability" channel: the capacity to adapt, customise, and integrate general-purpose AI tools into specific productive processes. For AI generation, the pattern is instructively different. The interaction with education is marginally significant, while the interaction with R&D is negative and insignificant. The two AI channels thus depend on different regional capabilities, consistent with the theoretical distinction between frontier invention and productive deployment. When both channels are included simultaneously, adoption retains its significant main effect and interaction terms, while generation's main effect is effectively zero. Three core findings emerge: adoption has the more robust growth association; that association is amplified by absorptive capacity; and R&D intensity is the key moderator for adoption, while education is the relevant moderator for generation.

These findings carry substantial policy implications. If AI matters for regional growth chiefly through adoption rather than generation, then the centre of gravity shifts from "how do we invent more AI?" to "how do we make the technology show up in production, services, and organisational practice?" A generation-first strategy is, for most European regions, a low-probability gamble given the self-reinforcing agglomeration dynamics behind frontier AI research. It carries clear opportunity costs, directing finite public resources towards frontier invention where catch-up is hardest means less investment in interventions that raise adoption capability and deliver broader economic returns. And it risks reinforcing the territorial polarisation that already drives discontent and strains European integration. Adoption offers a more inclusive pathway, though not an effortless one. The interaction results make clear that adoption is not "plug-and-play": its returns are systematically larger where complementary capabilities —particularly applied R&D capacity— are stronger. Adoption policy works best as part of a package, raising the productivity of investments in skills and applied research while also depending on them. The findings thus support a case for place-sensitive diffusion policy rather than a one-size-fits-all innovation push, pairing broad-based adoption with complementary capability-building and institutional readiness.

The paper makes three principal contributions. First, it provides systematic comparative evidence on the relative economic effects of AI generation versus AI adoption across

European regions. This is a distinction that has direct policy consequences but has rarely been tested empirically. Second, it examines complementarities between AI adoption and regional absorptive capacity, showing that adoption enhances the returns to investments in human capital and R&D, functioning as an amplifier of applied capability rather than a stand-alone growth lever. Third, it engages directly with Europe's competitiveness debate, arguing that the most plausible route to continent-wide AI-driven growth runs through diffusion and implementation rather than through expanding the frontier footprint, a conclusion consistent with the broader GPT literature on delayed and complementary-adjustment dynamics, and one that would prevent greater economic polarisation within Europe while making a more significant contribution to overall European competitiveness.

Keywords: artificial intelligence, AI adoption, AI generation, regional economic growth, absorptive capacity, technology diffusion, European regions

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