DOI: 10.2478/ie-2025-0063

Intereconomics, 2025, 60(6), 317-322
JEL: F21, L52, O33, O38

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Europe's Race to the Frontier: Building a Growth Model of De-Risked Innovation

Europe's growth challenge is to raise productivity while ensuring security, sustainability and resilience. This article proposes a de-risked innovation model that places technology at the centre of Europe's growth strategy, linking innovation, high-quality foreign direct investment and regulatory convergence into a coherent framework. It argues that technological leadership requires complementary advances across digital, green and quantum domains, supported by adaptive labour-market and education policies.

Global growth has slowed, but within the European Union it has almost stagnated, showing only minimal gains over recent decades. In contrast, the US and China have grown much faster (see Figure 1). This divergence persists even though major global shocks such as pandemics, energy crises and geopolitical disruptions have affected all economies. The difference, however, lies in Europe's structural and institutional features: the composition of its economy and the way policies target innovation and productivity.

The global order has shifted rapidly, transforming the geography of production and the distribution of power. Several developing countries have risen from poverty to global influence, while strategic resources are increasingly used as leverage through defensive trade and industrial policies. These changes have introduced new inefficiencies, slowed growth and heightened the need for economic resilience.

This article argues that Europe must respond through a smart industrial policy forming the basis of a new growth model. It advances the concept of de-risked innovation, a framework linking innovation, high-quality foreign direct investment (FDI) and regulatory convergence into a coherent strategy for sustainable competitiveness.

The proposed model complements the EU's pursuit of strategic autonomy and economic security, reframing openness not as vulnerability but as resilience. Anchored in secure access to technologies, diversified supply chains and coherent standards, de-risked innovation offers Europe a path to maintain competitiveness and technological sovereignty amid intensifying global rivalry and weaponised interdependence.

Open Access funding provided by ZBW – Leibniz Information Centre for Economics.

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Technological complexity and the new global order

A vast space of things

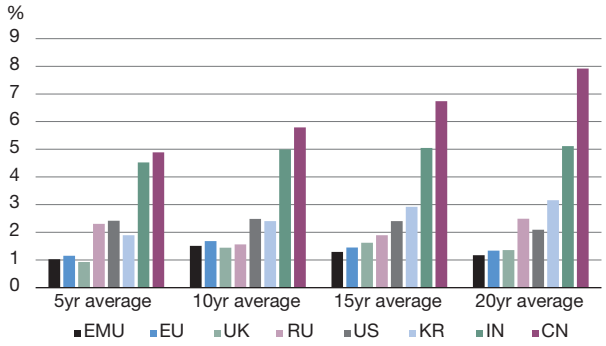
Production is no longer driven by a few homogeneous factors such as capital and labour, making traditional advice – like simply increasing investment – insufficient to sustain growth. A smart industrial policy, coordinated with trade, investment and migration strategies, is needed to foster sustainable development in the new global order. Aggregate output today depends not on the volume of inputs but on the interaction among product, task and technological spaces.

As emphasised by the recent Nobel Prize in Economics, creative destruction – the drive to innovate despite inevitable obsolescence – remains the foundation of long-term growth (Aghion & Howitt, 1992). Across four industrial revolutions, technological progress has introduced diversified products, production methods and occupations on an unprecedented scale.

According to the EU's Combined Nomenclature (CN8), 9,779 distinct products are now traded globally. The number of six-digit products in the Harmonised System rose from 5,228 in 1988 to 5,613 in 2022, with each revision adding new items such as electric vehicles. Similarly, global economy spans over 600 industries under NACE, 250,000 technological classes under the Cooperative Patent Classification and more than 430 occupations under ISCO-08.

This vast heterogeneity complicates the design of smart industrial policy. Europe must focus on critical technologies and industries: those essential to production systems and those

Figure 1
Average annual GDP growth rates over periods of 5, 10, 15 and 20 years up to 2024, selected economies



Source: World Development Indicators of the World Bank.

with the highest potential for long-term value creation. Smart specialisation should prioritise sectors that both enable other industries and enhance Europe's global position.

Ultimately, sustainable development depends on resilience – the ability to withstand diverse shocks. This requires diversification across products, resources and technological domains, ensuring that Europe's growth model remains dynamic, adaptable and competitive in an increasingly complex global environment.

Technologies that matter

Europe must leap forward to the technological frontier by developing complementary innovations. Since the emergence of revolutionary technologies, first movers have often gained monopoly power that reinforced their economic and political dominance. Yet, as the logic of creative destruction implies, technologies must evolve through complementary advances to realise their full potential.

Historically, technological complementarities have shaped global power. Gunpowder, first invented in China, transformed warfare, but without maritime capabilities, China's dominance remained limited. In Europe, the combination of gunpowder and intercontinental shipbuilding enabled the projection of power and the rise of colonial empires. Later, the steam engine revolutionised trade and transport, expanding markets and raising productivity. Over three centuries, nations with greater efficiency in trade and production accumulated geopolitical influence, guided by comparative advantage. Today, however, economic power is increasingly exercised through coercive instruments – sanctions, trade boycotts and technological restrictions – that intentionally disrupt global efficiency.

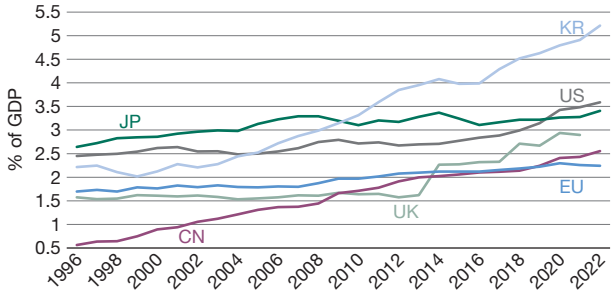
In the modern era, digital technologies have transformed how information is processed, stored and transmitted, underpinning both civilian and strategic domains – from entertainment to defence and security. Computing equipment capital, as a leading digital asset, has had a significant positive impact on labour productivity and employment (Ghodsi et al., 2024b). Between 2005 and 2019, tasks incorporating digital tools generated higher value added per worker, while teleworking during the COVID-19 pandemic amplified digitalisation and job creation.

Artificial intelligence (AI) represents another transformative leap. Emerging from the computing trajectory that began in 1945 and accelerated with the internet in the 1990s, AI now processes vast datasets to enhance efficiency and redefine the boundaries of productivity. Automation technologies – industrial robots, drones, surgical tools and service robots – extend this transformation by replacing routine tasks while simultaneously creating new occupations and more complex production processes. Recent firm-level evidence from Austria (Tverdostup et al., 2025) shows that automation often coincides with rising employment, particularly among low-educated migrant workers from outside the European Economic Area (EEA), suggesting that robots and migrant labour can be complements rather than substitutes. This interaction underscores the need for policies that integrate automation with inclusive labour and migration strategies, enabling firms to optimise costs amid demographic change and worsening labour shortages. Although robots may displace workers at the aggregate level within the EU (Ghodsi et al., 2024b), they also restructure labour towards more productive activities, raising average wages and labour-income shares (Ghodsi et al., 2024a). Harnessing these gains requires not only investment but also adaptive education and labour-market policies to mitigate displacement and ensure inclusive growth.

The EU has made notable progress in industrial robotisation, yet it still trails Japan, South Korea and China. The same is true for autonomous vehicles, where the EU lags behind the US and China. Companies like Google, in partnership with Jaguar, already operate self-driving taxis covering over a million miles per month in several US states. Start-ups such as Aurora Innovation and Kodiak AI are developing self-driving trucks expected to enter large-scale use by 2026 to automate land transportation. Despite Europe's strength in automate manufacturing, slower progress in software and AI has limited its competitiveness in autonomous mobility. Bridging this gap requires the integration of Europe's industrial base with emerging digital and AI capabilities to advance the innovation frontier.

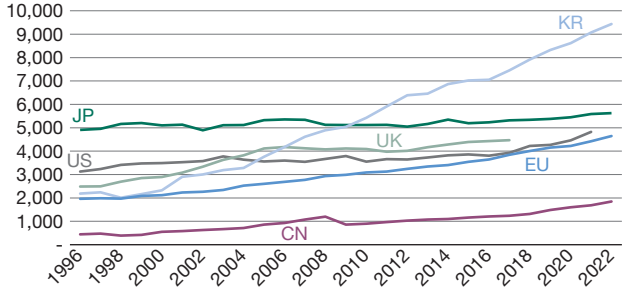
Equally critical are biotechnologies and green technologies, essential for mitigating environmental and societal risks. Innovations in solar power, wind energy, and portable battery storage now allow the harnessing of renewable energy

Figure 2
Gross domestic expenditures on R&D, selected regions



Source: World Development Indicators of the World Bank.

Figure 3
Researchers in R&D per million people, selected regions



Source: World Development Indicators of the World Bank.

flows and substitution of fossil-based systems. These advances are vital for reducing greenhouse gas emissions in transport and industry. Achieving net-zero emissions will mark a turning point where sustainable growth becomes inseparable from technological progress in green innovation.

At the same time, quantum technologies are already reshaping the frontiers of innovation. By exploiting the principles of superposition and entanglement, quantum systems could theoretically solve optimisation and simulation problems in minutes that would take classical supercomputers billions of years. This leap in computational power could revolutionise materials science, biotechnology and cryptography, where current processing limits constrain discovery. Quantum computing also holds promise for breakthroughs in defence modelling and genetic engineering, enhancing both precision and decision-making speed. Yet most applications remain experimental. Even today's most advanced anti-missile systems achieve only 50%-90% success rates in controlled conditions – an efficiency that, with the integration of quantum geolocation and real-time data processing, could approach near-perfect accuracy.

While Europe continues to lead in academic quantum research, it lags behind several US firms – IONQ, D-Wave, and IBM – in commercialisation. Closing this gap will require converting research excellence into market-ready technologies through stronger university–industry collaborations and targeted investment incentives.

Europe's innovation challenge: From fragmentation to strategic scale

The EU has developed a wide diversity of technologies, as reflected in its patent activity across regions (Castelli et al., 2025). Yet in critical domains – such as AI and green technologies – it still trails the US, China and Japan, whose pace of innovation has been far more dynamic.

To compete at the global frontier, the EU must raise its research and development (R&D) expenditures. As shown in Figure 2, Europe's R&D intensity, measured as a share of GDP, has long trailed that of the US, Japan and South Korea. It also fell behind the United Kingdom in 2014 and China in 2019. Similarly, Figure 3 shows that the number of researchers per million inhabitants remains below that of other major economies – except China, where the large population lowers the per-capita ratio.

One key reason for this gap could be under-compensation: European researchers often earn less than their peers in leading research nations and below degree-equivalent workers in their own countries (OECD, 2025). Despite the EU's rhetorical commitment to innovation, inadequate attention is paid to its main input – its scientific workforce.

Signs of renewal have emerged. In response to US federal research funding cuts, the EU launched the "Choose Europe" Initiative (2025-2027), pledging over half a billion euros to attract global scientific talent. Several member states are also narrowing salary gaps and expanding relocation and support services to recruit top researchers.

Furthermore, technological progress is not self-sustaining. It must be directed and governed to translate innovation into competitiveness. As Aghion et al. (2016) and Acemoglu et al. (2016) show, progress can be steered along paths that build upon previous advances. Europe must therefore strengthen the institutions that shape innovation incentives, diffusion and coordination. Advancing the EU's Capital Markets Union and deepening its financial markets would be crucial steps in mobilising the scale of risk capital needed to bridge this divide.

This institutional dimension is central. Technological breakthroughs alone cannot ensure growth if fragmented governance and underinvestment persist. Innovation governance – including R&D funding, coordination between public and

private actors and risk-sharing mechanisms – determine whether Europe's technological potential becomes productive capacity. The EU's challenge is to transform its scientific strength into industrial and economic power.

Technological progress provides the engine, Europe's institutional design determines how powerfully it runs

The reports by Draghi et al. (2024a, 2024b) argue that Europe's innovation deficit is institutional, not intellectual. The EU has the research base and talent for global leadership but lacks the scale, integration and speed to turn scientific potential into industrial power. The reports propose a Pan-European Innovation Compact to coordinate funding, governance and capital-market reform – translating research excellence into technological leadership.

Innovation, according to Draghi, is both Europe's core strength and its most urgent weakness. The widening gap with the US and China stems less from a lack of ideas than from fragmentation, underinvestment and limited access to risk capital. The proposed compact focuses on five strategic pillars:

Strategic deep-tech investment. Expand the European Innovation Council (EIC) and create a Deep-Tech Fund combining resources from the European Investment Bank (EIB), national development banks and private investors. Public funds should share risk and crowd in private capital, not serve as permanent subsidies.

A single market for technology. Harmonise certification, intellectual property and data governance rules to eliminate the EU's fragmented 27-country framework. Establishing pan-European testbeds, standards and industrial clusters would accelerate technology diffusion and SME participation.

Integrated capital markets. Advance the capital markets union to channel household savings into innovation. Pension and insurance funds should provide "patient capital" for high-risk, high-return ventures, strengthening Europe's capacity to scale new technologies.

Research-industry collaboration. Deepen cooperation between universities, start-ups and corporates through European innovation networks. Enhanced STEM mobility and skills programmes would expand the talent pipeline and strengthen knowledge transfer.

Streamlined governance. Establish a competitiveness and innovation board to coordinate funding, regulation and state-aid flexibility under one strategic framework. As Draghi (2024) puts it, Europe must evolve "from a continent of ideas to a continent of scale."

Implementing this vision requires acting as a single innovation ecosystem – integrating finance, regulation and industrial policy to convert scientific strength into global technological competitiveness.

A tangible early step is the proposed Cloud and AI Development Act, which builds on the InvestAI initiative to mobilise €200 billion in AI-related investment, including €20 billion for AI gigafactories. This initiative represents a critical move towards reducing Europe's strategic dependence on foreign cloud and data-service providers– a vulnerability compounded by the fact that European cloud providers account for only around 10%-15% of the EU market.

In an era of technological rivalry and geopolitical uncertainty, this overreliance poses clear risks. Strengthening Europe's domestic cloud and AI infrastructure would not only boost competitiveness but also enhance technological sovereignty. By aligning innovation funding, industrial policy and regulation under a unified framework, the EU can begin to close the gap with its global peers and build a more secure, resilient and scalable innovation system.

Ultimately, achieving scale is Europe's defining challenge. The continent possesses world-class talent and ideas but too often lacks the financial depth and institutional agility to commercialise them. The de-risked innovation model demands collective European action – pooling resources, harmonising rules and fostering risk-sharing mechanisms that translate research excellence into industrial success. Only through such an integrated approach can Europe move from incremental innovation to strategic technological leadership, securing both competitiveness and autonomy in a rapidly changing global order.

Multinational enterprises and innovation spillovers

FDI is a crucial driver of innovation. Empirical evidence shows that multinational enterprises (MNEs) are consistently more productive than domestic firms (Helpman et al., 2004; Castellani & Zanfei, 2007; Criscuolo & Martin, 2009). Their advantage stems from accumulated technological expertise, efficient sourcing through global value chains, and the ability to diversify management and organisational practices across markets (Javorcik, 2020; Exadaktylos et al., 2024). They also access wider pools of finance, enabling greater innovation capacity – particularly in economies with strong financial systems that amplify the growth effects of FDI (Alfaro et al., 2010).

MNE presence directly raises GDP through higher productivity and can enhance gross national product (GNP) when technological externalities benefit domestic firms. Davies et al. (2025) find that FDI across EU regional industries significantly boosts domestic-firm productivity, especially when foreign

subsidiaries are innovative. Moreover, stronger absorptive capacities – measured by patenting activity – allow EU firms to capture greater productivity spillovers from MNEs.

While large FDI stocks can sometimes depress domestic productivity through competition, FDI flows – greenfield projects, acquisitions or mergers – tend to stimulate it by generating new demand and economic activities. Innovation intensity, proxied by the number of patents held by MNE subsidiaries, magnifies these effects and offsets competitive pressures. To sustain productivity and long-term growth, Europe should prioritise innovative FDI in upstream sectors supplying high-quality intermediate goods to domestic producers.

Castelli et al. (2025) show that FDI inflows to the EU depend on both technological and regulatory proximity. MNEs prefer regions whose patent portfolios complement their subsidiaries' but differ from their own, allowing them to acquire technologies they lack. Conversely, wider regulatory distance – especially in technical barriers to trade – reduces investment. Micocci et al. (2025) further find that when MNE parent companies hold green patents, domestic firms in the EU are more likely to generate green innovations, evidencing effective cross-border knowledge diffusion beyond ownership boundaries. However, EU-based MNE subsidiaries' green patenting does not significantly affect local firms, suggesting that innovative parent MNEs are more effective vehicles for spillovers.

These findings imply that FDI can serve as a two-way channel of technological diffusion: European technologies can flow to MNE subsidiaries, while innovations of foreign parent MNEs diffuse into EU industries. Policymakers should therefore design FDI frameworks that maximise these reciprocal gains.

Towards a strategic FDI framework for Europe

Building on these insights, a new FDI strategy for Europe should:

- Align FDI attraction with smart specialisation strategies, targeting sectors such as green technologies and digital industries where domestic innovation trajectories overlap with foreign investors' technological strengths;
- Introduce absorptive-capacity compacts, conditioning investment incentives on local R&D collaboration, dual training schemes and supplier upgrading linkages;
- Embed technological, environmental and social criteria in FDI screening and evaluation processes to prioritise "high-quality" investors aligned with Europe's sustainability goals;
- Establish pre-competitive public-private partnerships in strategic technologies to accelerate knowledge diffusion across domestic and foreign firms.

This shift – from maximising quantity of inflows to optimising their quality and spillover potential – would transform FDI into a true engine of structural change. It would also reinforce Europe's strategic autonomy: linking investment incentives to compliance with European standards would expand the Union's normative power globally while deepening its domestic innovation networks.

By attracting FDI that strengthens rather than substitutes domestic capacity, the EU can integrate into global value chains on more favourable terms, ensuring that technological and green transitions reinforce competitiveness and sovereignty alike.

Standards, regulation and strategic convergence

Finally, technological leadership depends not only on innovation but also on the ability to set, diffuse and adapt standards – a decisive advantage in an era of rising trade costs and protectionism. Regulatory frameworks have become core instruments of both competitiveness and sustainability, shaping how technologies scale across markets. Regulatory convergence acts as a growth multiplier: it lowers compliance costs, enables scale economies, builds cross-border trust and amplifies the productivity effects of innovation and FDI.

Recent evidence by Ghodsi and Santeramo (in press) shows that bilateral regulatory distance, i.e. divergence in technical barriers to trade (TBTs) and sanitary-phytosanitary measures, significantly reduce trade flows. However, global value chain regulatory distance, which captures firms' exposure to multiple regulatory systems, can offset these effects. Firms operating within diverse, yet compatible frameworks tend to be more innovative and export-oriented. Similarly, Ghodsi (2024) finds that convergence in TBTs reduces transaction costs and boosts ICT trade, while Castelli et al. (2025) show that it also stimulates FDI.

These findings suggest that Europe should not pursue deregulation but rather manage regulatory convergence with its main trading partners. The objective is a level playing field that facilitates seamless market access, harmonising rules in critical domains such as environmental standards, digital safety, AI and health technologies, while retaining flexibility elsewhere.

Standards and regulations should thus be treated as industrial policy tools. With decades of experience in mutual recognition and harmonisation within the Single Market, the EU is uniquely placed to lead global norm-setting in areas like climate and digital technologies, AI and data governance. Aligning internal regulatory coherence with external engagement would reinforce Europe's competitiveness and extend its normative influence globally.

To realise this potential, Europe needs to pursue the following actions:

Regulatory diplomacy that embeds European norms in global value chains through mutual recognition agreements, sectoral alliances and accession conditionalities in trade and cooperation frameworks.

A pan-European standardisation infrastructure ensuring consistent testing, certification and interoperability across member states to decrease compliance costs and prevent fragmentation.

Dynamic standard-making that links industrial ecosystems, academic research and policy institutions in climate-critical sectors such as batteries, semiconductors, hydrogen and medical devices.

Conclusion: Towards a European model of de-risked innovation

A modern growth model must align R&D, finance, investment and regulation. Europe's growth challenge lies not in a lack of ideas or talent but in its failure to turn technological strength into scaled industrial success. Sluggish productivity reflects institutional fragmentation, underinvestment in R&D and weak risk-sharing mechanisms that hinder the diffusion of innovation across borders. A new growth model must rest on de-risked innovation – the secure diffusion of knowledge, capital and talent governed by European standards and strategic priorities.

A forward-looking smart industrial policy should rest on three pillars.

First, innovation and technological leadership must anchor competitiveness. As the Draghi Report emphasises, Europe's innovation deficit is institutional, not intellectual. Scaling science into market leadership requires a single market for technology, deep capital markets and mission-oriented investment in green, digital and quantum sectors. A European Innovation Compact, linking the EIB, EIC and national investment banks, could initiate this coordination and critical mass.

Second, FDI should be strategic rather than opportunistic. Multinational enterprises are more productive and innovative than domestic firms, but their impact depends on absorptive capacity and technological alignment. Europe should target high-quality FDI in green and digital industries, tied to local R&D collaboration, supplier linkages and skills transfer – turning FDI into a source of shared innovation and structural transformation.

Third, regulatory convergence and standards are engines of growth. Harmonised frameworks for digital, environmental and health technologies reduce costs, foster trust and magnify investment impact. Europe's leadership in setting global norms – from climate standards to AI governance – can strengthen competitiveness and strategic autonomy.

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