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What Europe must learn from China's ascent in critical technologies



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The global race for dominance in critical technologies – artificial intelligence (AI), semiconductors and quantum computing – is reshaping economic and geopolitical power dynamics. While the US leads in breakthrough innovations (by the number of novel patents filed, which we have tracked using large language models to identify which patents since 2019 have brought about breakthroughs in critical technologies), China's meteoric rise points to how rapidly the landscape is changing.

Analysis of the areas in which China and the US are excelling shows that the US still dominates in the most advanced fields, particularly quantum technology. China ranks second on average but dominates major subfields in semiconductors, such as fabrication, to which China has deployed \$90 billion in subsidies in the last few years. In AI, China is refining and deploying basic research on video and image processing, crucial for autonomous driving and surveillance. Chinese companies with access to massive data volumes, such as ByteDance, have a huge advantage in these fields, being able to turn their breakthroughs – in the form of novel patents – into readily monetisable products that can in turn feed new breakthroughs.

Europe's strongest critical technology area is the most embryonic – quantum technology, in particular subfields including photonics. However, Europe is clearly behind in AI and semiconductor technologies when measured by the number of breakthrough innovations (novel patents).

An even more concerning issue for Europe is that it is slow to adopt the breakthroughs of US and Chinese first movers. The average delay in replicating a novel patent filed by an American or Chinese company – or even another European company in a different European Union member state – is about a year. China takes less than half this time to replicate novel patents from US or European companies – particularly impressive in relation to the US when one considers that the US government has imposed tight export controls to limit Chinese access to critical technologies. The US also replicates patents, whether Chinese or European, very rapidly.

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Europe's slowness in replicating critical technology breakthroughs is probably due to market fragmentation and weak cross-country linkages between industry and academia; regulatory hurdles and language barriers could also be factors. In addition, European companies are smaller than American or Chinese companies, meaning that their innovation activities do not benefit from the same economies of scale.

That European companies have a size disadvantage when it comes to investing in research and development (R&D) can be seen from examining the global league tables of filers of novel patents in critical technologies. In the US, tech companies dominate in all three fields (AI, semiconductors and quantum). In China, there is a greater variety of companies (from insurance to telecom and tech). In Europe, there are fewer companies and more public research entities, though with some exceptions, particularly in telecoms.

Several policy remedies are available to Europe. First, EU-wide sandboxes for rapid patent licensing and cross-border tech transfer could be created, which should reduce replication delays. Second, grants from Horizon Europe, the EU's research funding programme, could focus more on applied R&D in scalable domains such as semiconductor fabrication, to generate monetary incentives for the deployment of new innovations. Third, public procurement could be used to generate demand for critical technologies, again fostering the application of European breakthroughs. Fourth, a 'Critical Tech Observatory' could be launched at EU level to track global patents and help trigger fast-follower strategies. Finally, Europe's recent push for military expenditure should offer new opportunities to fund innovation in critical technologies, as many military applications are dual-use.

All in all, China's ascent in critical technologies underscores two truths.

First, scale is needed to advance in radical technologies because the resources required are massive. China has the scale; despite its size, the EU does not. A fragmented single market is not only a problem for companies that want to scale-up – it also hinders innovation. The existence of diverse market ecosystems in EU countries may look enriching in terms of variety but, in a world in which economies of scale dominate, this model is insufficient.

Second, China demonstrates that innovation without diffusion is unsustainable. For innovation in basic research to find the necessary financing, companies must find ways to commercialise it. This requires close industry-university partnerships, more R&D in critical technologies at the company level and likely also in different sectors.

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