Intellectual Capital Protection by Patents

The Ultimate but Hidden Base of Europe's Defence Industrial Competitiveness

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Contemporary defence industrial strategies are driven by the assumption that innovative defence systems require global defence supply chains. Evidence based on patents filed by Boeing and Airbus suggests otherwise.

This paper understands patents as a significant building block of industrial ecosystems that have hitherto been conspicuously absent from the discussion about defence innovation. Our exploratory work compares patent filings by Airbus and Boeing. We find that the strategic relevance of international cooperation to produce innovation is not as straightforward as commonly perceived. It seems that patent filings in this sector are more important to protect product development and market shares rather than to genuinely enable innovation work. This finding is important in view of Europe's strive for defence industrial competitiveness.

Graphics: The authors

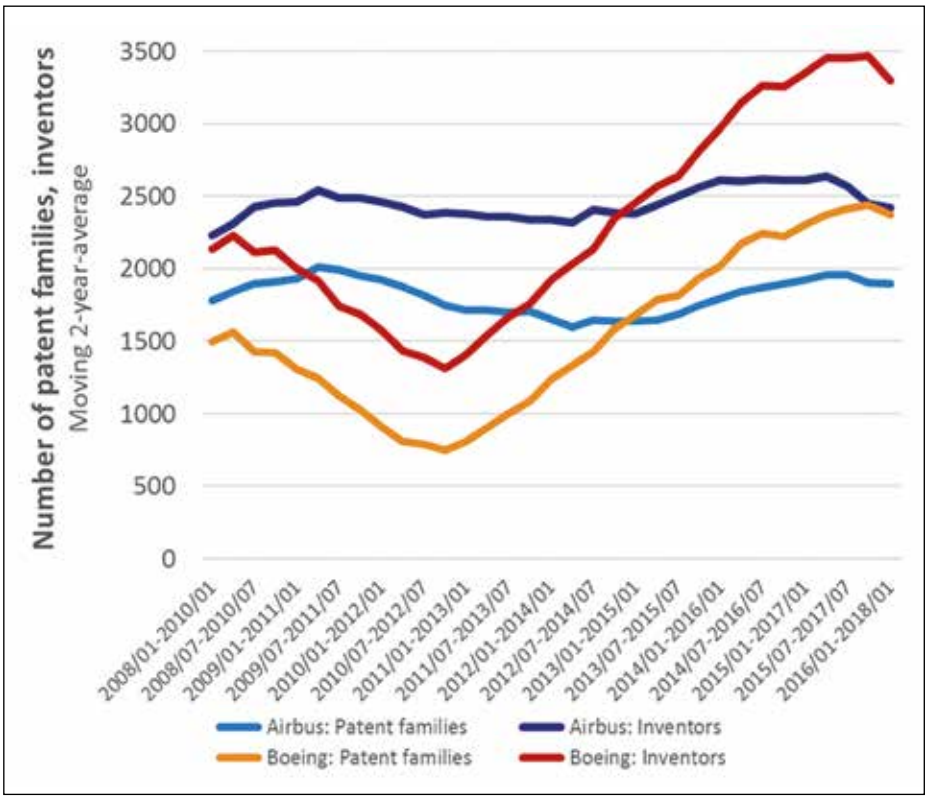

Figure 1: Airbus versus Boeing, number of patent families and inventors

Setting the Scene: Investment and Innovation Motives

In the second half of the 20th century, cross-border investment flows were primarily characterised by cost arbitrage. For the most part, companies have chosen their (new) locations based on two factors: an optimal cost-productivity balance for the required production factors or the need to build up local presence as a prerequisite for market development.

Local presence will continue to drive cross-border investment in the 21st century, in particular against the backdrop of a new wave of protectionism. Under protectionist trade regimes, substantial shares of local sourcing may turn out advantageous to maintain and expand a company's market position. The cost-oriented motive, by contrast, will need to be balanced against the rise of two additional investment motives. Companies invest in locations where resources essential for manufacturing are readily available and/or locations that provide a stable and low-risk regulatory framework that supports innovation. Both motives are of crucial importance for the aerospace and defence industry.

Currently, geostrategic changes set the aerospace and defence industry on a new trajectory for innovation. The transatlantic community looks at geostrategic competitors and recognises that their military ambitions are about to erode the West's long-held strategic advantages, in particular with regard to power projection. This has prompted a serious debate about how to adapt the armed forces of NATO and European Union (EU) countries in order to maintain advantages or to catch up in areas where competitors already seem to have taken the lead.

Defence innovation is a complex undertaking that requires a close interplay between operational requirements, cultural predispositions, organisational and resource needs as well as technological options. The defence industry is a vital

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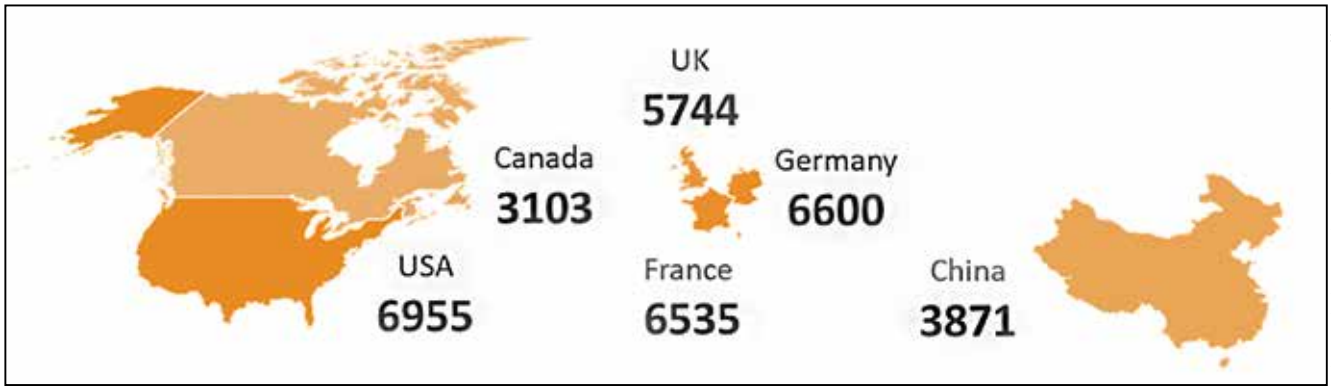

Graphics: Authors' calculations. Filings with national patent offices.

Figure 2a: Airbus – Worldwide distribution of protection rights. Darker shades of orange illustrate more patent fillngs.

Figure 2b: Boeing – Worldwide distribution of protection rights. Darker shades of orange illustrate more patent filings.

player in the innovation game. That is why the European Commission presented the European Defence Action Plan (EDAP) in 2016 as a key initiative to advance Europe's military capabilities and to improve the competitiveness of the European defence industry. This plan foresees establishing a European Defence Fund that supports defence research and acquisitions, fosters investment in defence-relevant small and medium-sized companies, and strives to strengthen the Single Market.

Much of the current thinking is about investing in technologies and prototypes that help maintain and expand critical military capabilities. If and to what extent Europe is actually able to develop the required technologies depends on funding, industrial capacities,and human skills. In a condensed form, the latter are materialising as intellectual property rights (IPR), in particular patents. IPR are the key building blocks that are hardly addressed, and they deserve in-depth inspection as they are the ultimate layer of Europe's defence technological expertise.

Patent Analytics

The proprietary patent analysis tool used for this paper builds on one of Europe's largest patent databases, which covers more than 80 million documents from over 90 worldwide sources to provide insight into the innovative strength of 195 countries and their inventors. With an average time-lag of around six weeks between the public filing of patents and their representation in the database, the tool covers innovation-related activities worldwide almost in real time.

Most customary patent assessments rely on the number of patents assigned to companies and other organisations recorded nation-wise. Such an approach is prone to distorted findings, as the entities that register patents and the original inventors may reside in different countries. By contrast, we draw upon individual inventors and groups of inventors and their respective affiliations to analyse patent-related innovation activity. This provides a superior understanding of national and corporate competitive strengths and sheds light on the dynamics in industry sectors as well as regional and cross-national clusters. This kind of patent analysis can inform strategic decision-making with regard to

- determining relative market shares of individual firms in specific technologies or entire technology fields;
- analysing the anatomy of complementary and rivalling technology networks to understand the level of competition among different defence supply chains as well as the dependence on singular suppliers;
- gaining a better understanding of the size and dynamics of the human capital base relevant for defence innovation.

Comparing Airbus and Boeing: Fasten Your Seat Belt as You Will Be Surprised

To illustrate the relevance of these generic aspects, we study the patent-related innovation ecosystems of Airbus and Boeing, both leading aerospace and defence players with a global footprint. For a start, let us look at raw data, which is already quite impressive. Altogether, we recorded 9,036 patent filings for Airbus and 8,028 Boeing-related entries. In total, there are 8,490 inventors affiliated with the Airbus innovation network, as compared to 7,537 inventors in the sphere of Boeing, with some of them being related to both.

The raw data, however, mask a very distinct underlying dynamic. At the start of our inquiry covering the period from 2008 to 2017, both networks hosted a similar number of inventors. On an annual basis, Airbus filed around 150 patent families more than Boeing. Patent-related productivity, i.e. the number of filings per inventor, was in favour of Airbus. In the aftermath of the great recession of 2007/08, company-specific patenting dynamics started

Graphics: The authors. Graph made with Gephi.

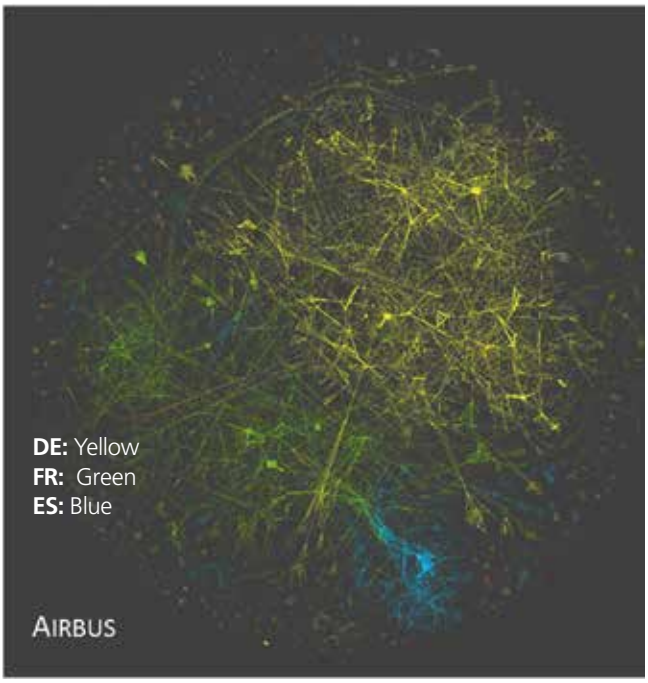

Figure 3a: Airbus – Co-Inventor Network

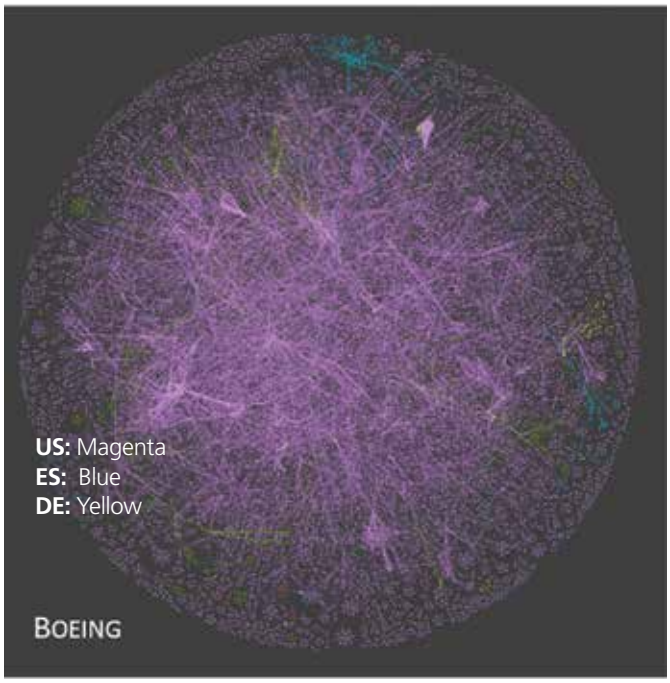

Figure 3b: Boeing – Co-Inventor Network

to diverge significantly. Whereas Airbus maintained its level of patent filings by and large, Boeing suffered an exact halving of its figures for patent filings and investors until around 2011 (Figure 1). Thereafter, Boeing's patenting performance caught up and surpassed the number of patent filings by Airbus after 2014 (growth from 2011 to 2014: 227%). It has only been very recently that Boeing's figures started to slightly decline again.

We reckon that patent filing performance follows corporate strategy and thus reveals important differences. Airbus seems to have relied on a strategy of organic innovation dynamics. Boeing, by contrast, tended to add intellectual assets to its portfolio by mergers and acquisitions. It is rather unlikely that Boeing's increase in patent-related performance results from organic activities in the airplane and spacecraft business, only as the lead time for innovation in these sectors amounts to several years. Thus, the patent filing uptick would have had to occur much earlier. In comparison, we find a rather limited hike in Airbus' patent filing activity, which very likely results from partial production offshoring, in particular geared towards the Chinese market.

This leads us to a second most interesting finding related to patent protection. As Figure 2a illustrates, Airbus pursues a rather balanced global protection rights strategy and counts even more patent filings in the US than in France or Germany. Boeing, by contrast (Figure 2b), is heavily US-focused. The UK, which is the second most important country for Boeing's patent filings, accounts for only about half as many filings as in the US. And most interestingly, if compared with the US, Airbus' patenting activity on the Chinese market is about one-third higher than Boeing's activity. This leads us to assume that Airbus has a strategic interest in protecting its market position in a country that is slowly but steadily growing into the role of a future aircraft manufacturer. Canada is another case in point. Here, Airbus already has a stronger patent filing position than Boeing. Acquiring a majority stake in Bombardier's C-series will likely reinforce this position and suggests that Airbus seeks to buy itself into innovative ecosystems.

The third major finding relates to know-howacquisition. Figures 3a and 3b illustrate the network typology of all Airbus and Boeing-related co-inventors. Knots represent individual inventors, and distance or proximity to the core of the network illustrates the degree to which each inventor is integrated into the network's activities. The most striking commonality is the fact that, in both cases, internationalisation of innovation has been limited to peripheral rather than core activities. Otherwise, the knots representing foreign co-inventors would be positioned much closer to the centre of the networks. This suggests that both companies can be understood as innovation co-coons. However, these cocoons result from very different approaches:

- Airbus' innovation ecosystem rests on three main pillars, as constituted by innovation activity in France, Germany and Spain, whereas the core of Boeing's ecosystem is entirely US-centric.
- With co-inventors in 38 countries, Airbus maintains an ecosystem that is more internationally diverse than Boeing's ecosystem that numbers 22 international partners. But the level of cooperation intensity (5.8 linkages per knot) is considerably higher in Boeing's ecosystem than in the innovation network operated by Airbus (3.9 linkages per knot).
- Boeing's network features a couple of extremely strong knowledge hubs as compared to that of Airbus, thus rendering Boeing's network more "hierarchical".

Overall, these network topologies suggest that Airbus has accomplished its core mission as a truly European champion of innovation transmission across different regions. Apart from the three core countries, five of the top six contributors of knowledge in the Airbus network, as measured by bilateral IPR balances, are European nations (ranking: UK, Austria, Italy, The Netherlands, and Poland). The US, the only non-European country in the top six, is at the helm. Boeing, by contrast, draws upon a transcontinental knowledge network with Spain, Germany, Australia, Canada, and Poland as the top five partners. Strikingly, the overall gain of IPR that the US acquires thanks to the network of Boeing outstrips the consolidated IPR gains of France and Germany by around 75%.

Conclusion

Based on the two case studies, we find that the IPR balance for the US as well as for France and Germany is positive. Hence, these countries benefit most from the innovation network of both companies. Most strikingly, all three countries gain rather than lose IPR from countries like China, Brazil, Russia, and South Korea. Established defence exporters may indeed come under pressure from rising competitors, but to date this appears to be more relevant for production volumes, export market access,

and value creation than for co-innovation. At least in the case of Airbus and Boeing, our results also suggest that international co-innovation work is not as relevant as commonly perceived in developing research-intensive defence systems.

Whether Boeing's innovation network might be subject to strain stemming from an increasingly protectionist domestic trade policy remains to be seen. Although Boeing cooperates more intensively with international co-inventors than Airbus, this cooperation seems less relevant for Boeing's core innovation activities. This would suggest that Boeing could be well prepared to cushion negative effects of protectionism. If, however, major technology developments occur outside the existing innovation ecosystem, the US-centricity of Boeing's innovation network might turn into an obstacle that effectively hinders the integration of outside activities into Boeing's core.

Airbus, by contrast, maintains a broader, regionally diversified co-innovator portfolio. But as the US and the UK, which are the two prime innovation partners, undergo difficult political transition processes, Airbus faces challenges as well. Airbus is dependent on seamless intra-European cooperation. As such, Airbus has a crucial interest in maintaining a healthy European ecosystem for aerospace and defence, while being vital itself for intra-European innovation diffusion. But toughening regulation, continued segmentation of the EU Single Market, and a general public risk aversion – as reflected by a dominance of the precautionary principle over the innovation principle – could endanger Airbus' intra-European hub function and prevent the company from benefitting maximally from its global innovation ecosystem.

Against this backdrop, the analysis of Airbus also offers important insights for the implementation of the EDAP. First of all, analysing patent filings and co-inventor networks underlines the strategic role of human capital. If Europe does not have the researchers with the right skills, Europe's strive for defence industrial competitiveness and excellence will fail. A comprehensive patent mapping provides important insight, such as the number of patents by individuals in relation to industry/science cluster structures or corporate age. This, in turn, provides opportunities for the tailored use of Europe's structural funds. These funds are instrumental in advancing smart specialisation across Europe and could enhance defence industrial competitiveness by developing adequate skills.

In addition, the current belief in top-down consolidation of Europe's defence industry should be reconsidered. The EU has made resilience a guiding principle of the new EU Global Strategy that provides the background for the EDAP. But a substantial body of literature suggests that resilience depends on diversity, rather than homogeneity, which would result from consolidation. If Europe is serious about a competitive defence industry, it should address strategic industrial resilience also by sustaining different regional clusters of expertise. This seems a prudent approach given the current degree of geostrategic uncertainty. But for distributed expertise to be of strategic benefit to Europe, Europe-wide transmission mechanisms are needed, as Airbus' co-inventor network underlines. Future EDAP programmes could thus identify the critical hubs in Europe's defence innovation network and adopt specific policy measures that bolster and expand existing hubs and create new hubs. Patent analyses can inform decision makers on how to achieve this alignment. ■

Note: No thematic filter was applied here; that is, figures for Airbus and Boeing encompass commercial and defence-related activities.