How to increase innovation from universities

The establishment of Humboldt University in 1810 marked the inception of modern research-based education, a model that was rapidly adapted by elite U.S. universities like Harvard, Princeton, and Yale. Over the past two centuries, this has positioned universities at the forefront of fundamental research, paving the way for innovative solutions. Given the substantial public funding for research at universities around the World, there is a growing demand to showcase that research can be transformed into solutions that benefit people and society. In medical and engineering sciences, the translation from fundamental research into practical applications are typically driven by clear unmet needs and has improved human health and propelled civilization. While natural sciences inherently are typically further from direct application, advancements in chemistry, physics and molecular biology have still resulted in e.g., new catalysts or materials, energy solutions, and advanced genome editing techniques, respectively.

Research can find its path to practical applications and societal benefits through diverse avenues. A particularly effective method is through direct partnership with industry, utilizing research breakthroughs for product development or other business enhancements. This may involve licensing intellectual property (IP) from research institutions or forming research collaborations where academic or hospital experts collaborate with industry on addressing a specific challenge. Licensing is often paired with a collaboration agreement, offering a seamless transfer of the technology and associated knowhow from institutions to companies eager to leverage the IP. However, while licensing is the more straightforward avenue for translating research, IP from universities or hospitals is often too basic and might need significant refinement and risk mitigation before corporate companies find them appealing. In these cases, researchers can establish a spin-out company from their respective research institution and seek venture capital to mature the research and solidify the business case. Consequently, transferring IP to such a spinout company has emerged as a prime method to transform university and hospital research into applied products and services. The formation of spinouts from universities and hospitals is therefore a very good proxy for quantifying the innovation level at a research institution. However, given that research and education have historically been the main strategic priority, universities vary significantly in their efficiency of translating fundamental research into innovation. In a recent report we commissioned from Damvad Analytics, we found that among prominent life science ecosystems, there is a notable disparity in the number of companies spun out from their respective research institutions. In global biotech innovation hubs, the translational efficiency, measured as the rate of spin-out companies formed per scientific publication, is quite consistent. Boston, leads with one spin-out for every 70 publications, followed closely by Singapore at 72 and the London/Cambridge/Oxford region at 85, while Switzerland falls slightly behind with 128 scientific publications per spinout. Intriguingly, Damvad Analytics found that the number for Denmark is set at 227 publications per spinout. Considering the comparable quality and quantity of scientific output per capita across these five regions, Denmark's significantly lower number suggests a large opportunity of untapped life science innovation potential within the Danish universities.

This led us to perform a more detailed analysis of the three leading life science universities in Denmark: University of Copenhagen (UCPH), Aarhus University (AU), and Technical University of Denmark (DTU). We considered the period from 2015-2022 and our data was sourced from scientific research databases and complemented with spin-out statistics and academic staff counts from the universities' TTO offices and the university departments websites, respectively. Our analysis reveals significant variations among the three universities and even greater discrepancies at department level (Figure 1). When assessing academic productivity, measured by the average number of publications per academic staff, UCPH and AU perform similarly with a value of 9-10, whereas DTU has a slightly lower productivity rate of around 7. Turning to translational efficiency, the discrepancies between the universities widen considerably with 880 publications per spinout for UCPH, 431 for AU, and 98 for DTU. Even at department level marked differences become evident also within the three universities. The highest rates for translational efficiency are set by DTU Biosustain and DTU HealthTech, both matching the performance in the Boston region with about 70 publications per spinout. Notably, at DTU BioSustain this impressive innovation performance does not compromise the academic productivity, which is comparable to the average academic productivity for UCPH and AU. At AU, the Department of Biomedicine distinguishes itself by being one of the better performing Danish departments when it comes to both academic productivity and translational efficiency. At UCPH, the Biotech Research and Innovation Center (BRIC) demonstrates a comparable translational efficiency to AU biomedicine. Yet, with BRIC having a somewhat lower academic productivity than AU Biomedicine, the number of spinouts from the two research institutes in the explored period was 4 and 11, respectively. Similarly, with just one spinout company the relatively high translational efficiency rate of the NNF ReNEW center at UCPH (data predominantly based on the former DanStem center) is due to a very low publication productivity. In contrast, several departments at UCPH, including the NNF Center for Basic Metabolic Research (CMBR) and department of Pharmacy (PHARMA), have high average academic productivities, but with only 3-4 spinouts, these departments have low translational efficiencies in the range of 500-1000, again indicating untapped opportunities.

In the analysis, we further examined the academic impact as measured by number of citations per publication normalized to the field citation ratio and here, we did not see any correlation with neither academic productivity nor translational efficiency.

Our analysis clearly highlights the potential for increasing the number of life-science spinouts from Danish universities. Targeting an average of 100 publications per spin-out, consistent with the metrics from London/Cambridge/Oxford and Switzerland, and in line with DTU's average, it should be possible to yield an additional 31 life science startups from UCPH and 13 from AU each year. Another key takeaway from our analysis is that high innovation performance does not compromise academic output, as showcased by leading examples such as AU Biomedicine and DTU Biosustain. At these research institutes, the top management champions innovation, cultivating a robust culture that values both innovation and academic excellence.

While enhancing innovation efficiency by increasing spinout numbers is crucial for transitioning scientific breakthroughs to the market, the indispensable role of fundamental research cannot be understated. As indicated above, a deep comprehension of biology has resulted in transformative technologies and consequently opened novel avenues for treating numerous diseases. Yet, without an ingrained culture of innovation, such groundbreaking discoveries risk remaining uncommercialized, representing a missed opportunity for the benefit of society at large.

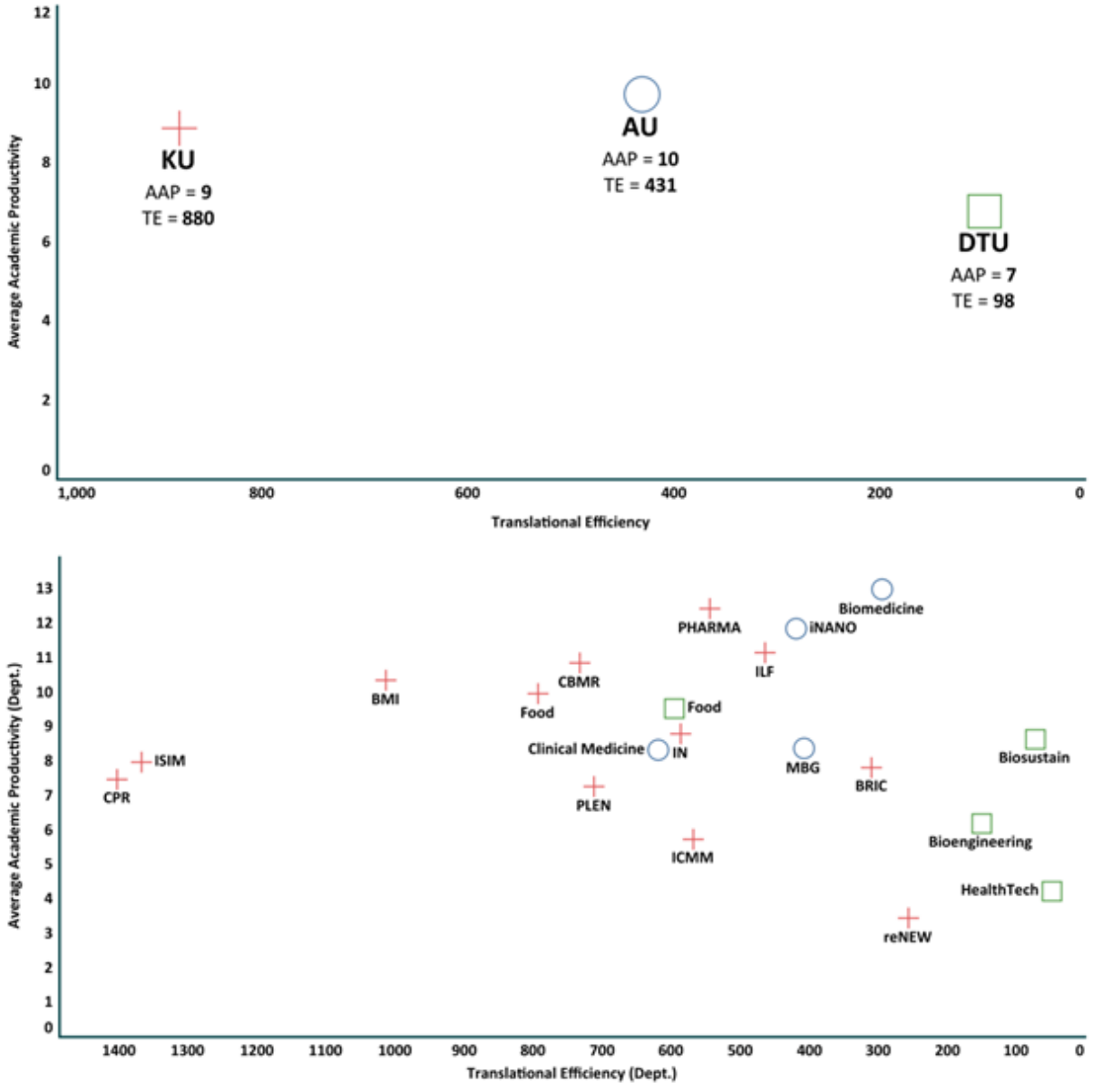

Figure 1. Academic vs translational performance at Danish universities from 2015-2022.

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Average Academic Productivity (AAP) is measured as total number of publications per academic staff (including Phd students and postdocs) and the Translational Efficiency (TE) is measured as total number of publications it takes to make a spinout. Publications were extracted from Dimensions, headcounts of academic staff were obtained from the university department's websites and spinout numbers were obtained from the university TTOs. Abbreviations: University of Copenhagen (UCPH): BMI (Dept. of Biomedical Science), ICMM (Dept. of Cellular and Molecular Medicine), ISIM (Dept. of Immunology and Microbiology), IN (Dept. of Neuroscience), PHARMA (Dept. of Pharmacy), ILD (Dept. of Drug Design and Pharmacology), BRIC (Biotech Research and Innovation Centre), CPR (NNF Center for Protein Research), CBMR (NNF Center for Basic Metabolic Research), reNEW (NNF Center for Stem Cell Medicine), PLEN (Dept. of Plant and Environmental Science), NEXS (Dept. of Nutrition, Exercise and Sport), FOOD (Dept. of Food Science). Aarhus University (AU): Biomedicine (Dept. of Biomedicine), iNANO (Interdisciplinary Nanoscience Center), Clinical Medicine (Dept. of Clinical Medicine), MBG (Dept. of Molecular Biology and Genetics). Technical University of Denmark (DTU): Bioengineering (Dept. of Biotechnology and Biomedicine), Health Tech (Dept. of Health Technology), Food (National Food Institute), Biosustain (NNF Center for Biosustainability).