IN SILICO MEDICINE

Investment in next-generation life sciences innovation empowered by computational modelling and simulations

December 2023

Beauhurst

UKRI Innovate UK KTN

Contents

Introducing in silico

'In silico studies' refers to using computer modelling and simulation to undertake virtual experiments (chips are largely made of silicon, hence the name). This report will focus on in silico technologies applied to the life sciences or healthcare to facilitate the discovery, development, optimisation or regulatory evaluation of medicines or healthcare products. In silico studies utilise computational modelling to simulate or predict cellular, molecular, or even subatomic interactions, such as DNA replication, protein folding, and RNA splicing. However, more recently, methods underpinned by very similar fundamental approaches have been used to model tissues, organs, full organisms and entire populations in health and disease.

In silico differs from in vivo (meaning "in life") and in vitro ("in glass"). In vivo refers to studies conducted on living organisms, while in vitro refers to studies conducted in test tubes or other laboratory settings outside a living organism.

In silico approaches emerged to overcome limitations inherent to lab experimentation with living organisms, cells and specimens. Primarily, it reduces the need for extensive lab work and expensive clinical trials, accelerates regulatory approval, and allows experimentation to be done on a much faster and larger scale. In some form, these techniques have been used for around 30 years, often in combination with in vitro research methods. However, in silico approaches have increased over the last few years thanks to upgrades in computational power and innovations in machine learning and computational sciences. They are becoming an increasing part of research and innovation in life sciences and healthcare thanks to the increasing and vast availability of digital data.

This report focuses on UK SMEs using in silico technologies to support a range of outcomes in the life sciences and medical technology sectors. These companies range from those using in silico technologies for drug discovery purposes to those using the technology to test medical devices and those are developing in silico technologies as their primary proposition.

The data in the report pertains to 77 UK headquartered in silico companies that are either currently active, independent private companies or have historically been part of this category but have exited via acquisition or IPO or have ceased operations. The rapid development of COVID-19 vaccines shows how rapidly new and effective drugs can be created. In silico technologies promise to improve further and accelerate our ability to tackle disease and health problems with safer and more effective therapeutic practices, drugs, and medical devices.

Foreword

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Computational Medicine (aka in silico medicine) is an emerging discipline devoted to quantitative approaches for understanding the mechanisms, diagnosis, and treatment of human disease through the systematic application of mathematics, engineering and computational science. Other sectors, including automotive, aerospace, and manufacturing, could not exist nowadays without modelling and simulation at their core, as envisioned by the Industry 4.0 paradigm. However, dealing with the extraordinary multi-scale complexity, variability and uncertainties intrinsic to human biological systems and health data demand radically new approaches compared to manufactured systems. In silico methods offer considerable advantages to improve medicines and medical technology by (i) enabling solid scientific evidence preceding bench or animal studies; (ii) extending the trial cohort to rare, extreme or difficult-to-recruit patient phenotypes; (iii) directly comparing alternative treatments on identical virtual populations (reducing the observed effect variance); (iv) evaluating drugs or devices under practically challenging physiological conditions that could represent extreme but plausible applications (off-label use); and (v) reducing the number of animals and humans required in trials, and the refinement of long-term studies to minimise suffering. Studies demonstrate that human in silico drug trials shows higher accuracy than animal models.

Many reports have pointed to this broken and slow innovation system and its impact on societal costs and suboptimal healthcare. Radical changes

> **Dealing with the extraordinary multi-scale complexity, variability and uncertainties intrinsic to human biological systems and health data demand radically new approaches compared to manufactured systems.**

to this innovation process are still to be developed. Before gaining regulatory approval, pharmaceuticals and medical devices must progress through long and expensive clinical trials. Failure rates are high and can be extremely costly. Today, over 30% of drugs entering Phase II studies fail to progress, and over 58% fail in Phase III. UK's vibrant life sciences ecosystem of start-ups and spin-offs shows its innovative strength and vulnerability, given this is the period with the highest risk of commercialisation failure. The overall likelihood of approval from Phase I for all developmental drug candidates was 7.6% from 2011-2020, with an average of 10.5 years for a Phase I asset to progress to regulatory approval. With success rates declining and clinical trial costs rising, innovation stagnates. Clinical trials in the US and UK are moving abroad where costs are lower. However, patient profiles, regulations and quality assurance may differ from those relevant to ensuring patient safety and benefit in these geographies. Despite considerable efforts to protect patient safety and access to better therapies, global regulatory processes are increasingly seen as obsolete and unsuitable for high-value care. In silico methods offer an avenue to achieve product innovation in a responsible, patient-sparing way that balances the desire for certainty in the drug efficacy and medical technology performance while limiting the delay in patient access associated with increased certainty.

> **In silico methods offer an avenue to achieve product innovation in a responsible, patient-sparing way.**

The latest government figures found that businesses in the UK life sciences industry generated £94.2 billion in turnover in 2021, a 9% increase from the £86.4 billion turnover in 2020. Turnover has seen an upward trend since 2013 but has increased sharply between 2019 and 2021. Four sectors operate within the UK life sciences industry (biopharmaceutical core, biopharmaceutical service and supply, medical technology core, and medical technology service and supply). The sector with the highest proportion of sites and employment was the medical technology core sector, accounting for 44% of sites and 40% of employment in 2021. This sector has continuously accounted for the highest number of sites and employment between 2009

and 2021. The sector that generated the highest turnover in 2021 was the biopharmaceutical core sector, accounting for 43% of the total turnover generated across the life sciences industry. This was followed by the biopharmaceutical service and supply and medical technology core sectors, each accounting for 25% of turnover in 2021.

Alongside benefits to the UK economy and NHS mission and sustainability, in silico medicine presents socioeconomic opportunities and a growing market to tap into. The global in silico drug discovery market size was valued at US$2.8 billion in 2022 and is expected to reach US$5.1 billion by 2030 at a compound annual growth rate (CAGR) of 7.1%. 44% of this growth is likely to come from North America. Ensuring the UK life sciences sector benefits from this market opportunity requires staying at the forefront of science and technology and consistent R&D investment and creating the optimal conditions for entrepreneurial activity, venture capital, and innovation-friendly regulations. By capitalising on its excellent public and private R&D capabilities, NHS infrastructures, and investment capabilities, the UK will become the best milieu for delivering medical innovations using in silico evidence and regulatory science.

This report shows that the UK can build on its unique assets, mobilise risk capital, attract inward investment to undertake in silico new drugs and health tech discovery, and assess their safety and efficacy through in silico trials. I invite you to reach out to the InSilicoUK Network (www.insilicouk.org) and join over 1500 professionals from industry, academia, government, and regulators in accelerating this transformation.

“Alongside benefits to the UK economy and NHS mission and sustainability, in silico medicine presents socioeconomic opportunities and a growing market to tap into.

Executive summary

Henry Whorwood
Head of Research and Consultancy
at Beauhurst

In this report, we highlight the rapidly growing in silico sector in the UK. Beauhurst has identified 75 high-growth companies in this sector, many of which have achieved significant commercial success and raised equity investment, positioning them to advance healthcare and biotechnology using the latest computational techniques.

The growth of in silico companies in the UK is driven by a number of factors, including the availability of highly-skilled workers from top academic institutions; supportive government policies, such as the £39.8b allocation to R&D for 2022 to 2025; and access to funding.

The success of in silico companies in the UK is a testament to the country's commitment to fostering innovation and supporting the growth of emerging industries. Organisations like UK Research and Innovation (UKRI) play an important role in supporting the country's research endeavours, not only through funding but also by investing in accessible, world-class research facilities — like the supercomputer ARCHER — and by supporting the development of researchers at all stages of their careers.

The in silico industry has the potential to reshape the healthcare and biotechnology industries, particularly in terms of research methods. The technologies being developed are opening the doors to impressive pharmaceutical and medical technology innovations, creating more ethical research environments and allowing for greater research turnover rates with the speed at which studies can be conducted using in silico techniques.

This report provides a high-level analysis of the state of the private company in silico sector in the UK, highlighting demographic data and investment trends. The report is intended as a resource for anyone interested in the in silico industry, from investors and entrepreneurs to policymakers and researchers.

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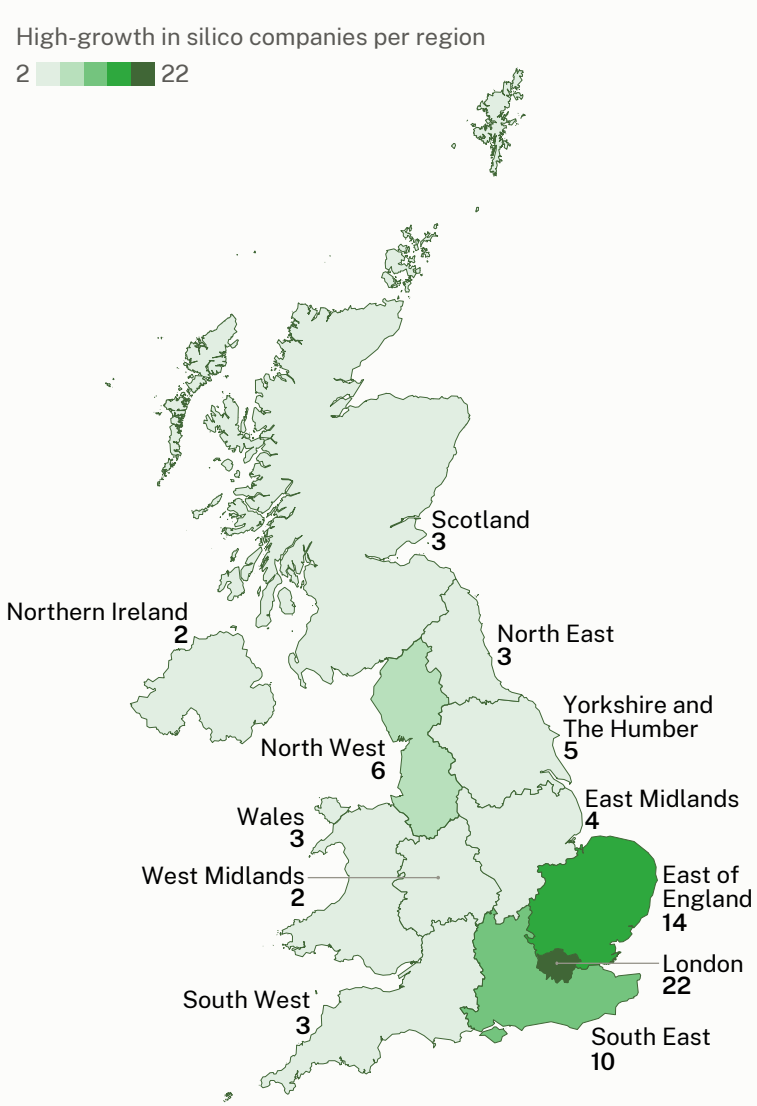
1 Cohort demography

Location

Number of in silico companies by UK region (2022)

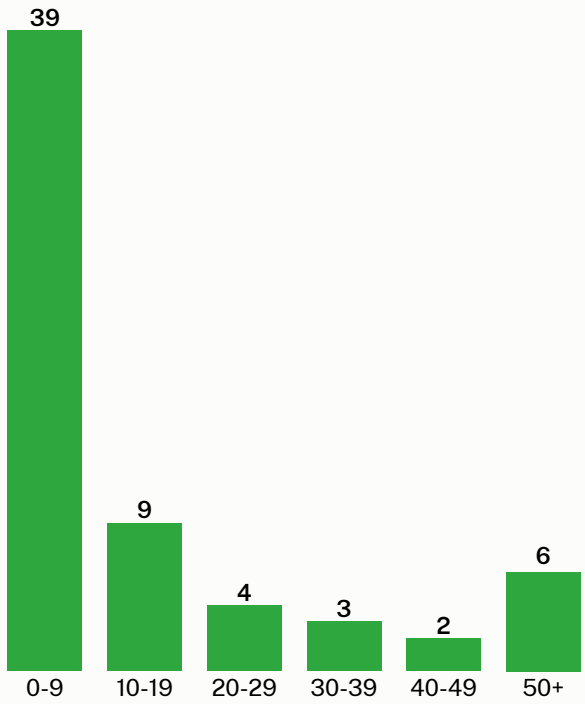


London is home to the largest number of in silico companies (22), followed by the East of England (14) and the South East (10). This geographical density of in silico companies in the south of the UK aligns with the distribution of technology and IP-intensive companies seen in the country's wider business population. This is due to the accessibility of resources for early-stage in silico businesses in the south, including many high-quality academic institutions and their facilities, employee talent pools, and investors.

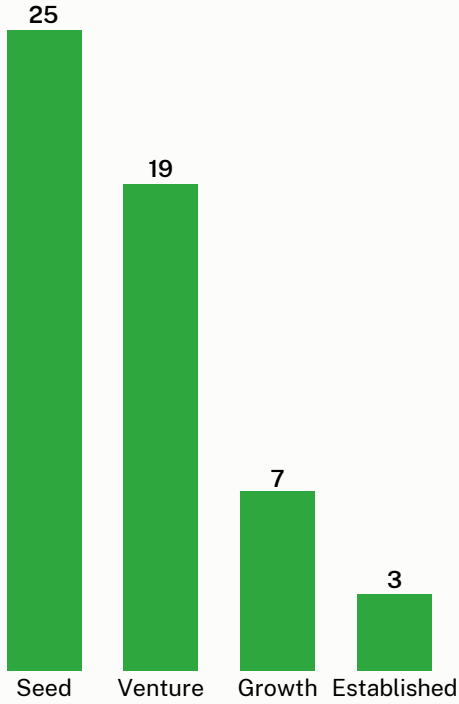
Yorkshire and The Humber (5) and the North West (6) are the next most populated regions in regards to in silico companies. One reason for this may be due to the presence of investors with a focus on these regions. For example, the North West Fund for Biomedical, that has invested in the likes of Liverpool-based Ostara, which develops human fertility treatments.

Size and stage

Number of in silico companies by headcount (2022)



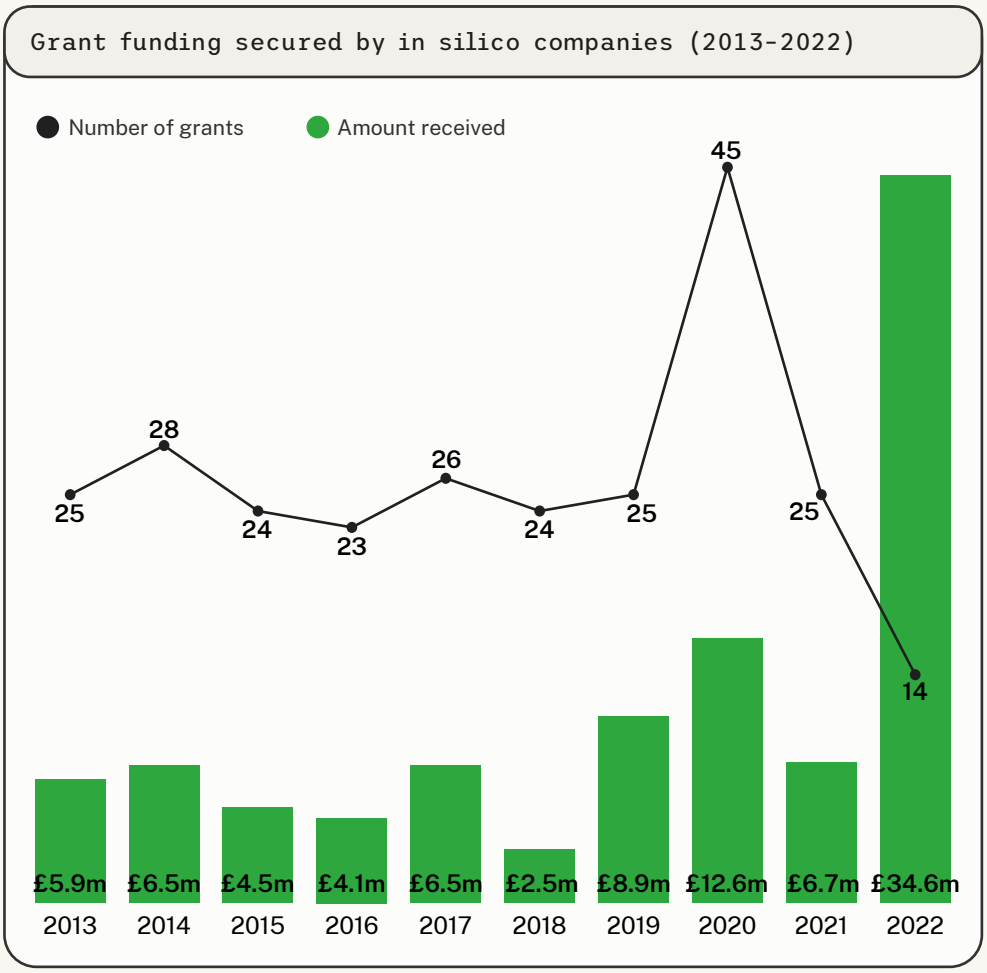
Number of in silico companies by stage of evolution (2022)



Of the 54 high-growth in silico companies, 44 (81.5%) are at the seed or venture stage and this corresponds with the most populated headcount ranges being 0-9 (39) and 10-19 (9). The dominance of these early-stage companies may be indicative of the sector's development potential, with there being few established players in the high-growth space (3). This suggests that there is opportunity for greater institutional support, in terms of financial assistance and commercial expertise, to help facilitate the growth of the in silico industry.

Despite this, there are some companies that have matured beyond these early stages. Quotient Sciences is an example of this. Launched in 1990, the company provides accelerated drug development and manufacturing services, and has since raised £107m in equity investment from two rounds.

Grants



£92.9m
total received
2013-2022

260
number of grants
2013-2022

The total number of grants received by companies that utilise in silico research methods has not changed significantly over the past decade. The cohort of companies received on average 25.9 grants per year. In contrast to the equity investment data, these companies saw an increase in the value and number of grants received in 2020, securing £12.6m via 45 grants. This was a result of the additional support companies received during the COVID-19 pandemic, in particular, Innovate UK's push to deliver financial assistance, such as continuity grants, to R&D-intensive companies.

While the number of grants received dropped significantly between 2021 and 2022, from 25 to 14, the value of these grants set the decade's highs of £34.6m. This is due to a large grant secured by DIOSynVax in March 2022, which received £32.1m from the Coalition for Epidemic Preparedness Innovations to develop a vaccine for a variety of coronaviruses.

Spinouts

26

total count of in silico spinouts (historical)

33.8%

spinouts as a proportion of all high-growth in silico companies

Of the 77 in silico companies, 26 were spun out of an academic institution, coming from a range of universities. The University of Oxford and University College London were the two most frequent institutions these businesses spun out of, producing five and three respectively. This high representation of spinouts within the in silico sector is understandable, given these technologies allow researchers to conduct their studies in a cheaper and more timely manner — providing fewer barriers to commercialisation.

Case studies

Autifony Therapeutics
(University College London)
Launched in 2011, Autifony Therapeutics develops pharmaceuticals to treat central nervous system disorders. Based in Stevenage, the company has secured £23.4m in equity investment via four rounds from investors such as Pfizer Venture Investments and SV Health Investors.

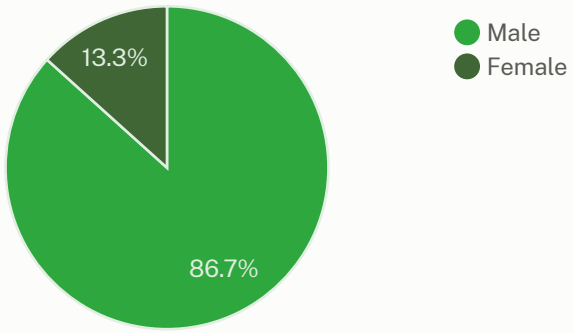
Phasecraft
(University of Bristol/University College London)
Co-founders Toby Cubitt, Ashley Montanaro and John Morton set up Phasecraft in 2018, developing quantum algorithms and software to help investigate a range of computational problems. The Bristol-based company has secured £4.45m in equity investment via two fundraising rounds and an additional £883k in grant funding.

InoCardia
(Coventry University)
Based in Coventry, InoCardia provides cardiac screening services for pharmaceutical and biotechnology companies to use in R&D phases. The company was founded by Helen Maddock in 2013 and has since raised £529k in equity funding and £827k in grant funding.

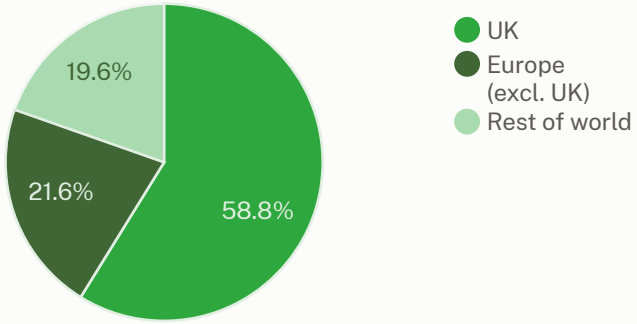
BioSystems Technology
(University of Exeter)
Founded in 2015, BioSystems Technology develops alternative drug testing methods to reduce mammal-based testing, including using cell cultures, insect larvae and computer modelling. The Exeter-based company has secured £200k in equity investment from one round and £387k in grant funding.

Founders

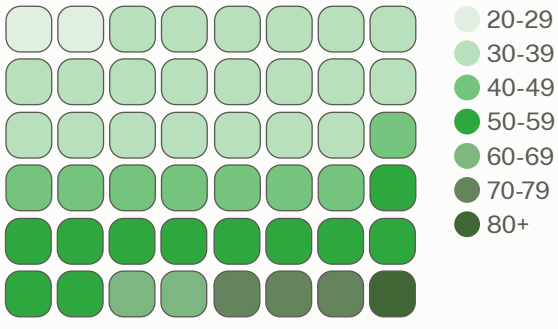
In silico founders by gender (2022)



In silico founders by nationality (2022)



In silico founders by age (2022)



*One box = one founder

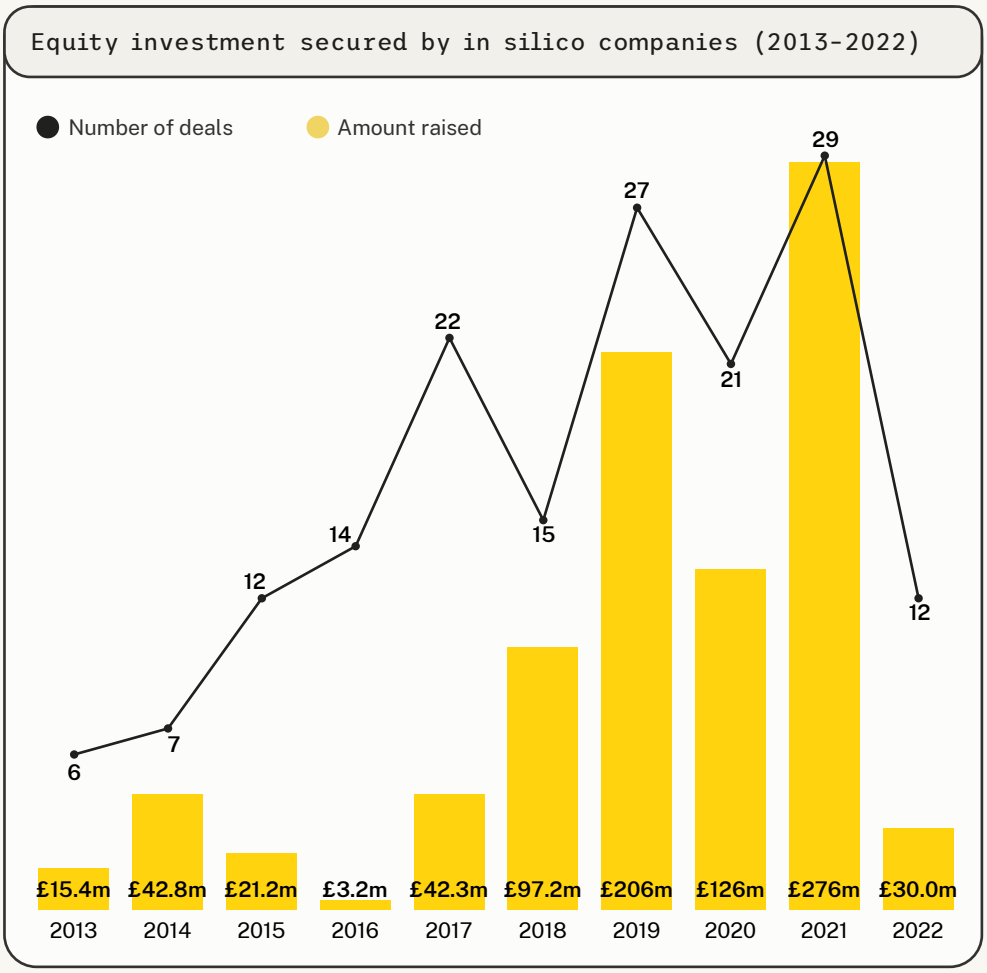
Female founders make up just 13.3% of the founder population for in silico companies, while male founders make up 86.7%. This aligns with the wider founder demographics seen in the high-growth ecosystem. This indicates the need for additional support for female entrepreneurs in this industry and in STEM industries more generally.

As expected, founders of in silico companies were most commonly from the United Kingdom (58.8%), while 21.6% of the remaining founders are citizens of European countries. The fact that 41.2% of founders originated from outside of the UK may be a reflection of the country being an alluring place for academic founders to set up businesses. This may be due to the advantages founders benefit from in the UK, such as governmental support for R&D-intensive companies, including tax credits, alongside the country's strong talent pools and access to funding.

The age breakdown for the founders of in silico companies differs slightly compared to the founders of all high-growth companies tracked by Beauhurst, for which the most popular age bracket is 50-59. In silico companies, however, tend to have younger founders with the 30-39 age bracket (44%) being the most populous. This can perhaps be attributed to the youthful nature of the industry and may be a symptom of the industry being at the forefront of the latest advancements in computational technologies.

2 Equity investment

External investment



£860m
total raised
2013-2022

165
number of deals
2013-2022

Companies that utilise in silico techniques secured significant equity investment over the past decade, with both the number and value of deals rising dramatically. Between 2013 and 2021, the number of deals increased by an impressive six-fold, while the total value of these deals increased by almost twenty-fold — from £15.4m in 2013 to £276m in 2021. This trend reflects the recent innovations within in silico technologies, particularly the development of machine learning and AI techniques, and their contribution to successful, virtual research approaches.

The decade's high of £276m raised in equity funding in 2021 can be attributed to one deal by AI drug discovery firm Exscientia, which secured £162m in April 2021 from investors such as BlackRock. There is a noticeable drop in investment in 2022, which aligns with the trends seen in the wider market, as investors take a step back amid the challenging macroeconomic conditions.

Top investees

Top in silico companies by total equity raised (2013-2022)

£300m	Exscientia	Exscientia	Year incorporated: 2012 Headquarters: Oxford Total equity deals: 7
£253m	BenevolentAI	BenevolentAI	Year incorporated: 2015 Headquarters: Camden Total equity deals: 6
£107m	Quotient Sciences	Quotient Sciences	Year incorporated: 2015 Headquarters: Rushcliffe Total equity deals: 2
£16.7m	Axis Spine Technologies	Axis Spine Technologies	Year incorporated: 2016 Headquarters: St Albans Total equity deals: 9
£14.3m	CN-BIO Innovations	CN Bio Innovations	Year incorporated: 2008 Headquarters: South Cambridgeshire Total equity deals: 7
£13.4m	autifony Therapeutics	Autifony Therapeutics	Year incorporated: 2011 Headquarters: Stevenage Total equity deals: 3
£12.7m	Pathfinder Medical	Pathfinder Medical	Year incorporated: 2014 Headquarters: Wandsworth Total equity deals: 6
£11.3m	SYNTHETICGESTALT	SyntheticGestalt	Year incorporated: 2018 Headquarters: Westminster Total equity deals: 3

'Headquarters' refers to the local authority of the firm's head office.
'Total equity deals' are deals secured 2013-2022.
Deals may include a debt component.

Top investors

Top investors into in silico companies by number of equity deals (2013-2022)

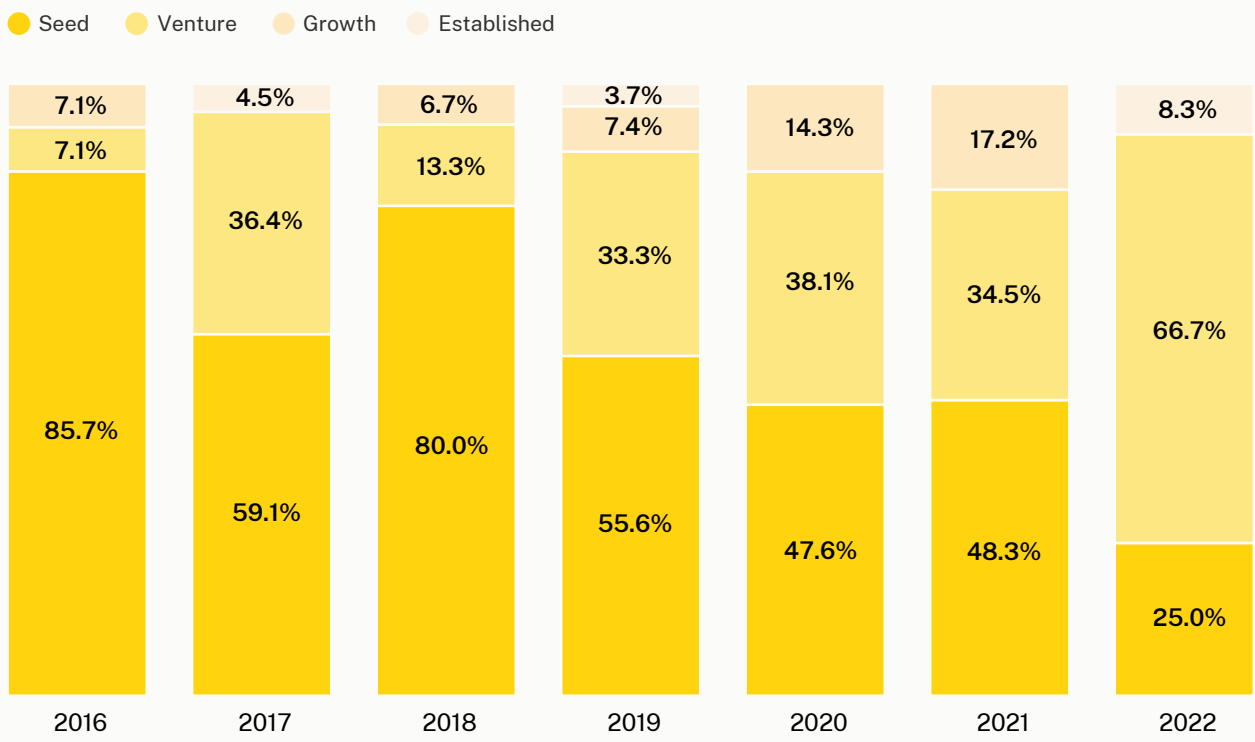
Mercia Fund Managers	6
Cambridge Angels	6
ACF Investors	6
SyndicateRoom	4
Parkwalk Opportunities EIS Fund	4
Oxford Science Enterprises	4
Old College Capital	4
North West Fund for Biomedical	4
London Co-Investment Fund (LCIF)	4
GT Healthcare	4

From the 165 equity investment deals, Parkwalk Opportunities EIS Fund and Old College Capital ranked as two of the most frequent funders of in silico companies, participating in four deals respectively. Both of these funds have a focus on academic spinouts, the latter on those that are associated with the University of Edinburgh, and this fits with the fact that 34% of the cohort have spun out of an academic institution.

Angel networks such as Cambridge Angels and ACF Investors are also some of the most common investors in these companies, participating in six deals each. This is indicative of the youthful nature of this industry, with 62% of companies incorporating within the last decade. It can be difficult for these early-stage companies to access other sources of capital, highlighting the importance of angel investors to the in silico industry, not only for their financing capabilities but also for their support and expertise.

Investment opportunities

Equity deals by stage of evolution at time of fundraising among in silico companies (2016-2022)



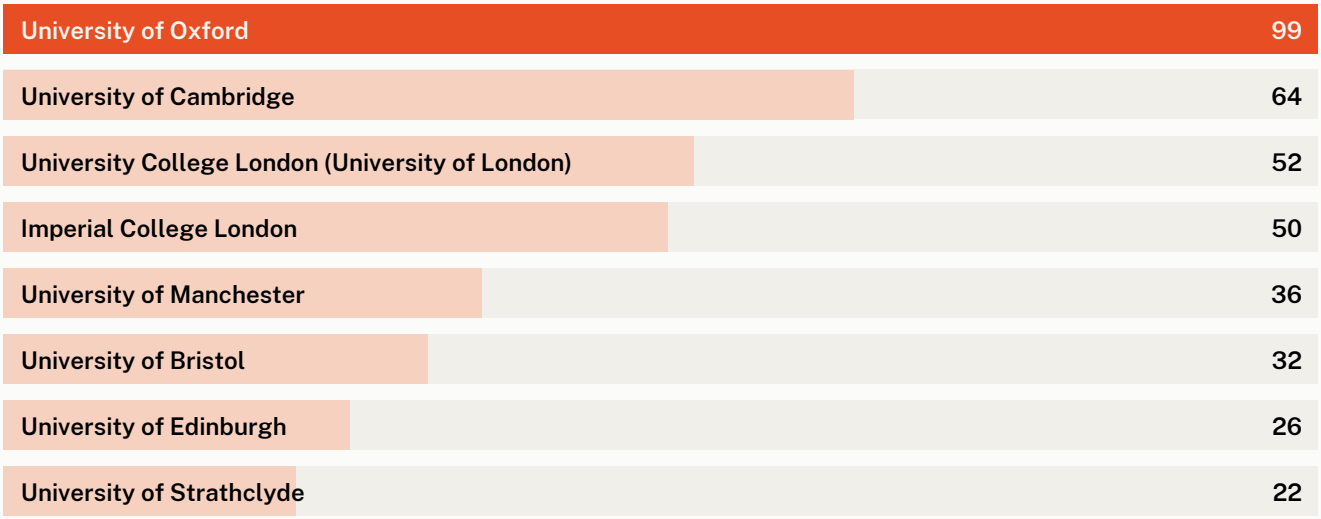
Between 2016 and 2022, the majority of equity investment deals were completed by companies at the seed or venture stage. The proportion of deals completed at the seed stage gradually decreased from 85.7% of deals in 2016 to 25% of deals in 2022, with venture-stage deals taking up a larger proportion over time, rising from 7.1% in 2016 to 66.7% in 2022. This data reflects the nascent nature of the industry, with much of this fundraising activity related to an early wave of in silico companies.

The above figures, combined with 81.5% of active in silico companies being at seed or venture stages, indicate that while the industry is maturing, there is still opportunity for investors to play a role in advancing early-stage businesses in this sector. The potential for success in the industry is best exemplified by BenevolentAI, an AI drug discovery company. It became a publicly traded company on the Euronext Amsterdam in April 2022, in what was the largest European SPAC merger at the time.

3 UK context

Role of universities

Top universities by number of medtech and life sciences spinouts (historical)



The figure above shows the academic institutions historically ranked as the most common universities to commercialise medtech and life sciences research. Of the 717 medtech and life science companies that have spun out of academic institutions, 99 were produced by the University of Oxford, which is followed by the University of Cambridge (64) and University College London (52). This reflects that universities are an integral source of companies for the life sciences and medical technology industries due to their access to the personnel, facilities and intellectual property required to launch these businesses. These same factors mean that universities will play a crucial role in the long-term growth of the in silico sector in the UK.

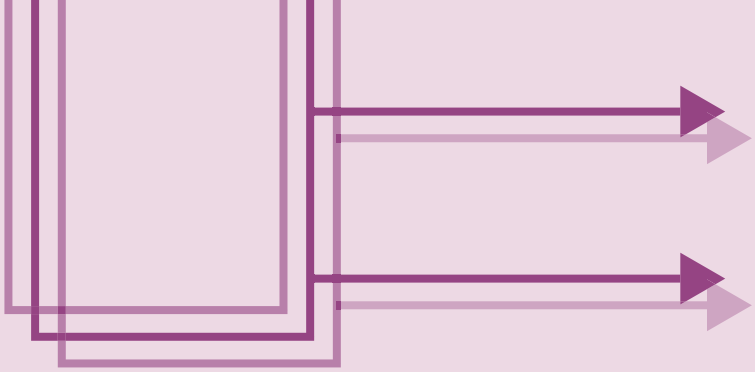
As page 8 shows, universities are already an important source of in silico companies. This, in combination with the above, suggests that universities will likely continue to be one of the focal points for the growth of the emerging industry and play a key role in spreading the adoption of in silico technologies.

Universities also play a role in funding in silico spinouts in their early stages, and this is highlighted by Old College Capital (the University of Edinburgh's venture fund) ranking among the top funders of in silico companies (page 13). Another example can be seen in the UCL Technology Fund, which invested in the seed-stage company Phasecraft, a developer of quantum algorithms and software to help accelerate experimental research.

Large companies

Partnerships between larger corporations and smaller, high-growth companies can often prove to be fruitful relationships for both parties. These relationships can come in many forms, one of these being corporate venture capital investments. This provides the high-growth company with not only access to capital but also access to industry expertise, resources and the larger corporate's markets. An example of this in the in silico industry is Pfizer's investments in Autifony Therapeutics, which develops pharmaceuticals to treat central nervous system disorders, in both June 2013 and July 2015.

Another way in which larger corporations may support in silico startups is through accelerator programs. Accelerators can vary in the types of support they offer to help early-stage businesses grow but support can include specific skill development and access to mentorship and potential investors. These programmes may be managed or sponsored by larger corporate bodies, for example Johnson & Johnson sponsor the IMAGINE IF! accelerator, which focusses on science and technology ventures in the healthcare sector. IMAGINE IF! attendees from the in silico cohort include Sixfold, which uses nanotechnology to develop cancer treatments. Another example is the AstraZeneca-sponsored Accelerate@ Babraham programme, which aims to develop life sciences and early-stage biomedical companies, and has been attended by in silico businesses such as computational modelling platform Oppilotech and ML-drug discovery firm Antiverse.



Conclusions

The future is encouraging for in silico companies, with their technologies holding the potential to revolutionise the healthcare and biotechnology sectors by making research both faster, more ethical, and more affordable.

The UK has historically been home to 77 private in silico companies, which have received a total of £860m in equity investment via 165 deals between 2013 and 2022. There is a range of investor types supporting the industry, with companies gaining access to funding from private equity and venture capital firms, university investment arms, and angel networks. All of these are providing early-stage in silico companies with capital to support their growth and allow them to focus on the development of innovative technologies for the industry.

The investment data also suggests there is still a lot to come from the industry. Since 2016, the majority of in silico companies that have received equity investment have done so at the venture or seed stage, indicating that there is significant opportunity for those looking to invest in early-stage businesses within the sector.

Universities and corporate entities will play a key role in advancing the industry and can help create more success stories such as BenevolentAI and Exscientia. Universities have typically played an important part in commercialising research and producing academic spinouts, particularly within the medtech and life sciences sectors. Meanwhile, corporate entities have developed relationships with ambitious companies through their venture arms and contributions to accelerator programmes. It is probable that these trends will continue to benefit the in silico industry. This means the UK is well positioned to become a global leader in in silico technologies.

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Beauhurst is a searchable database of the UK's high-growth companies.

Our platform is trusted by thousands of business professionals to help them find, research and monitor the most ambitious businesses in the UK. We collect data on every company that meets our unique criteria of high-growth; from equity-backed startups to accelerator attendees, academic spinouts and fast-growing scaleups.

Our data is also used by journalists and researchers who seek to understand the high-growth economy, and powering studies by major organisations — including the British Business Bank, HM Treasury and Innovate UK — to help them develop effective policy.

For more information and a free demonstration, visit beauhurst.com

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