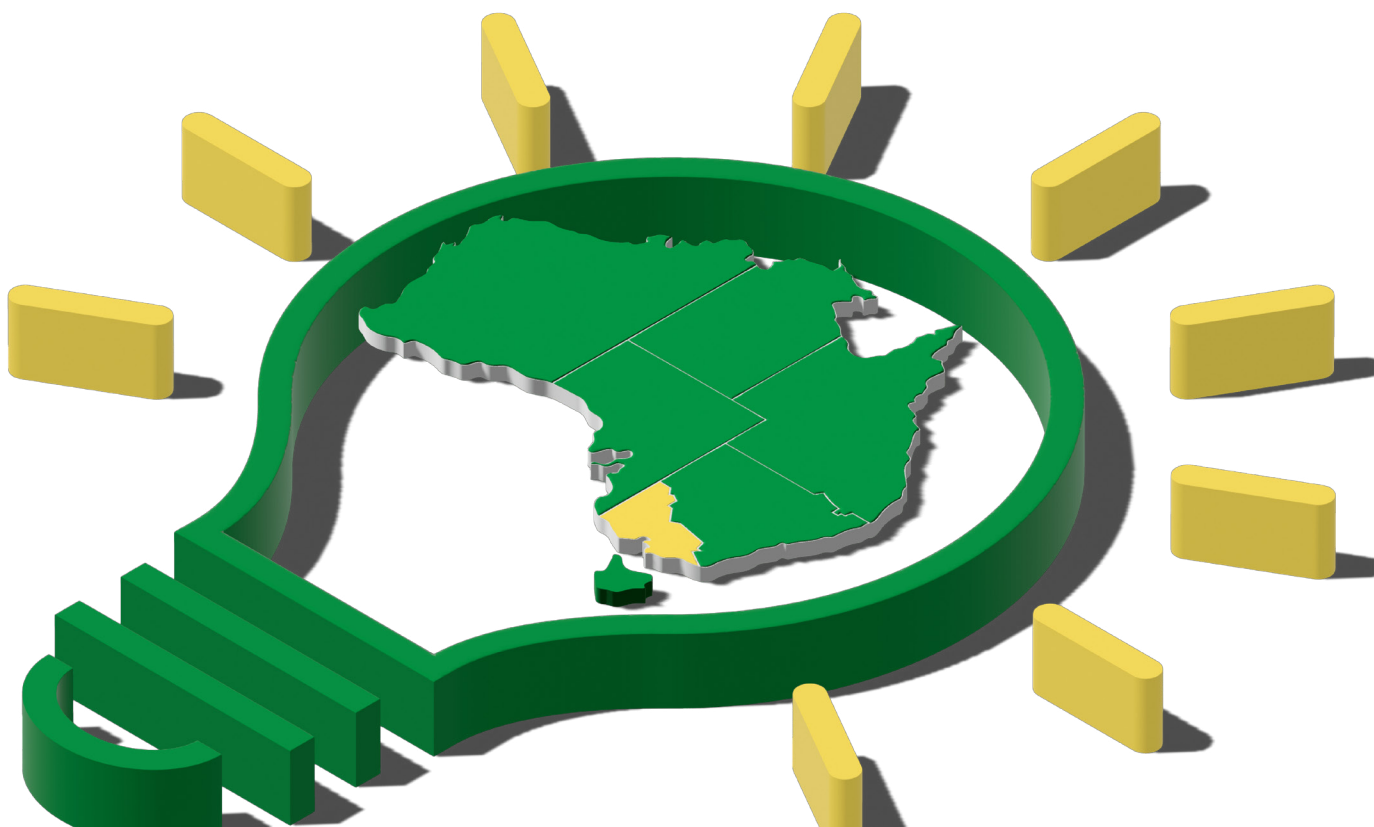




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BENCHMARK RESEARCH COMMERCIALIZATION AND TECHNOLOGY TRANSFER IN VICTORIA

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The Milken Institute is a nonprofit, nonpartisan think tank focused on accelerating measurable progress on the path to a meaningful life. With a focus on financial, physical, mental, and environmental health, we bring together the best ideas and innovative resourcing to develop blueprints for tackling some of our most critical global issues through the lens of what's pressing now and what's coming next.

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LaunchVic is Victoria's startup agency. Its role is to fuel the growth of Victoria's startup ecosystem by building the confidence and capability of Victorians to create, scale, and invest in startups. LaunchVic was established by the Victorian government in 2016. Since 2017, LaunchVic has supported 858 Victorian startups to grow. In addition, it has upskilled over 11,407 entrepreneurs. Through its work, LaunchVic has unlocked more than \$371 million of private-sector investment (via grants and the Alice Anderson Fund).



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EXECUTIVE SUMMARY

Over the past several decades, the state of Victoria has established itself as Australia's higher education leader, with a concentration of universities, researchers, and ideas to rival many of the greatest centers of learning in the world. Despite these tremendous resources, Victoria's overall ability to harness this research and innovation to stimulate the state's economy is limited relative to other world-leading centers of education. Whether in terms of partnerships with private industry, technology, patent licenses, or production of new startups, Victoria has found itself at a disadvantage compared with many other ecosystems that have developed around renowned universities and clusters.

In partnership with LaunchVic, the startup agency of the Victoria government, the Milken Institute has set out to conduct a two-part assessment of the tech transfer, commercialization, and entrepreneurial capabilities and environment at different universities in Victoria. This public report will discuss the broader Victoria ecosystem, a comparison to similar ecosystems around the world, and leveraging best practices in other countries and regions to help inform and assist policy implementation both in Victoria and Australia as a whole.

This assessment draws on the following key elements:

- Surveys of the state of tech transfer and commercialization activity in Victorian universities;
- Establishment of benchmarks for university tech transfer, commercialization, and startup activity, utilizing the previously issued Australian National Survey of Research Commercialisation (NSRC) and its successor, the Survey of Commercialisation Outcomes from Public Research (SCOPR) administered by Knowledge Commercialisation Australia; and
- Engagement with numerous stakeholders at the universities, in the private sector, and at connected and significant nongovernmental organizations.

Information gathered through desk research, individual interviews, and group meetings contributed to defining the proper benchmarks for evaluating the current status and future prospects of tech transfer and commercialization, as well as formulating recommendations for further action to remove obstacles on the path from concept to commercialization.

Key Findings

- Australia has been steadily improving its technology transfer and commercialization performance in recent years. Still, it lags behind some other developed countries in key metrics such as research and development spending and patent applications.
- Broadly speaking, the root causes of the tech transfer and commercialization problem are gaps in *financing*, *talent*, and *incentives*. The financing gap refers to funding deficiencies at the government, university, and private-sector levels; the talent gap refers to the lack of experienced professionals who can effectively translate research into commercialization; and the incentives gap refers to the lack of incentives at universities aimed at faculty members' pursuing research commercialization.
- The strength of Australia's national innovation system is its ability to translate patent applications into licenses, options, and agreements (LOA). Australia's weakness lies in its relative inability to translate research and development into invention disclosures. Herein lies a challenge: most of Australia's LOAs are sent overseas; hence, very few of these accrue locally or nationally into some form of economic development benefits. The exception is large revenue windfalls for universities.
- Australian universities are some of the finest in the world in research and development; the university-generated LOAs result in huge revenue windfalls for them. But on the downside, Australian universities lag their international peers in tech transfer and commercialization, particularly in venture capital-backed startups. There is a policy imperative to increase the focus on startups and build local capabilities.
- Victoria is a regional leader in tech transfer and commercialization in *volume* but not *efficiency*.
- The comparative advantage of Victorian universities is their *research output* and *quality*, particularly in biotech. By some accounts, Melbourne has one of the world's largest life science clusters. Victoria's strong regional leadership can be largely attributed to its two Group of 8 member universities, University of Melbourne and Monash University.
- The comparative disadvantage of Victorian universities stems from their inability to efficiently translate research expenditures into licensing revenues. Given its prolific research institutions and research output, what puts Victoria and Melbourne at a disadvantage is that they do not have the financial capital that Sydney has. Finding ways to help startups and expand licensing opportunities and thereby addressing the apparent bottleneck in the innovation mechanism is in the direct interest of Victorian universities, the state of Victoria, and its economy.
- Universities in other commonwealths, such as the University of New South Wales, Australian National University, and University of Queensland, are more advanced in tech transfer and commercialization.
- While expanding funding is important, the most important asset and yet the greatest challenge in Australia's innovation ecosystem is *talent*. Having experienced and capable technology transfer professionals is instrumental to the success of a university's tech transfer office, whether that be managing intellectual property (IP) or licensing.

- Both the Australian and Victorian governments recognize the importance and are making greater investments in technology transfer and commercialization. The policy landscape is changing, and there is a wider recognition in the state and national governments of the importance that universities play in promoting innovation, startups, and growth. The Australian Universities Accord and the National Reconstruction Fund (NRF) will bring about transformative reforms to Australia's higher education system and help diversify Australia's industry and economy.

Key Recommendations

- First and foremost, the government has an important role to play. Long-term strategic planning and carefully thought-out policy can shape the future of Australia's tech transfer and commercialization. Currently, government's competitive research grants are geared toward academic research but not for commercialization. The state and national governments must rethink competitive grants that promote tech transfer and commercialization.
- Victorian universities should do more to create faculty *incentives* to pursue tech transfer, commercialization, and new ventures/entrepreneurship. As a starting point, all academics and PhD students (as well as the general student population) should have access to quality accelerator programs within universities led by people with commercial and startup expertise.
- Finding and distributing capital and assistance to grow companies, assist founders, and transfer licenses require not only developing and retaining the people needed to execute such efforts but also recognizing when faculty and other officials are not best positioned to do so.
- Universities must find ways to attract and retain experienced and capable tech transfer professionals from within Australia or outside. Such *talent* is instrumental to the success of a university's tech transfer office, whether managing IP, licensing, or entrepreneurship programs.
- For resource-strapped universities and entrepreneurs, pooling tech transfer and commercialization-related resources and forging partnerships may be an approach to reaping quicker and more successful commercial returns.
- Although there is now a wider recognition that *campus startups* are important, Victorian universities must double down their efforts to transform their campuses into innovation ecosystems.
- Each university should identify its key areas of *comparative advantage*, beyond simply resources and personnel, and leverage those areas to achieve clear, tangible results. For example, the University of Melbourne and Monash University should leverage their incredible research apparatuses to strengthen industry ties and broadly expand their tech transfer, entrepreneurship, and commercialization efforts. Smaller universities, such as Victoria University and Swinburne University, should be more selective and strategic about their areas of specialization.
- Public programs can help to bridge this chasm by providing early-stage financing to pre-seed startups, particularly high-tech firms. Public-sector investments tend to be less risk averse, employ a long-term perspective, and are particularly well-suited to investments with high social returns rather than private returns. However, public-sector investments can go only so far; private-sector investment is necessary

to ensure the sustainability of the innovation ecosystem. Public investments are most effective when they assume the risk as first-movers and sufficiently lower the risks for the private capital markets to follow suit. Involving the private sector in the early stages of the life cycle is key.

- There is also great potential to extend the PhD talent pipeline to industry. As it stands, Australian universities produce many more PhDs than there are academic career opportunities, and expanding career opportunities for PhDs will serve the long-term interest of research universities. If universities are serious about tech transfer and commercialization, they must find ways to engage the private sector's expertise and experience in deciding what should be commercialized. If the private sector is serious about developing innovative new products and ideas, it ought to tap into universities' deep knowledge pool.



AUSTRALIA'S STATE OF TECHNOLOGY TRANSFER AND COMMERCIALIZATION

The Role of R&D in Innovation

In the 21st century's globally connected knowledge economy, universities are important not only as producers of human capital but also as critical facilitators of tech transfer and commercialization—the very keys that unlock prosperity and competitiveness for regions and nations.

Innovation is the cornerstone of knowledge-based economic development. Experimentation and inventions, or more precisely, the commercial applications of these inventions, drive a nation's long-term economic growth. Nations on the knowledge frontier prosper because they best capture the commercial value of economic knowledge and export these sophisticated, high-value-adding goods and services. In addition, a lesson from the Cold War is that public investments in basic research and development (R&D) in nuclear weaponry and the space race generated a variety of innovative civilian technologies (positive externalities). The economic knowledge from basic R&D generated knowledge spillovers, and its commercial value was captured by large and small firms in the private sector—perhaps the most notable byproduct being the invention of the internet. The internet started as a governmental research initiative, but its commercial potential was eventually realized by private firms, large and small.

The historical lesson here is that the two types of R&D, *basic* and *applied*, are equally important. Basic R&D refers to pure scientific research that is conducted at higher education and federal research institutions. Applied R&D refers to applied research, such as engineering, that is often conducted by the private sector, particularly in the USA. The statement that universities do basic R&D and the private sector does applied R&D is an oversimplification, but given the different incentive structures, it underscores the concepts of *specialization* and *comparative advantages*.

Basic R&D usually occurs with public funds and in risky ideas with a long-term payoff for which the private sector lacks the incentive to pursue. But basic R&D produces scientific knowledge that forms the basis for many applied inventions. The payoff from applied R&D, derived from the commercial application of inventions, tends to be shorter-term in nature. Both public and private R&D investments are essential for unleashing the potential of innovation and shaping a future capacity for economic growth. A shortage of applied R&D investments in the private sector challenges Australia's global competitiveness.

Australia's problem is not an *invention problem* but a *tech transfer and commercialization problem*. During an address at the National Press Club in July 2022, Larry Marshall, the chief executive of Australia's

Commonwealth Scientific and Industrial Research Organisation (CSIRO), a government agency responsible for scientific research, spoke about the state of Australia's tech transfer and commercialization with a great sense of urgency.¹ He commented that the nation stood at a "pivotal point." In November 2022, Australian Minister for Industry and Science Ed Husic emphasized the crucial role of entrepreneurs in advancing tech transfer and commercialization, stating, "Investing in human capital also means supporting the next wave of Australian entrepreneurs, emerging from our universities, our cities and towns... [It means] encouraging Australians to invest in new ideas and new businesses that could be our next big breakthrough."²

The 2020 World Intellectual Property Organization (WIPO) Global Innovation Index ranked Australia as the 23rd most innovative nation. The index showed that although Australia's *inputs* were ranked high. Market sophistication (seventh), human capital and research (ninth); institutions (10th). But its technology and commercialization *output* indicator (knowledge and technology outputs) is ranked low (40th) and is an evident bottleneck.³ Australia boasts a number of world-class research institutions that generate new ideas and receive patents for inventions. In fact, Australia ranked ninth out of 31 Organisation of Economic Co-operation and Development (OECD) countries in a top 200 list of world universities.⁴ Inventions such as wi-fi and low-cost solar designs are testaments to Australia's inventive capability.

National Indicators of Technology Transfer and Commercialization

When it comes to technology transfer and commercialization, there are several key national indicators that can be used to compare Australia's performance to other nations.

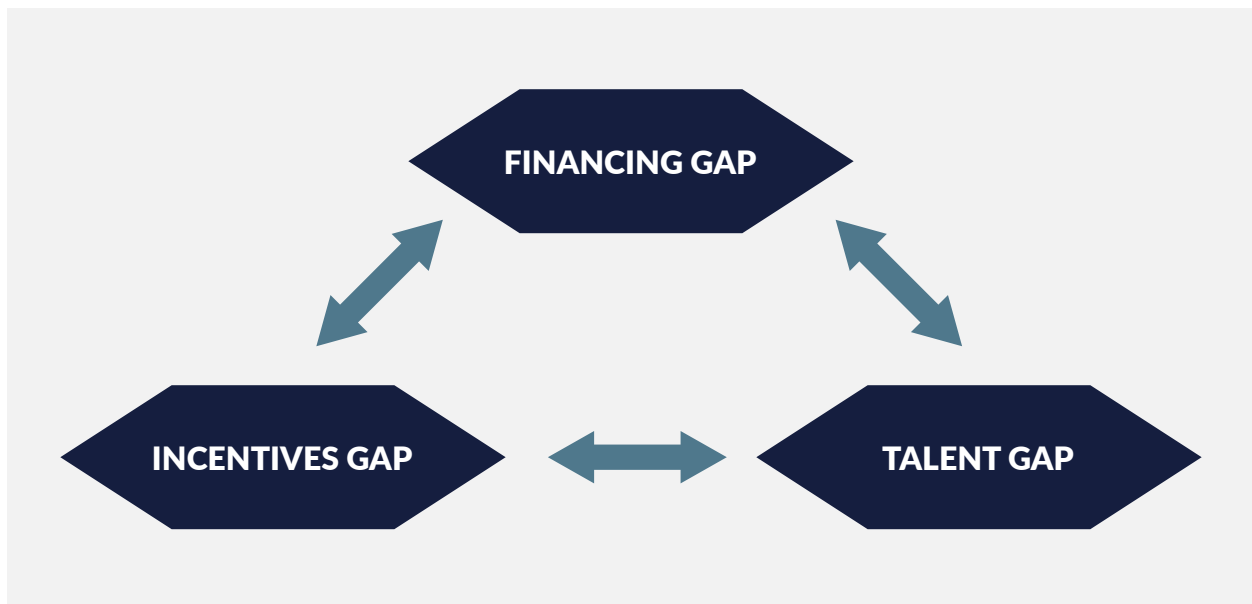
- 1. R&D Spending.** According to the latest data from the UNESCO Institute for Statistics (UIS), Australia's R&D spending as a percentage of Gross Domestic Product (GDP) was 1.8 percent for 2019.⁵ Between 1996 and 2019, Australia notched a high of 2.4 percent in 2008 and a low of 1.51 percent in 1998. Generally speaking, Australia's R&D spending is lower than many other developed nations. By comparison, between 1996 and 2020, the United States had a low of 2.45 percent in 1996 and has steadily increased its spending to reach a high of 3.45 percent in 2020. Canada, on the other hand, has very comparable numbers to that of Australia in the range of 1.6 and 1.7 over the same time period. The global leaders in this metric are Israel and South Korea, who boast a 5.44 percent and 4.81 percent, respectively.
- 2. Patent Applications.** According to the WIP, Australia filed around 13,000 patent applications in 2021, which is significantly lower than other developed countries such as the United States (510,000), South Korea (268,000), United Kingdom (54,000), Japan (413,000). Singapore filed a comparable 10,000 and Canada filed roughly twice Australia's at 26,500.
- 3. Startups and Venture Capital.** Australia has a growing startup ecosystem, with several successful tech companies like Atlassian and Canva as well as Linktree and Airwallex that hail from Victoria. However, Australia still lags behind other countries in terms of venture capital investments. According to the OECD data from 2019, Australia had a total venture capital investment that is estimated at \$1.5 billion USD.⁶ By comparison, Canada had \$3.4 billion USD; United Kingdom had \$3.3 billion USD; and the United States had nearly \$136 billion USD.⁷

4. **Technology Transfer Offices (TTOs) and Startup Support Services.** Australian universities and research institutes have been expanding technology transfer and commercialization activities in recent years, with many establishing dedicated TTOs and startup support services. However, these offices are still relatively new and may not have the same level of resources and experts as TTOs and startups support services in other countries. More will be discussed in the next section.
5. **Government Support.** The Australian government provides significant support for research and innovation across the country. In recent years, the government has launched several initiatives aimed at promoting technology transfer and commercialization. For example, the Research and Development Tax Incentive provides tax breaks to businesses that invest in research and development. Similarly, the Cooperative Research Centres (CRC) program provides funding for collaborative research between industry and research institutions.

Gaps in Technology Transfer and Commercialization

Broadly speaking, the root causes of the tech transfer and commercialization problem are gaps in financing, talent, and incentives (see Figure 1). These gaps reinforce one another since a gap in one area exacerbates gaps in other, making technology transfer and commercialization even more difficult to achieve. A nation's innovation ecosystem is only as strong as its weakest link; a system that is strong in two but not in one will be held back by that one gap. Therefore, policymakers and practitioners must work together to fill these gaps to improve the ecosystem as a whole. The financing gap refers to funding deficiencies at the government, university, and private-sector levels; the talent gap refers to the lack of experienced professionals who can effectively translate research into commercialization; and the incentives gap refers to the lack of incentives at universities aimed at faculty members' pursuing research commercialization.

Figure 1: Australia's Gaps in Technology Transfer and Commercialization



Source: Milken Institute (2023)

Deficiencies in government competitive research grants, university budget allocations for tech transfer offices and startup support services, and the private sector's "Valley of Death" dilemma contribute to a financing gap. First, government competitive research grants are geared principally toward academic research rather than commercialization. Further, these grants tend to cover only two-thirds of the full cost of research, leaving very little room for researchers to explore commercial applications of their ideas.

"Smaller universities tend to have less funds and resources to invest in commercialization compared to larger universities. The Victorian government can help level the playing field by supporting all universities regardless of their size to access funds for commercializing research."

— Quin Chang, Chair, Knowledge Commercialization Australasia (KCA)

"The biggest opportunity for Australian universities in the research and innovation space is to receive support to translate more research to benefit others outside the academic community."

— Calum Drummond, Deputy Vice-Chancellor, Research and Innovation, Royal Melbourne Institute of Technology (RMIT)

"When people talk about raising capital, when they look for grants, they look for lobbying the government and how the government is going to help me with this. I need to speak to the Minister rather than let's go speak to the VCs. Let's go speak to the Angel investors."

— Stephanie Morris, Director of Translation and Innovation, Adelaide Intermediary Program

Second, research commercialization is a low priority for universities because it rarely generates a return on their investment. Therefore, universities are reluctant to devote sufficient funds for tech transfer offices and startup support services to attract and retain qualified staff—limiting their capacity to fulfill their missions.

This is a structural issue resulting from Australia's stream of funding model where revenue stems largely from international student fees. As a result, their budget allocations are geared towards climbing the global rankings for the purpose of attracting more international students. This imperative translates into doubling down on efforts to increase research output, which improves global rankings and thereby attracts more international students.

Victorian universities such as Melbourne, Monash, RMIT, and Deakin derive more revenues from international students than their peers elsewhere in Australia and North America. For example, 35 percent of RMIT's revenue comes from international student fees, compared to an average of 27 percent across Australia. In comparison, only 20 percent of revenue in US universities comes from student fees—both domestic and international.

Australian universities would be able to afford and be motivated to put a higher priority to research commercialization if their funding model was more diversified. Universities funded by more government and industry research grants will naturally have more of an incentive to prioritize research commercialization.

“Research commercialization is very rarely a financially profitable venture for universities. In most cases, commercialization at universities will not generate a net financial return on investment back to the university. However, there are much broader economic and societal benefits from research translation, such the creation of new jobs, industries, entrepreneurial skills, and sovereign capability.”

– *Quin Chang, Chair, KCA*

“There’s no lack of ideas or inventions. There’s a lack of capacity to capture it and to have staff dedicate time to recording and progressing it. This is due to a big gap in the current funding model for university research and innovation in Australia.”

– *Calum Drummond, Deputy Vice-Chancellor, Research and Innovation, RMIT*

Third, Australia’s innovation ecosystem suffers from the “Valley of Death,” that is, the phase during the startup life cycle in which venture capitalists (VCs), angel investors, and traditional financiers are unwilling to invest seed capital because of uncertainties about return on investment in certain basic sciences. The private sector is driven by profit; therefore, it invests in knowledge derived from applied sciences that will maximize returns. Bridging this chasm is crucial to the ability of the nation’s innovation ecosystem to thrive.

Public programs can help to bridge this chasm by providing early-stage financing to pre-seed startups, particularly high-tech firms. Public-sector investments tend to be less risk averse, employ a long-term perspective, and are particularly well-suited to investments with high social returns rather than private returns. However, public-sector investments can go only so far; private-sector investment is necessary to ensure the sustainability of the innovation ecosystem. Public investments are most effective when they assume the risk as first-movers and sufficiently lower the risks for the private capital markets to follow suit. Involving the private sector in the early stages of the life cycle is key.

“Most venture investors are in a business model of seeking fewer later-stage de-risked opportunities. This, in turn, results in less prominent early-stage ecosystem participation.”

– *Andrew Lai, Managing Director, Boab AI*

“Commercialization does not follow a linear equation, where the more money you put in, the more commercialization comes out. It can be hit and miss at times because of inherent uncertainty and risk.”

– *Quin Chang, Chair, KCA*

“High reliance on Australia is still expecting the government to fund a lot of that early-stage commercialization. I think government funding has a role absolutely in the exploratory, fundamental sciences and research. But once it starts to move along, the government should not be the one to take a product to the market. There is a transition. Australia has an expectation that happens a lot later, whereas I think Europe it’s much earlier.”

– *Stephanie Morris, Director of Translation and Innovation, Adelaide Intermediary Program*

*A talent gap hinders Australian universities' ability to adequately incentivize or streamline the commercial application of inventions.*⁸ There is no lack of ideas or inventions, but a shortage of experienced and competent staff creates capacity issues. The most scalable way for Australian universities to unlock the full potential of innovative capacities is to provide researchers with all the tools and resources they need to pursue research commercialization. University researchers should have access to support programs that help them engage with the private sector, develop entrepreneurial know-how, and run a business.

Having experienced and capable technology transfer professionals is instrumental to the success of a university's tech transfer office and entrepreneurial centers, whether that be managing IP or licensing or providing entrepreneurship training. While expanding funding is important, the most critical asset and yet the greatest challenge in Australia's innovation ecosystem is *talent*. They must find ways to attract and retain talent, whether from within Australia or outside. For resource-strapped universities, pooling resources and forging partnerships may be a path to reaping quicker and more successful commercial returns.

As a starting point, all academics and PhD students (and the general student population) should have access to quality accelerator programs within universities led by people with commercial and startup expertise. Further, technology and transfer offices should be less process oriented and more outcome driven. More generally, national and state policymakers must devote more resources to programs that support and upskill founders, support and educate investors, and support and develop talent.

“Cruxes believes that the most scalable way to unlock the potential of Australian research to make a difference in the world is to give researchers themselves the tools, the skills, the support to lead the creation of that impact.”

— Jonathan Lacey, Co-founder, Cruxes Innovation

“I could probably count on my two hands the amount of good pitches I've seen out of hundreds of deals over the years. So I think generally in Australia, pitching quality has a long way to go.”

— Andrew Lai, Managing Director, Boab AI

Australian universities strongly incentivize academic research but provide little or no incentive for faculty members to commercialize their research. In fact, the lack of reward or recognition actually has the effect of discouraging research translation. Further, this activity distracts from fulfilling requirements for academic promotions that are based on research, publication, and teaching—becoming a risky enterprise for one's career.

This is clearly a system-level issue that must be addressed. At the very least, universities should not penalize academics for participating in commercial activities. Better yet, they could recognize commercialization as one element of career advancement.

Overlooking all these challenges is perhaps the slowest changing one related to *culture*. The recommendation to incentivize the pursuit of commercialization and tech transfer is aspirational but assumes an entrepreneurial and commercial mindset among Australian academics. Australian academics must disassociate commercialization from any form of stigma and view it as a noble and worthwhile endeavor.

“In most parts of the current Australian research system, researchers are not incentivized to pursue research translation and technology transfer.”

— *Emily Chang, Co-founder, Cruxes Innovation*

“Research commercialization is not a requirement for academic promotion at universities. In some cases, it’s seen as a distraction or barrier to traditional academic promotion, which is driven by research and teaching metrics.”

— *Quin Chang, Chair, KCA*

“Most of the Australian research system is focused and optimized to produce and support researchers who achieve research success by a narrow set of success metrics: publications and citations in top journals.”

— *Jonathan Lacey, Co-founder, Cruxes Innovation*

With that being said, finding and distributing capital and assistance to grow companies, assist founders, and transfer licenses requires not only developing and retaining the people needed to execute such efforts, but also recognizing when faculty and other officials are not best positioned to do so.

Incentivizing commercialization must be done with the proper understanding that even with good incentive mechanisms, very few researchers may be induced to pursue that path and for good reasons. Most obviously, academics chose their career path for a reason and staying put on that course is not only individually preferential but probably best for the society—they are best at research and therefore, their talent is put to best use when they do research.

To move the needle in commercialization and entrepreneurship, improving incentive programs at universities may not be enough—there is a need to creatively find alternative routes to increase the pipeline. One such path might be to the adoption of a model whereby academics and universities are able to transfer IP rights to expert partners or businesses that commercialize ideas on their behalf—and inventors reap some future benefits whether in equity, flat payments, or commissions. This alternative can unlock and increase commercialization and entrepreneurial endeavors at universities without diverting researchers. The advantage of this path is that it significantly minimizes researchers’ opportunity costs or risk exposure, all the while increasing the pipeline of commercialization ventures.

Triad of Government, University, and Industry Partnership

Australia’s most successful case of government-funded and university-driven commercialization is Cochlear, a medical device company best known for its nucleus cochlear implants. The Sydney-based company was founded in 1983 by Graeme Clark while he conducted research at the University of Melbourne with financing from the Australian government to commercialize the implants. If more of these technologies could be transferred and commercialized, Australia’s future is bright. The crucial question is how. Australia’s

innovation ecosystem's success hinges on the triad's commitment to addressing the aforementioned gaps in its system.

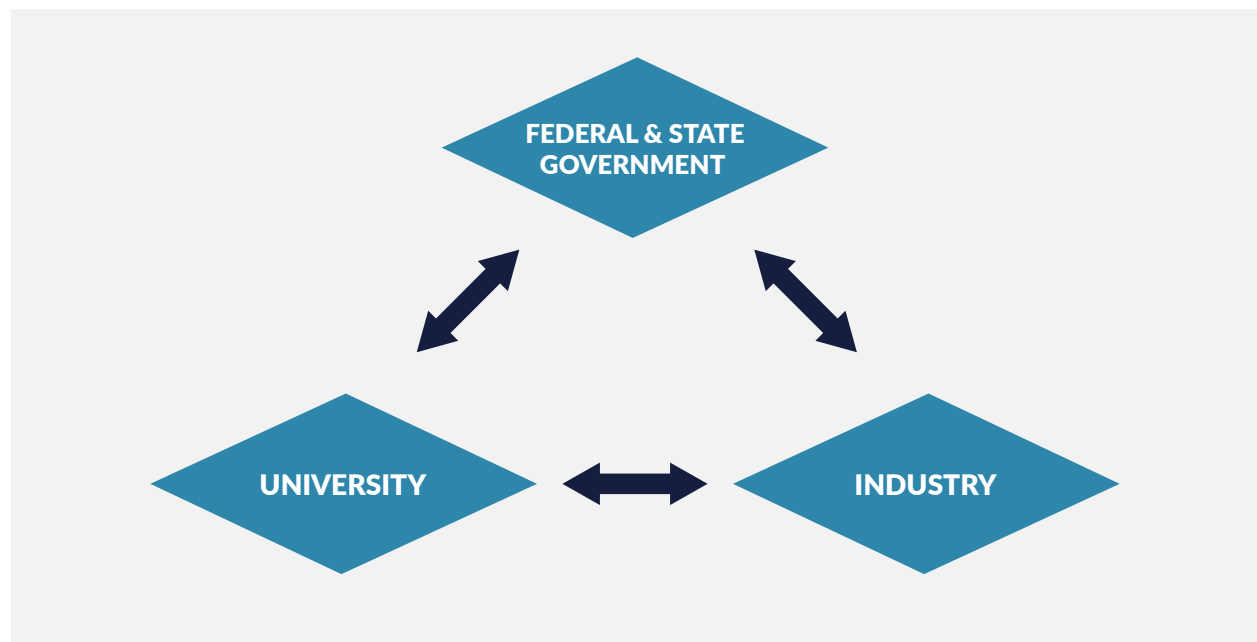
How could these financing, talent, and incentives gaps be improved? Solving this problem requires a concerted effort by the triad entities, namely the government (federal and state), universities, and industries (including corporations and startups).

First and foremost, the government has a role to play. In the United States, the federal government runs the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs that fund startups and small businesses across technology areas and markets to stimulate technological innovation, meet federal R&D needs, and increase commercialization to transition R&D into impact.⁹ These programs were established in 1982 with the enactment of the Small Business Development Act.

Many state SBIR-related programs are designed to complement the federal SBIR programs. In this way, states leverage federal funding and bolster innovative activities through multilevel public funding.¹⁰ As a testament to the success of the SBIR/STTR program, it has been reauthorized twice by the US Congress since 1982. The commitment to public funding for innovation in the US is something many other countries can only aspire to.

Second, universities and industries must forge partnerships to promote technology transfer and commercialization (see Figure 2). Universities are superb at knowledge creation but tend to be poor at the commercial application of inventions. Corporations and startups, on the other hand, may be weaker at knowledge creation but are adept at the commercial application of inventions. Therefore, universities and companies both stand to gain from more collaboration.

Figure 2: Triad of Government, University, and Industry Partnership



Source: Milken Institute (2023)

For instance, universities and corporations could also incorporate industry practicums, such as the co-op programs common at US and Canadian universities, where students alternate their time between classes and applied work in industry. They could also jointly develop programs that teach cutting-edge research and theory simultaneously. Such programs would create a new class of startup leaders and CEOs who can “translate” between researchers and the commercial environment.

There is also great potential to extend the PhD talent pipeline to industry. As it stands, Australian universities produce many more PhDs than there are academic career opportunities available, and more than expanding career opportunities for PhDs will serve the long-term interest of research universities. If universities are serious about tech transfer and commercialization, they must find ways to engage the private sector’s expertise and experience in deciding what should be commercialized. If the private sector is serious about developing innovative new products and ideas, it ought to tap into universities’ deep knowledge pool.

Unfortunately, the potential benefits from collaboration may not be immediately apparent to the parties and agreeing on terms may be challenging. Both parties should be interested and committed to working through disagreements together. Australia’s university administrators are skeptical about allocating resources to research translation; likewise, Australia’s industry and startup leaders have yet to fully appreciate the real potential that university-generated knowledge holds. Changing this culture or perception will require significant effort. Highlighting how the industry-university partnerships create great social returns for the region and its people may help to affect this change.

“There seems to be more reliance on the government to fund research and I think they should fund the research, but when it’s starting to get a bit more commercial ready, moving along that technology readiness level pathway, there is absolutely a role to play with industry.”

— *Stephanie Morris, Director of Translation and Innovation, Adelaide Intermediary Program*

“People often ask, ‘Why don’t we do more research translation in Australia? Why don’t we create more impact with our research? Why don’t we generate more spinouts and startups?’ People say, ‘Oh, well, there’s a capability problem,’ or ‘Researchers aren’t incentivized properly,’ or ‘The IP rules are too tricky.’ All of those things are true. But they’re not causes; they’re symptoms. The fundamental problem is that Australian universities and Australian companies just don’t see one another as vital partners.”

— *Emily Chang, Co-founder, Cruxes Innovation*

The good news is that Australia’s innovation problems have caught the attention of policymakers. State and national governments are pouring significant resources into tackling this problem. A noteworthy sea change is the Australian government’s commitment to an Australian Universities Accord—AU\$2.7 billion over two years (2022–2023) to reform the university and higher education sector.¹¹ A 12-month review aims to develop recommendations and performance targets to improve the quality, accessibility, affordability, and sustainability of Australia’s higher education.

Another major initiative is the establishment of the AU\$15 billion National Reconstruction Fund (NRF)

to support, diversify, and transform Australia's industry and economy. The NRF invests across seven priority areas: (1) renewables and low-emission technologies; (2) medical sciences; (3) transportation; (4) agriculture, forestry, and fisheries; (5) value-add in resources; (6) defense capability; and (7) enabling capabilities. This nation-building fund presents a significant opportunity for these seven industries of key strategic importance after years of uncertainty and lack of a strategic plan. Further, it marks the largest government investment in recent times to modernize manufacturing capability to unleash the potential embedded in its human capital and technologies. In particular, the incumbent government has exhibited a sound understanding of the need for and importance of connecting industry to science: university tech transfer and commercialization.



VICTORIA'S STATE OF TECHNOLOGY TRANSFER AND COMMERCIALIZATION

Regional Indicators of Technology Transfer and Commercialization

Australia's technology transfer and commercialization performance can vary significantly across states due to differences in resources, industries, and economic conditions. However, there are a few key indicators that can be used to compare the performance of different states.

- 1. R&D Spending:** One of the most important indicators of a state's technology transfer and commercialization performance is its investment in R&D. According to the latest available data from the Australian Bureau of Statistics (ABS), the largest R&D spenders in Australia are New South Wales (NSW), Victoria (VIC), and Queensland (QLD). VIC performed AU\$881 million; NSW performed AU\$794 million; QLD performed AU\$642 million. These three states accounted for 64 percent of the total AU\$3.6 billion in R&D performed by the Australian government during the 2020–2021 financial year.¹² VIC alone accounted for 24 percent of the R&D performed.
- 2. Patent Applications:** Another useful indicator of technology transfer and commercialization is the number of patent applications filed by each state. Australian Capital Territory (ACT) filed 85; NSW filed 1,119, QLD filed 528, South Australia (SA) filed 152, Tasmania (TAS) filed 35, VIC filed 769, and Western Australia (WA) filed 334 patent applications in the fiscal year 2020-2021. To put this in perspective, NSW, QLD, and VIC accounted for over 80 percent of all patent applications filed in Australia. VIC accounted for about 25 percent of the total.¹³
- 3. Startup Ecosystem:** The strength of a state's startup ecosystem can also be a good indicator of its technology transfer and commercialization performance. States with thriving startup ecosystems tend to have more successful technology transfer and commercialization activities. In recent years, states like NSW, VIC, and QLD have emerged as major hubs for startups, with a large number of successful companies being founded in these states. Sydney, the capital of NSW, has a well-established startup ecosystem, with several successful startups such as Canva or Atlassian. Queensland has a growing startup ecosystem, with promising startups such as Go1 and RedEye. Melbourne, the capital of VIC, also has a thriving startup ecosystem, with several successful startups such as AirWallex and Culture Amp.

4. **Industry Collaboration:** The level of collaboration between research institutions and industry is another important factor that can impact a state's technology transfer and commercialization performance. States with strong links between industry and research tend to have higher rates of technology transfer and commercialization. According to the ABS, states like VIC, QLD, and SA have a high proportion of businesses collaborating with research institutions.
5. **Research Institutions:** Universities and research centers are critical to the success of technology transfer and commercialization in Australia. In states VIC, several world-class research institutions specialize in fields like biotechnology, life sciences, advanced manufacturing, and engineering. For example, the University of Melbourne and Monash University are home to several research centers specializing in biotechnology and materials science.
6. **Government Support:** In addition to federal government support, state governments also provide support for technology transfer and commercialization. For example, the Victorian government has established several initiatives, such as LaunchVic aimed at promoting the growth of the local startup ecosystem. Similarly, the New South Wales government has launched several initiatives aimed at supporting the development of a thriving startup ecosystem.

Overall, NSW and VIC tend to be the leading states in terms of technology transfer and commercialization performance, with strong investment in R&D, high numbers of patent applications, and thriving startup ecosystems. However, other states like QLD, WA, and SA are also making significant strides in this area, driven by strong industry collaborations and government support.

Victoria's Tech Transfer and Commercialization Initiatives

Victoria is home to some of the best scientists and universities in the world. Hence, there is no lack of good ideas or inventions.

Policymakers and leaders work to ensure that Victoria's researchers and innovators can turn great ideas into great businesses. To achieve this goal, public investment is needed to accelerate translational research, innovation, entrepreneurship, and commercialization, which will unlock the full potential of Victorian universities. LaunchVic's own research has demonstrated that only 6 percent of all commercializing technology is developed at universities. This number suggests that many untapped commercial ideas are sitting at universities.

The landmark AU\$2 billion Breakthrough Victoria Fund—a public fund that invests in research and innovation in the key industry sectors of health and life sciences, agricultural technology, advanced manufacturing, clean energy, and technologies—is a step in the right direction. Like many public investments in research, the fund will play a critical role in bridging the Valley of Death, where private investors are unwilling to step in because risks are too high, or profit opportunities are too low. However, public investments, like Breakthrough Victoria Fund, in and of themselves are not enough; the requisite talent must be in place—not only administrators to manage and direct the funds in a meaningful way but also founders and other entrepreneurs to magnify the impact of both the research and the funding.

One state agency that manages and directs the funds as well as provides various support programs in Victoria is LaunchVic. LaunchVic was started with AU\$60 million and subsequently refunded to establish and grow the startup ecosystem and drive innovation in Victoria. LaunchVic manages investment funds and offers support programs that build startup capability, including via accelerators, and connects the ecosystem through research and events. Support programs, like LaunchVic can act as a bridge and actively foster industry-university collaborations and partnerships.

Victoria's startup ecosystem continues to grow at 23 percent per annum. LaunchVic estimates that in 2022, more than 2,600 startups employed nearly 50,000 people.¹⁴ However, the Victorian startup ecosystem possesses even greater potential; by some estimates, it could support an additional 15,700 jobs each year over the next 20 years.¹⁵

One in five startups is in health and life sciences. Melbourne's life science startup community is world-class, and its strengths lie in infrastructure and quality of and access to talent.

Some examples of innovation ecosystems for the Melbourne metro area are Parkville, Arden Macauley, Fishermans Bend, La Trobe Bundoora, and Monash Clayton.¹⁶ Many Victorian universities have either their main or satellite campuses in Melbourne. Being connected to the Melbourne innovation ecosystem is vital if these universities want to expand industry-university collaborations.



A BENCHMARK STUDY OF TECHNOLOGY TRANSFER AND COMMERCIALIZATION

Introduction

The US houses some of the world's preeminent universities, spawning some of the world's most innovative companies. To its north, the size of Canada's population and the structure of its higher education system better resemble the Australian environment. Yet Canadian universities perform better on a variety of tech transfer metrics than their Australian counterparts. In both the US and Canada, the Association of University Technology Managers (AUTM) keeps detailed and consistent survey data on the tech transfer performance of each university over time, which outshines the Survey of Commercialisation Outcomes from Public Research (SCOPR) survey conducted in recent years by Knowledge Commercialisation Australasia (KCA). It is instructive to analyze how Victorian universities match up with their North American counterparts to identify initiatives and practices worth emulating.

On the American side, an earlier Milken Institute report identified the University of Utah as the nation's top tech transfer university.¹⁷ The report lauded the incentives Utah offers for entrepreneurship and the resources it provides through the Lassonde Entrepreneur Institute (for students) and the Entrepreneurial Faculty Scholars program. It also highlighted Utah's distinctive Commercialization Engine Committee, which brings in outside experts to advise faculty and the university on the most effective commercializing methods.

On the Canadian side, a well-cited academic article from 2008 (from scholars at the University of Toronto) singled out the University of Waterloo as a particularly "entrepreneurial" university. One key feature of Waterloo's approach to tech transfer is a longstanding policy that the inventor owns the IP of their invention.¹⁸ This policy helps to attract faculty doing applied research and incentivizes commercialization. Waterloo also offers a leading cooperative education program, where students work in local organizations as part of their degree program. These co-ops strengthen ties between the university and local firms, which may later partner on R&D, but students also directly transfer "tacit knowledge" (e.g., how to leverage computers in the 1990s) from lecture halls to company offices.¹⁹

In the United States, private-sector expenditure in R&D is heavily concentrated in smaller firms. According to OECD data from the early 2010s, small and medium enterprises (SMEs) (with fewer than 250 workers) employ 45 percent of the private-sector workforce but account for only 15 percent of business R&D expenditures. In contrast, in Australia, SMEs account for 70 percent of the workforce and about 35 percent of R&D expenditures. In this regard, Australia is much more similar to Canada, where about 40 percent

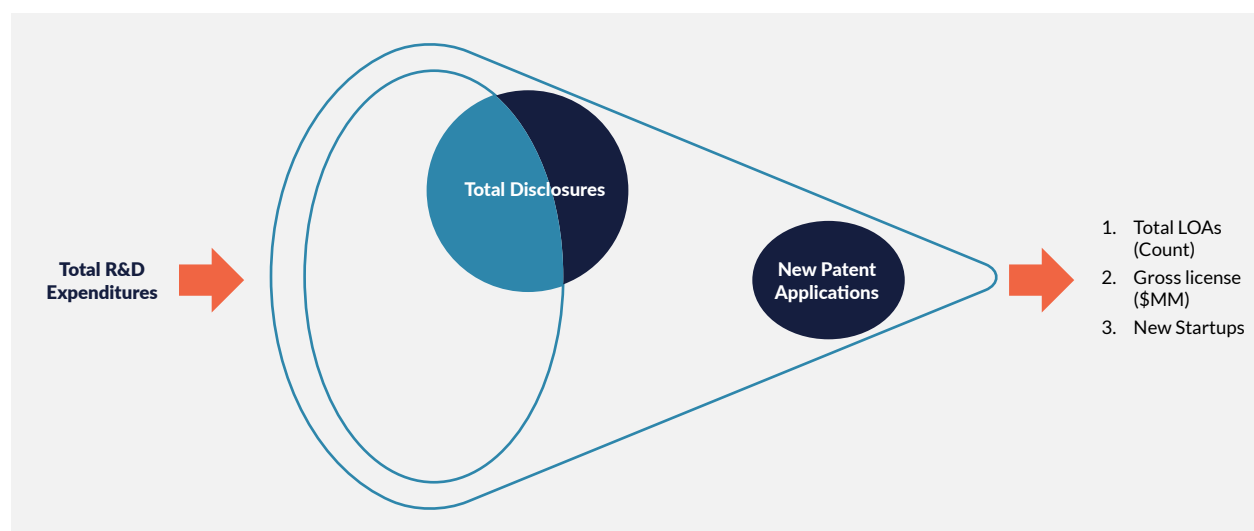
of private R&D comes from SMEs. In New Zealand, the contrast is even starker as almost 40 percent of business R&D spending comes from a smaller subset of firms with 50 employees or fewer (in Australia, these firms contribute around 20 percent of industry R&D).

Increased involvement from SMEs can expand the pool of partners in commercialization and tech transfer. Still it can also create additional challenges for tech transfer offices and business commercialization teams within universities (which are typically separate from TTOs). For example, small-business owners may be less educated about finding commercialization opportunities and taking advantage of the grants and resources available to support commercialization. In addition, they may be more risk-averse when investing in R&D because they cannot absorb the downside risk inherent in early-stage commercialization.

Methodology

If we can conceptualize the innovation funnel as a linear function of inputs and outputs, the input is total R&D expenditures (See Figure 3). The intermediate products are invention disclosures and patents, both of which can protect invention and property rights. But invention disclosures are the first recording of an invention, and patent applications are filed if inventions are comprehensive for effective evaluation. The output variables found at the end of the innovation funnel of Figure 3 are licensing revenues and startups. Revenue indicators from licensing activities are the total count of LOAs and gross licensing revenues in dollar terms. The data on startups are often very limited and imprecise; startup data are often available only in counts, unlike LOAs, which can be quantified in revenue dollars. VC-backed startup data is often limited in public data on tech transfer and commercialization. So, in the later section, we supplement the SCOPR, Australian National Survey of Research Commercialisation (NSRC), and AUTM data with Pitchbook data on VC-backed startups. However, when it comes to tech transfer and commercialization data, it is imperative that data on job creation and local investment from research commercialization is also tracked and reported.

Figure 3: Innovation Funnel



Source: Milken Institute (2023)

We matched Australian universities to their American and Canadian counterparts based on four primary criteria.²⁰

- Total research expenditure for 2020 in US dollars (universities self-reported this information in the SCOPR survey [AU] and AUTM survey [US and Canada])
- 2020 QS World University Rankings
- Establishment type (public vs. private)
- Presence of a medical school

For each Victorian university, we found the most similar American and Canadian universities in terms of QS rank and research expenditure. From these top candidates, we selected the closest match that shared similar characteristics in terms of establishment type (because public and private universities often have different missions) and medical offerings (because a lot of tech transfer occurs in the healthcare and pharmaceutical space).²¹ With American universities, we limited our matching to public universities, which operate more similarly to Australian universities (most Australian universities are public). The notable exception is Australian Catholic University, a private university, and we found a comparable private Catholic university in the US (Marquette University).

The following table shows the matches.

Table 1: Victorian University Matched with Canadian and American Universities

Victorian University	Canadian University	American University
University of Melbourne	University of British Columbia	University of North Carolina at Chapel Hill
Monash University	University of Toronto	University of Pittsburgh
RMIT University	University of Waterloo	North Carolina State University
La Trobe University	University of Victoria	Oregon State University
Deakin University	Dalhousie University	University of Kansas
Swinburne University	York University	University of Delaware
Federation University of Australia	Ryerson University	Northern Arizona University
Australian Catholic University	University of Manitoba	Marquette University

Note: See Appendix for additional detail on the data used to produce these matches. The appendix presents eight tables with three rows and four columns, each expressing the validity of matches. For University of Melbourne, Monash University, La Trobe University, and RMIT University, we use both the NSRC data for 2000–2016 and SCOPR data for 2017–2020. For Federation University of Australia, NSRC data for 2000–2016 is missing, though SCOPR data for 2017–2020 is available. For Australian Catholic University, only SCOPR data from 2020 was available, and for Victoria University, data was entirely unavailable. So, we matched Australian Catholic University on the 2020 data and entirely omitted Victoria University from the analysis due to lack of data.

Source: Milken Institute (2023), based on data from AUTM, NSRC, and SCOPR

We examined the following six tech transfer and commercialization indicator variables based on AUTM, NSRC, and SCOPR:

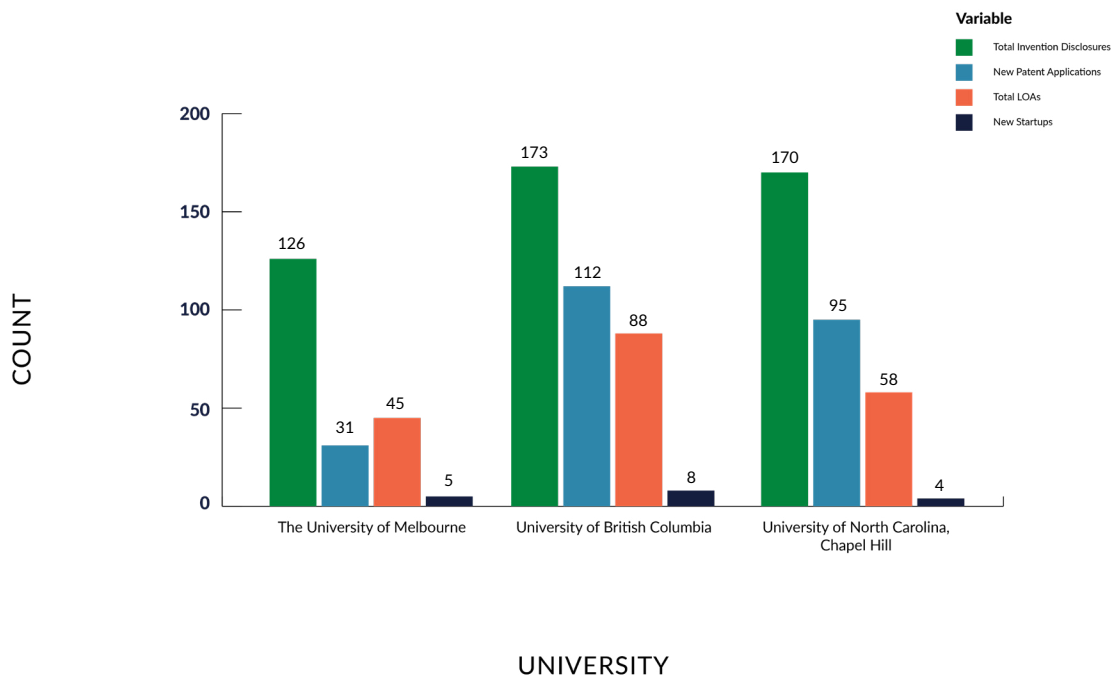
- gross_lic\$MM: Gross licensing in AU\$ millions
- new_patapp: New patent application count
- new_startup: New startup count
- tot_LOA: Total licenses, options, and agreements (LOAs)
- tot_disc: Total invention disclosures
- tot_exp\$MM: Total R&D expenditures in AU\$ millions

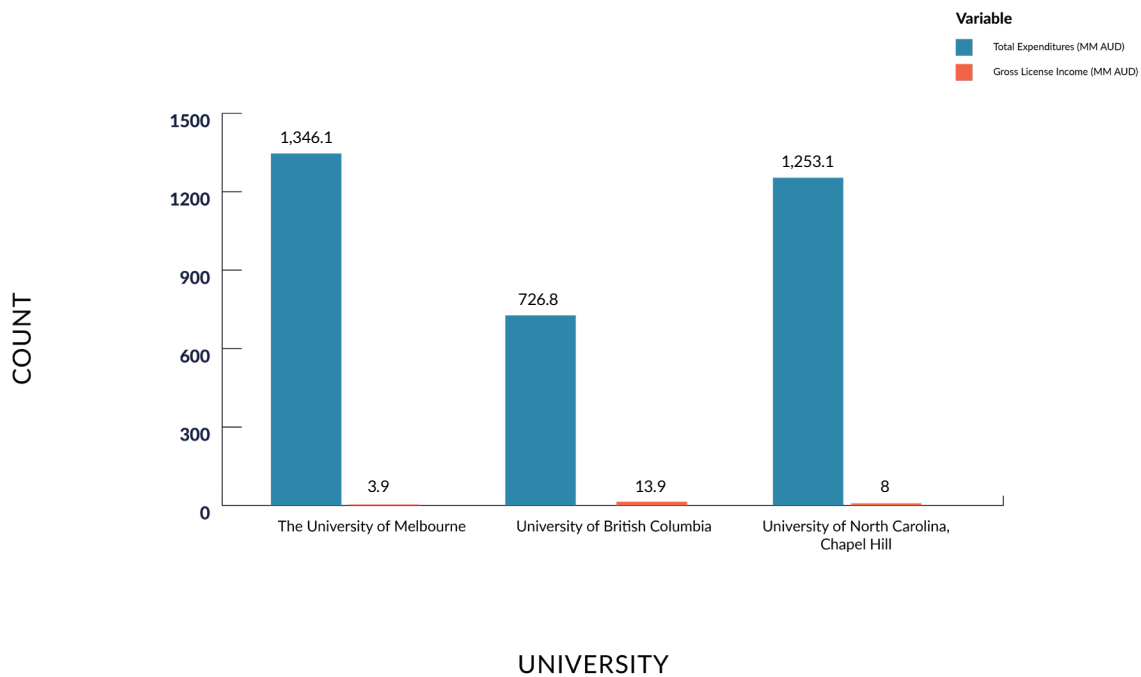
Performance Comparisons: Matched Peers (Individual)

In this section, we restrict the sample to the 23 universities in Table 1, with the notable exclusion of Australia Catholic University due to missing data. We then compare the individual performances of Victoria’s seven universities with those of matched peers in the US and Canada based on the six tech transfer and commercialization variables.

UNIVERSITY OF MELBOURNE

Figure 4: Tech Transfer and Commercialization Variables for the University of Melbourne and Matched Peers





Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

PERFORMANCE COMPARISON

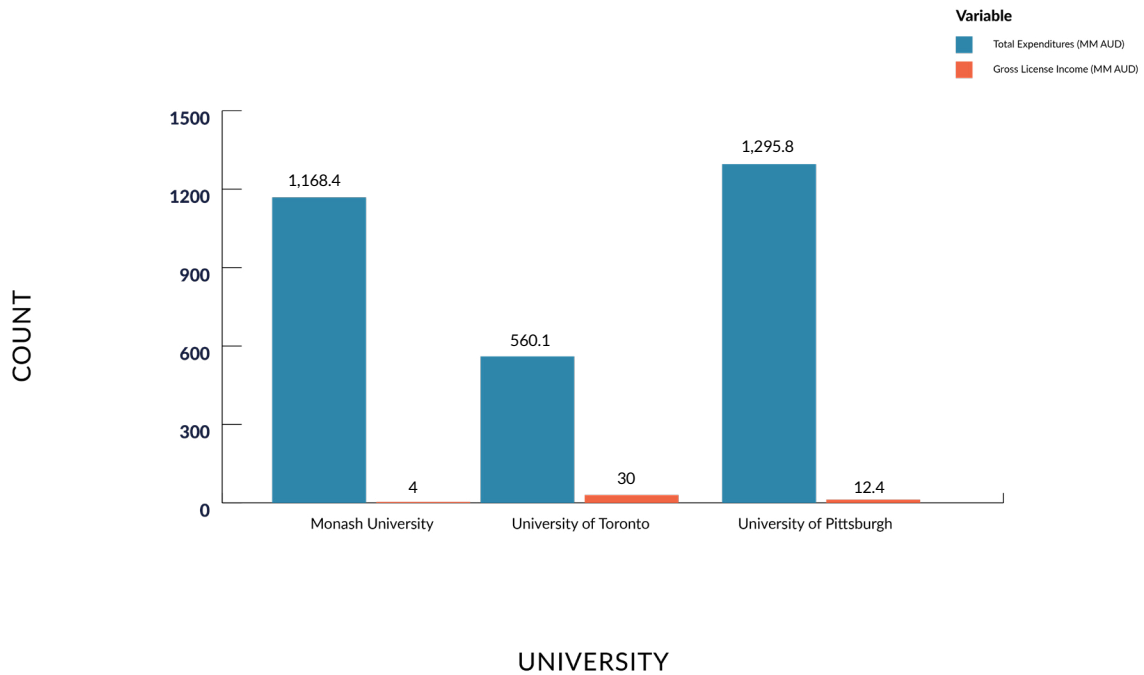
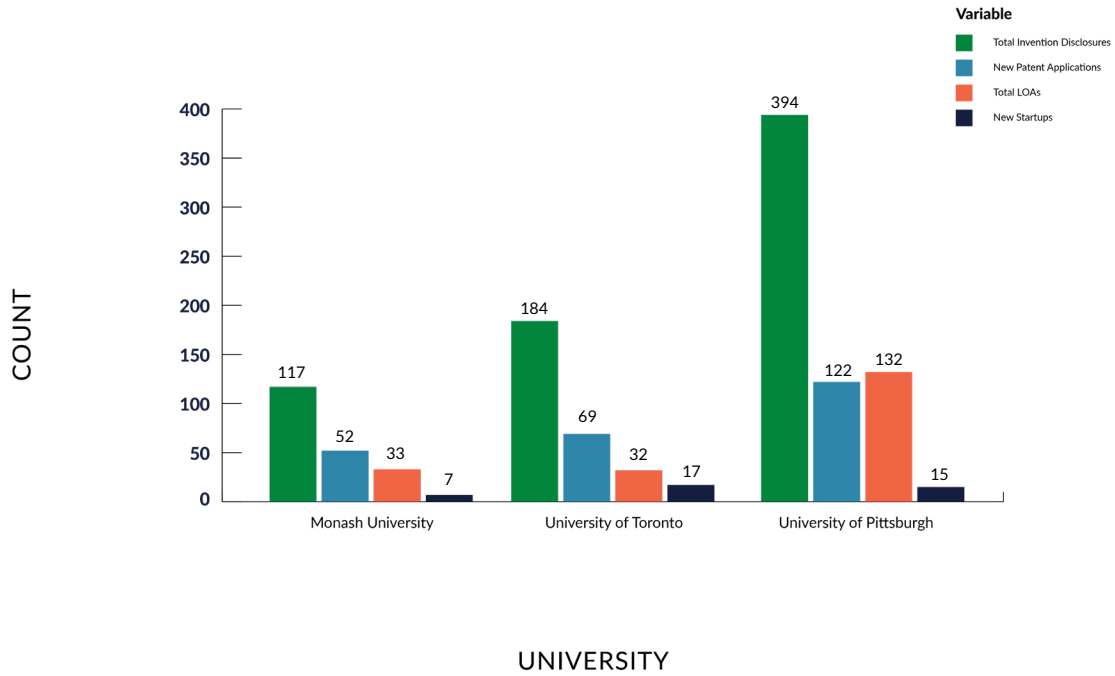
The University of Melbourne is one of the top universities for tech transfer in Australia, and 2020 was a particularly strong year for its tech transfer office. It received more invention disclosures, processed more LOAs, and founded more startups in 2020 than any other year over the past decade for which we have data. However, like most Victorian universities, it produced fewer inventions and firms than North American schools with similar research budgets.

TECH TRANSFER AT COMPARABLES

The University-Industry Liaison Office at the University of British Columbia (UBC) offers a suite of services, including a seed accelerator fund and support for prototype development.²² As of 2013, eligible inventors received 50 percent remuneration from licensing. UBC's Center for Drug Research and Development offers expertise and access to capital in the medical space (which comprises most of UBC's industry-funded research).²³

As the oldest public university in the US, the University of North Carolina at Chapel Hill (UNC-Chapel Hill) prides itself as the original public university. To accelerate the pipeline of ideas that have commercial potential, former Chancellor Carol Folt created the Vice Chancellor's Office for Innovation, Entrepreneurship and Economic Development (IEED) in February 2015. The Office of Technology Commercialization (OTC), housed within IEED, oversees all aspects of the tech transfer at UNC. UNC puts technology commercialization as a high priority by meticulously monitoring its performance and actively supporting its innovation ecosystem. In 2018 alone, 454 active startups were affiliated with UNC-Chapel Hill that collectively created nearly 9,000 jobs in North Carolina and generated annual revenues of US\$11 billion.²⁴

Figure 5: Tech Transfer and Commercialization Variables for Monash University and Matched Peers



Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

PERFORMANCE COMPARISON

Monash kept pace with the University of Toronto on most key metrics, completing a comparable number of license agreements and patent applications. However, its commercialization income remains one-tenth of that of the University of Toronto. The University of Pittsburgh outpaces Monash both in absolute terms and on a per-research-dollar basis.

TECH TRANSFER AT COMPARABLES

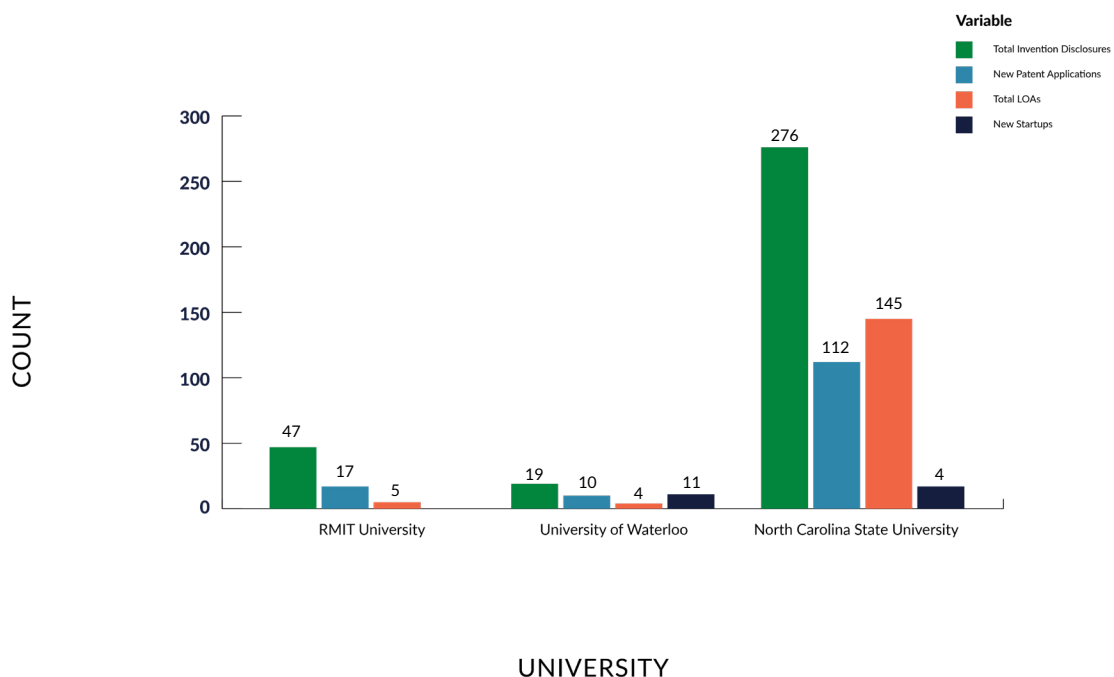
Like their Australian counterparts, tech transfer officials at the University of Toronto have cited a lack of “receptor capacity”—that is, the ability of industry to take on commercialization projects—as a limiting factor of its tech transfer efforts.²⁵ The University of Toronto has responded with a suite of entrepreneurship programs for students and faculty, such as its dozen accelerator programs, some with a focus on particular fields.²⁶

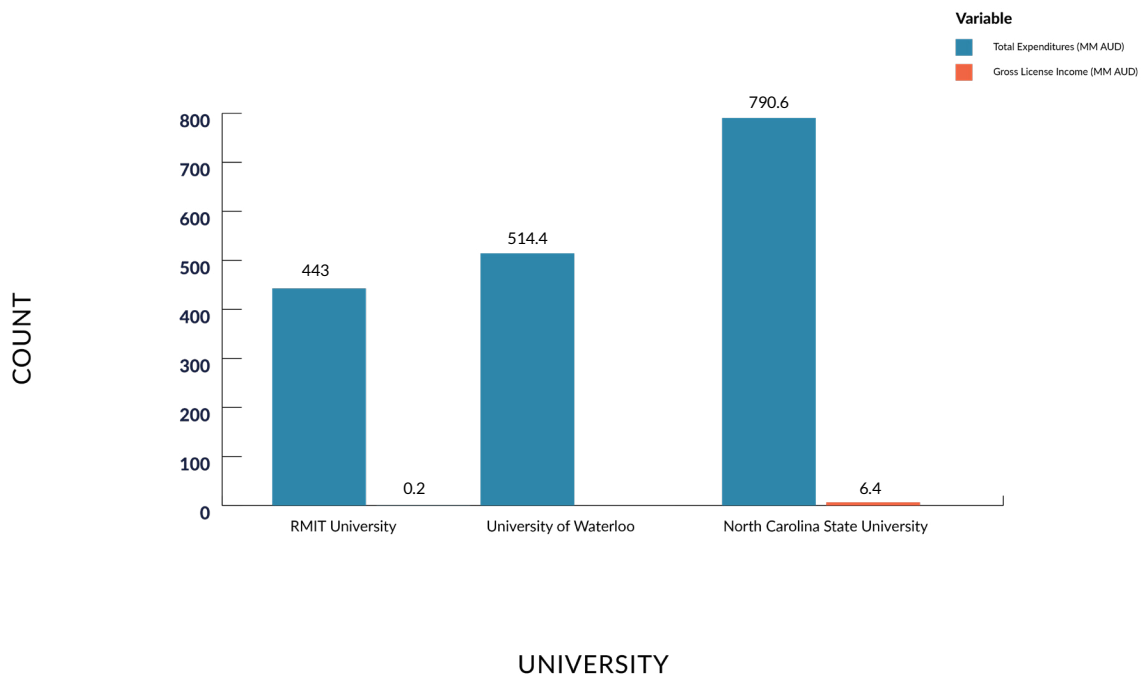
At a provincial level, the government of Ontario is working to implement its first “Intellectual Property Action Plan,” which includes measures to “clarify the roles and mandates” of tech transfer offices and increase IP literacy among researchers and business owners.²⁷ The report on Ontario’s innovation ecosystem also notes that universities consider commercialization in promotion decisions and hire commercialization staff with extensive education and experience as effective ways to support tech transfer.²⁸

Tech transfer is also a strength at the University of Pittsburgh. A 2017 Milken Institute report ranked the university 24th for tech transfer and commercialization in the US, lauding it for its strong medical school and close collaboration with neighboring Carnegie Mellon University.²⁹

RMIT UNIVERSITY

Figure 6: Tech Transfer and Commercialization Variables for RMIT University and Matched Peers





Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

PERFORMANCE COMPARISON

RMIT outperforms the University of Waterloo across the board, though the similarly ranked North Carolina State University outpaces them both. RMIT has experienced a consistent and marked increase in invention disclosures over the past decade; it averaged 13 disclosures a year from 2011 to 2015 but averaged 42 a year from 2016 to 2020.

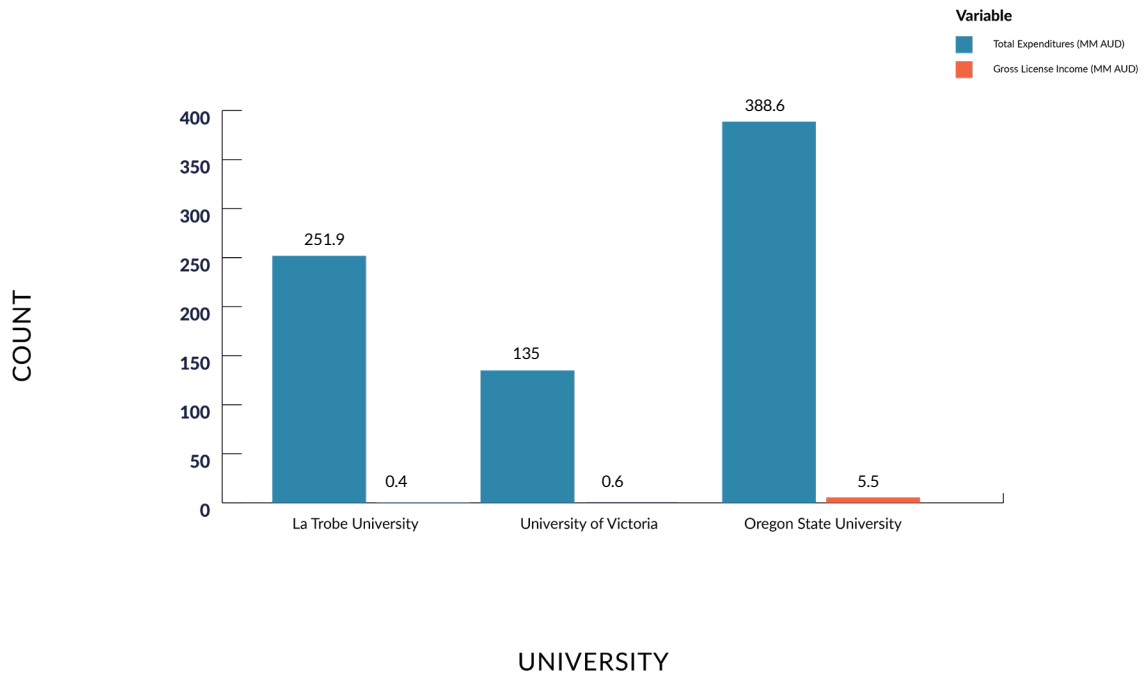
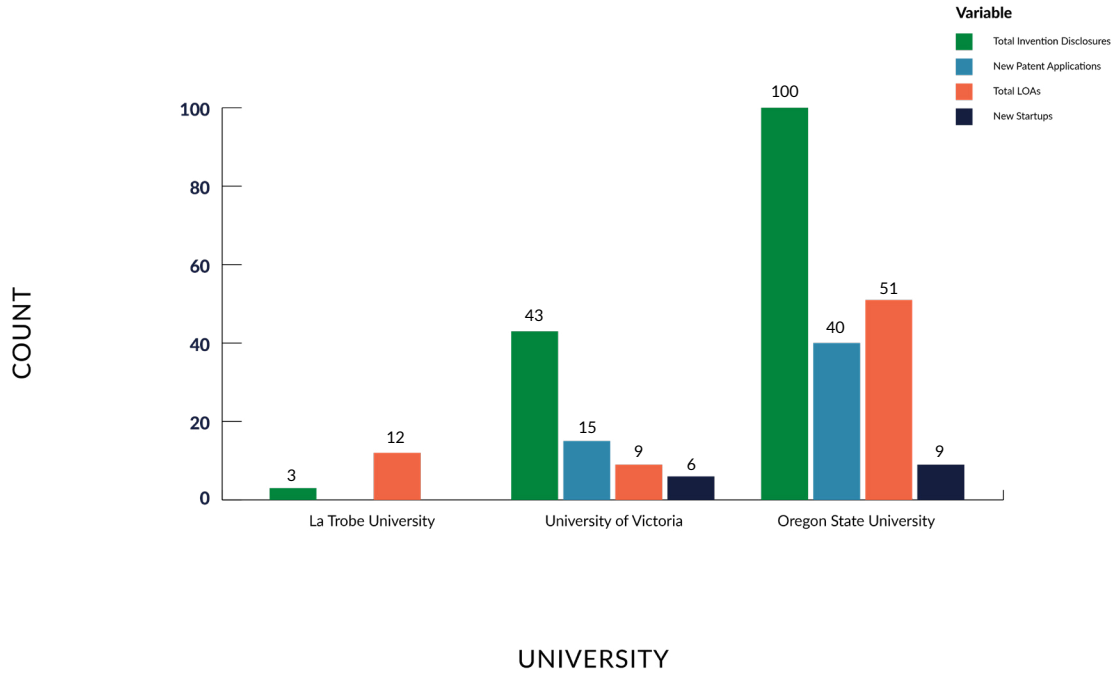
TECH TRANSFER AT COMPARABLES

North Carolina State University has seen a surge in commercialization activity over the past decade. Despite lacking a medical school, it is now outperforming more prestigious Research Triangle neighbors such as Duke University and the University of North Carolina on metrics such as faculty entrepreneurship. A recent Heartland Forward report declared that the school “demonstrates a public university that believes commercialization is central to its mission can be a top performer.” Heartland credited the university’s detailed commercialization guidelines and the chancellor’s broad prioritization of tech transfer and STEM programs.³⁰ Meanwhile, the assistant vice chancellor for commercialization recently noted that the school is “not trying to make selective bets” and is more intentional about supporting as many startups as possible.³¹

The University of Waterloo’s (UW) contribution to local and regional economic dynamism extends beyond knowledge creation and research scientists in the mechanisms of tech transfer; its progressive Coop, entrepreneurial education programs, and innovative IP policies have contributed to the growth and innovation of the local and regional economy. UW has a unique “creator-owned” IP rights policy to foster an entrepreneurial environment.³² Its Waterloo Commercialization Office (WatCo) has been largely successful in acting as a conduit of research commercialization, and UW has become a classic case study for tech transfer and commercialization in the scholarly communities.³³

LA TROBE UNIVERSITY

Figure 7: Tech Transfer and Commercialization Variables for La Trobe University and Matched Peers



Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

PERFORMANCE COMPARISON

La Trobe reported a relatively small amount of commercialization activity in 2020. However, it performed much better in previous years, filing 11 patent applications in 2018 and negotiating 42 LOAs in 2019. Over the past five years, La Trobe has been notably effective in turning the disclosures it receives into licensing agreements. However, its startup performance may lag those of the comparison schools because it only reported equity in two startups as of 2020.

TECH TRANSFER AT COMPARABLES

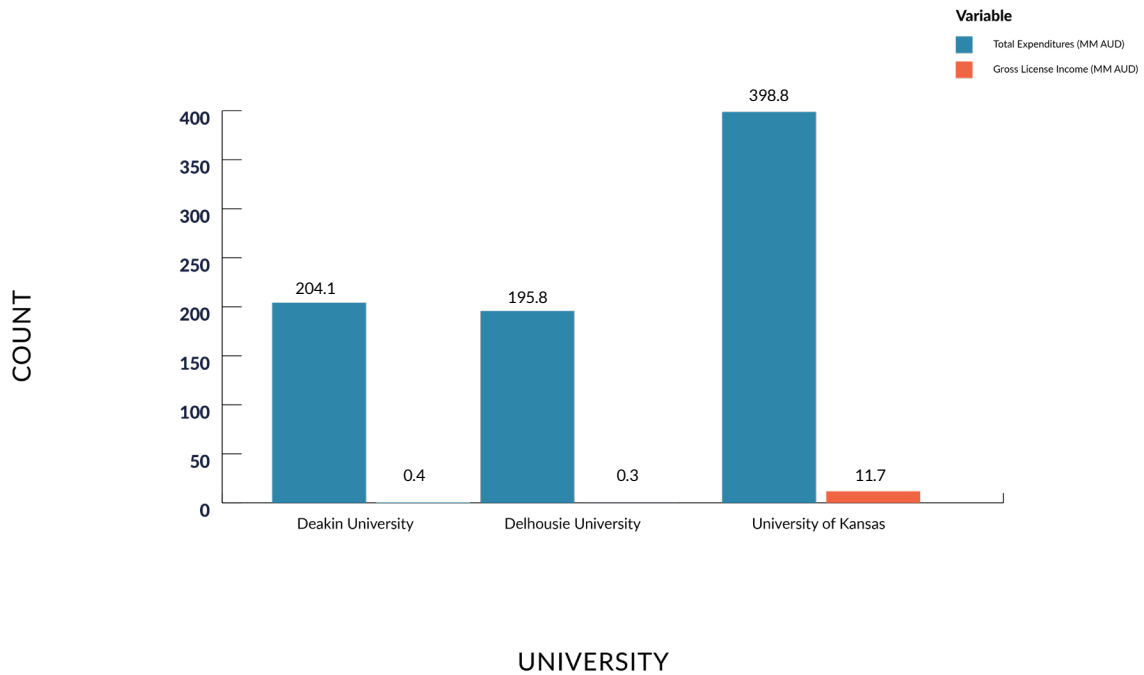
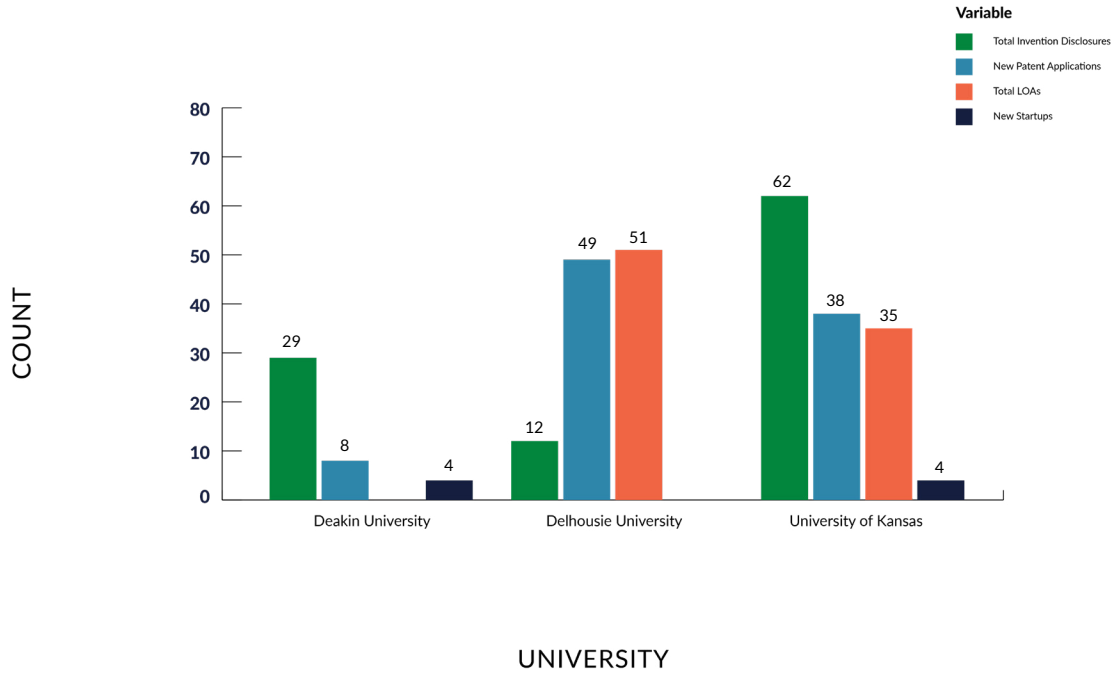
Oregon State University was one of the first universities in the US to publicly consider patenting in promotion and tenure decisions. Its tenure guidelines advise that "... authorship of a patent in the faculty member's field is considered as evidence of creative scholarship."³⁴ The university also offers a comprehensive incubator program to university affiliates and the local community. The incubator often hires undergraduate and MBA interns to assist with market research and launch campaigns.

In addition, Oregon State University researchers and tech transfer officers are spearheading the National Science Foundation-funded Promotion & Tenure-Innovation & Entrepreneurship (PTIE) coalition, working to recognize innovation and entrepreneurship in promotion and tenure decisions across US higher education.³⁵ The university hosted a conference on the topic in July 2022, and its researchers have published a summary of their recommendations in *Science*.³⁶ At a high level, their recommendations are as follows:

- linking a university's stated mission (including social impact or economic progress) to promotion and tenure decisions,
- creating a widely recognized set of metrics that can be used to quantify innovation and entrepreneurship impact (including but not limited to patents, entrepreneurship, corporate funding, and mentorship of student startups),
- collecting recommended language through which innovation and entrepreneurship can be incorporated into the existing review framework, and
- developing a set of process recommendations, such as mandating a personal narrative statement, letters of instruction to reviewers, and explicit processes to validate faculty impact (e.g., through a market analysis of faculty inventions).

DEAKIN UNIVERSITY

Figure 8: Tech Transfer and Commercialization Variables for Deakin University and Matched Peers



Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

PERFORMANCE COMPARISON

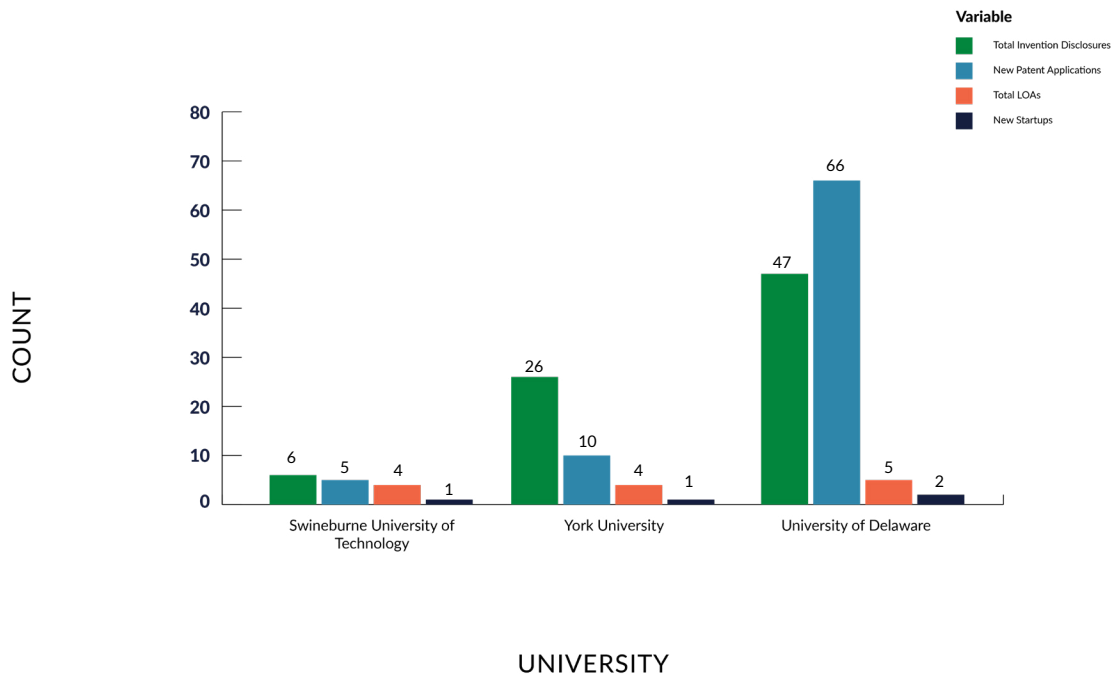
Deakin did not report significant patent activity, and it did not report data on licenses to SCOPR in 2020. However, it reported 357 LOAs in 2016 (the last year with data), which was abnormally high relative to its peer institutions and past performance.

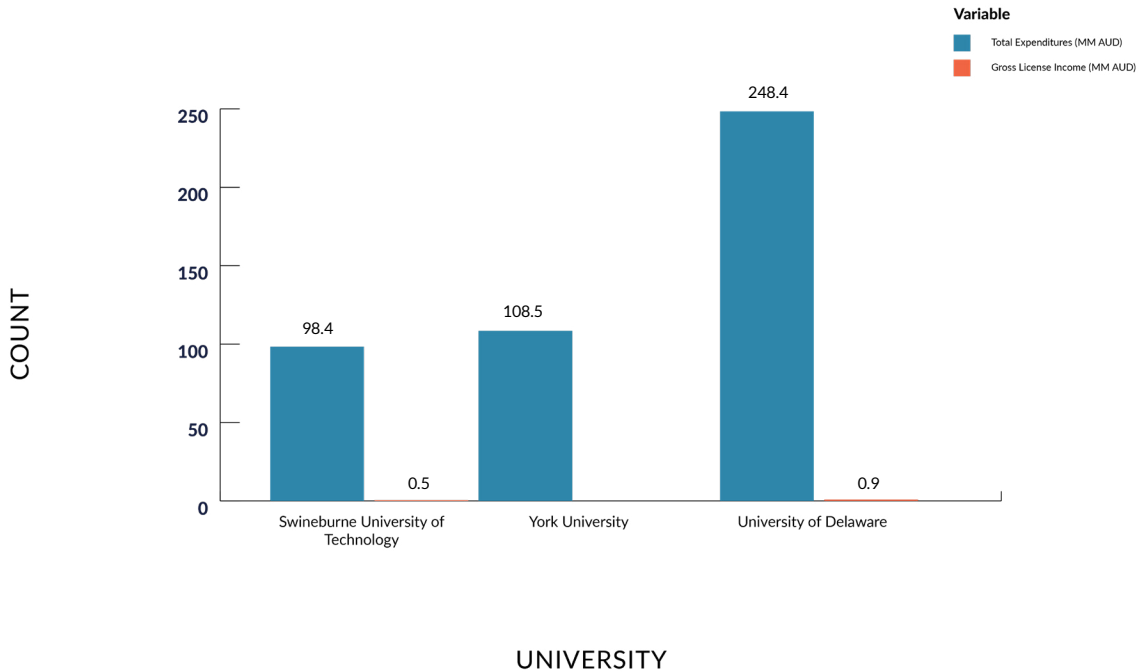
TECH TRANSFER AT COMPARABLES

Dalhousie University in Nova Scotia houses some preeminent researchers in battery technology, and it has capitalized on its position through tech transfer partnerships. For instance, Tesla funds an advanced materials lab at the university and commercializes the IP that the lab produces.³⁷ The University of Kansas (KU) forged a tight-knit innovation ecosystem, working closely with the Lawrence Chamber at the city, county, and state level. The Biosciences and Technology Business Center (BTBC) acts as KU's business incubator, and KU's Center for Technology Commercialization (KUCTC) is the one-stop commercialization enterprise that facilitates the tech transfer and commercialization for the campus and the medical center. KUCTC and BTBC have been the key players, who through their partnership, helped KU generate remarkably high licensing revenues of over US\$10 million.³⁸

SWINBURNE UNIVERSITY

Figure 9: Tech Transfer and Commercialization Variables for the Swinburne University and Matched Peers





Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

PERFORMANCE COMPARISON

The outputs that Swinburne reported in 2020 were less than those reported by the comparison set, both on an absolute and per-expenditure basis. However, most of that gap arises from the disparity in inventions disclosed, suggesting that the university has the capacity to commercialize innovations when they are developed. Swinburne's total research expenditures are essentially identical to that of York University, but University of Delaware is about 1.5 times higher.

TECH TRANSFER AT COMPARABLES

The University of Delaware has engaged with a variety of prominent industry partners, such as Google and Exxon Mobil.³⁹ It also offers a variety of entrepreneurship resources to state residents, such as programs to help small businesses secure federal grants concurrently with its tech transfer services.⁴⁰

Performance Comparisons: Matched Peers (Aggregate)

We restrict the sample to the 23 universities in Table 1, with the notable exclusion of Australian Catholic University due to missing data and compute the averages at the national level. But instead of levels, we focus on the ratios of tech transfer and commercialization indicator variables as proxies for efficiency and compare Australia's performance (Victorian universities) to their matched peers at the aggregate level. Table 2 describes the seven tech-transfer and commercialization-indicator variables in total that we examined.

Table 2: Description of Tech-Transfer and Commercialization-Indicator Variables

Ratio	Numerator	Denominator	Description
rev\$/R&D	gross_lic\$MM	tot_exp\$MM	Gross licensing revenue per \$100 million spent in R&D expenditures
inventions/R&D	tot_disc	tot_exp\$MM	Total disclosures per R&D expenditures
patapp/invention	new_patapp	tot_disc	Ratio of new patent applications to invention disclosures
LOA/patapp	tot_LOA	new_patapp	Ratio of LOAs to new patent applications
rev\$/license	gross_lic\$MM	tot_LOA	Gross licensing revenue (\$) per LOAs
LOA/invention	tot_LOA	tot_disc	Ratio of LOAs to invention disclosures
startup/patapp	new_startup	new_patapp	Ratio of new startups to new patent applications

Source: Milken Institute (2023)

Table 3 displays the national averages of our matched sample universities from Table 1. We find that Victorian universities outperform both their US and Canadian matched peers in “Ratio of LOAs to new patent applications” and “Total disclosures per R&D expenditures” but underperform in “Gross licensing revenue per \$100 million spent in R&D expenditures” and “Ratio of new patent applications to invention disclosures.” These numbers show that Victorian universities are globally competitive with their US and Canadian matched peers. Further, each country has its own strengths and weaknesses in tech transfer and commercialization.

The fact that Victorian universities outperform in “Total disclosures per R&D expenditures” is yet another testament to the presence of world-class research in Australia. These numbers suggest that for every dollar that flows into public research, Australian academic institutions generate a higher rate of invention disclosures than their matched international peers.

The fact that Victorian universities outperform in “Ratio of LOAs to new patent applications” suggests that once a patent application is filed, they enjoy a higher conversion rate into LOAs compared to their US and Canadian peers. This is likely a positive sign. It could be a result of less bureaucracy or a more efficient system. However, it is also possible that patent applications filed by Victorian universities are simpler or less sophisticated than their peers or that the higher ratios are a result of a relatively lower rate of patent applications.

Table 3: National Average Ratios (Matched Sample)

Country	Gross licensing revenue per \$100 million spent in R&D expenditures	Total disclosures per R&D expenditures	Ratio of new patent applications to invention disclosures	Ratio of LOAs to new patent applications	Gross licensing revenue (\$) per LOAs	Ratio of LOAs to invention disclosures	Ratio of new startups to new patent applications
AU	0.27	0.77	0.44	1.20	0.11	0.56	0.17
CA	0.73	0.26	0.73	0.73	0.10	0.98	0.32
USA	1.35	0.25	0.80	0.99	0.16	0.48	0.10

Source: Milken Institute (2023), using data from CHIPS Act of 2022, Pub. L. No. 117-167, Div. A (2022)

The fact that Victorian universities underperform in “Gross licensing revenue per \$100 million spent in R&D expenditures” compared to their matched international peers suggests that for every dollar that flows into public research, Australian academic institutions are reaping much less in licensing revenues.

The fact that Victorian universities underperform in “Ratio of new patent applications to invention disclosures” compared to their matched international peers is perhaps an empirical confirmation of the stakeholder comments that their universities struggle with a shortage of tech transfer office talent and research translation as a whole. This is a major bottleneck in the Victorian innovation ecosystem. Invention disclosures should translate into patent applications before the true commercial value of the invention can be captured as licensing revenue or through a new startup venture.

Performance Comparisons: Full Sample (Cross-national)

In this section, we conduct a cross-national assessment of tech transfer and commercialization, but this time, we broaden the sample from just the eight Victorian universities and their matched eight Canadian and eight US universities to the *full sample* available. Australia’s data combines NSRC and SCOPR, while Canada and the US is based on the AUTM data.

National averages in the full sample (Table 4) are higher in “Gross licensing revenue per \$100 million spent in R&D expenditures” but lower in “Total disclosures per R&D expenditures” when compared to the Victorian university averages in the matched sample (Table 3). Thus, the seven Victorian universities together trail the Australian national average in their ability to translate research expenditures into licensing revenues. Nevertheless, they are better at converting research expenditures into invention disclosures. However, compared to their US and Canadian peers, Australian universities, not just in Victoria, are not as efficient

at converting research expenditures into licensing revenue or invention disclosures. Australian universities also fall behind the US and Canadian universities in converting invention disclosures into new patent applications.

Table 4: National Averages (Full Sample), 2020

Country	Gross licensing revenue per \$100 million spent in R&D expenditures	Total disclosures per R&D expenditures	Ratio of new patent applications to invention disclosures	Ratio of LOAs to new patent applications	Gross licensing revenue (\$) per LOAs	Ratio of LOAs to invention disclosures	Ratio of new startups to new patent applications
AU	1.06	0.12	0.28	1.48	0.21	0.41	0.14
CA	1.81	0.22	0.52	0.90	0.18	0.47	0.12
USA	2.85	0.23	0.60	0.61	0.34	0.36	0.07

Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

Surprisingly, Australia continues to outperform its US and Canadian counterparts in “Ratio of LOAs to new patent applications.” The fact that Australia dominates in the “Ratio of LOAs to new patent applications” category, whether in the matched sample comparisons (Table 3) or in national averages (Table 4), is remarkable. A higher conversion rate of patent applications to LOAs compared to the US and Canadian counterparts is a positive sign for tech transfer and commercialization. This suggests that Australian universities have less inflow of research expenditures and as a result, fewer invention disclosures and new patent applications. But once the ideas make it through invention disclosures and new patent applications, a lot more of those new patent applications convert to LOAs than in the US or Canada.

Table 5: National Averages with Victoria Separated (Full sample), 2020

Country	Gross licensing revenue per \$100 million spent in R&D expenditures	Total disclosures per R&D expenditures	Ratio of new patent applications to invention disclosures	Ratio of new patent applications to invention disclosures	Gross licensing revenue (\$) per LOAs	Ratio of LOAs to invention disclosures	Ratio of new startups to new patent applications
AU (Other)	1.53	0.14	0.25	1.80	0.24	0.45	0.13
AU (VIC)	0.27	0.09	0.34	0.88	0.09	0.30	0.15
CA	1.81	0.22	0.52	0.90	0.18	0.47	0.12
US	2.85	0.23	0.60	0.61	0.34	0.36	0.07

Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

Table 5 recreates Table 4 but disaggregates Australia into Victoria and non-Victoria. Comparing the aggregate averages, Victoria underperforms the rest of Australia on five of seven indicators. The only bright light to Victoria is in the “Ratio of new patent applications to invention disclosures.”

Performance Comparisons: Full Sample (Cross-regional)

In this section, we conduct a cross-regional assessment of tech transfer and commercialization. Table 6 presents the six tech-transfer and commercialization-indicator variables disaggregated by Australia’s seven provinces. Some notable observations are:

- New South Wales dominates in most indicators, with the notable exception of gross licensing revenues in which Queensland outperforms others by a wide margin.
- Nearly one-third (32 percent) of Australia’s research expenditure originates in Victoria. Likewise, nearly one-third (31 percent) of new patent applications and one-third (30 percent) of startups are from Victoria.
- About one-fifth (17 percent) of Australia’s gross licensing revenue and one-quarter (24 percent) of reported total disclosures are from Victoria.

Table 6: Regional Averages (Full Sample), 2020

Province	R&D expenditure (in\$MM)	Total disclosures	New patent applications	Total LOAs	Gross licensing revenue (in \$MM)	New startups
ACT	477.15	42.50	10.00	17.50	0.28	1.50
NSW	3,507.18	457.67	136.42	238.00	8.35	14.83
QLD	1,430.43	171.25	47.67	37.08	44.37	3.17
SA	585.33	154.25	35.58	41.00	5.87	9.33
TAS	174.26	14.76	3.25	4.00	0.13	0.75
VIC	3,311.41	300.00	113.75	83.50	13.82	13.25
WA	897.73	123.25	21.75	18.75	6.74	2.00

Notes: ACT (Australian Capital Territory); New South Wales (NSW); Queensland (QLD); South Australia (SA); Tasmania (TAS); Victoria (VIC); Western Australia (WA). Data are for 2020 and 2017–2020, where available.

Sources: Milken Institute, based on data from AUTM, NSRC, and SCOPR (2023)

Table 7 displays Table 6 data but with ratios rather than levels, much like in Tables 3, 4, and 5. When we turn to ratios, Victoria looks less dominant for a reason. First, Victoria is a regional leader in tech transfer and commercialization in *volume* but *not efficiency*. Second, the most important tech transfer and commercialization entities are the Group of 8 (Go8) member universities. The lion’s share of Victoria’s tech transfer and commercialization can be attributed to its Go8 member universities, University of Melbourne and Monash University. New South Wales dominates because of Sydney, Australia’s financial center, and its two Go8 schools, University of Sydney and University of New South Wales. Queensland has University of Queensland in Brisbane; South Australia has University of Adelaide in Adelaide. Western Australia has University of Western Australia in Perth; and Australian Capital Territory has the Australian National University in Canberra.

Table 7: Regional Average Ratios (Full Sample), 2020

Province	Gross licensing revenue per \$100 million spent in R&D expenditures	Total disclosures per R&D expenditures	Ratio of new patent applications to invention disclosures	Ratio of LOAs to new patent applications	Gross licensing revenue (\$) per LOAs	Ratio of LOAs to invention disclosures	Ratio of new startups to new patent applications
ACT	0.06	0.09	0.24	1.75	0.02	0.41	0.15
NSW	0.24	0.13	0.30	1.74	0.04	0.52	0.11
QLD	3.10	0.12	0.28	0.78	1.20	0.22	0.07
SA	1.00	0.26	0.23	1.15	0.14	0.27	0.26
TAS	0.08	0.08	0.22	1.23	0.03	0.27	0.23
VIC	0.42	0.09	0.38	0.73	0.17	0.28	0.12
WA	0.75	0.14	0.18	0.86	0.36	0.15	0.09

Notes: ACT (Australian Capital Territory); New South Wales (NSW); Queensland (QLD); South Australia (SA); Tasmania (TAS); Victoria (VIC); Western Australia (WA). Data are for 2020 and 2017–2020, where available.

Source: Milken Institute (2023), using data from CHIPS Act of 2022, Pub. L. No. 117-167, Div. A (2022)

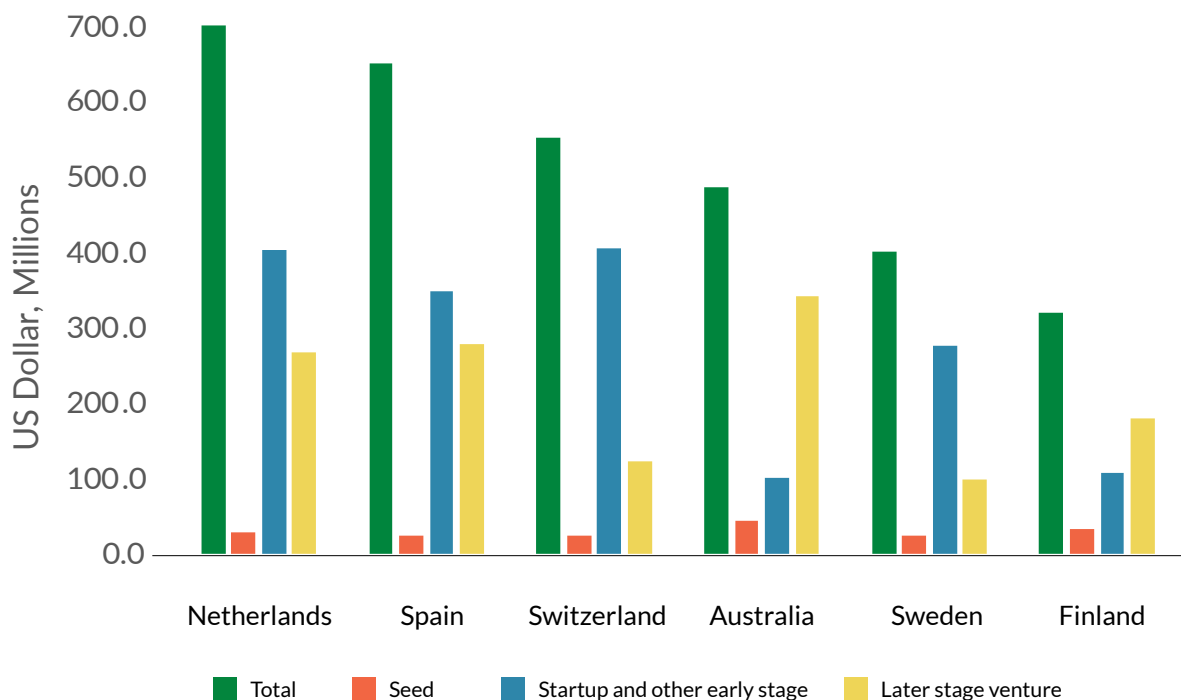
Some noteworthy performances from Table 7 are as follows:

- QLD scores an outsized 3.1 in “Gross licensing revenue per \$100 million spent in R&D expenditures.”
- VIC scores the highest among states in “Ratio of new patent applications to invention disclosures.”

A BENCHMARK STUDY OF VENTURE-BACKED STARTUPS

Australia's venture capital investment trails its international peers. Based on 2019 statistics, the US leads the world with nearly US\$136 billion. Canada and the UK each have about US\$3.3 billion. Surprisingly, Israel outperforms many of its peers at US\$7.2 billion. Using the OECD data, we found peer nations with similar venture capital investments to Australia's \$487 million (Figure 10). These peers are the Netherlands, Spain, Switzerland, Sweden and Finland. OECD data tracks not just the net total of venture capital investments but also by type: seed, startup and other early stage, and later stage venture. What stands out immediately is that Australia outperforms its peers in later stage ventures but underperforms in startup and other early-stage venture investments.

Figure 10: Venture Capital Investments, 2019



Source: Milken Institute, based on data from OECD (2023)

Next, we turn to examine VC-backed startups associated with universities as a way to dig deeper into the state of Australia’s VC-backed startups. Pitchbook’s annual university rankings compare schools by counting VC-backed startups founded by college alumni and the total value of VC they raised.⁴¹ The data analysis is based on more than 144,000 VC-backed founders. The 2022 rankings are based on startups that received a first round of funding between January 1, 2012, and October 21, 2022.

At the top of the chart is Stanford University (first) and the University of California (UC), Berkeley (second), both of which have more than 1,400 founders that collectively founded more than 1,200 startups over the last ten years between 2012 and 2022. Stanford alumni entrepreneurs raised a whopping US\$73.6 billion and UC Berkeley US\$45.7 billion. Of course, these universities’ success is primarily due to their industry-university partnerships with the well-known Silicon Valley.

The Pitchbook data are limited because they are not based on all startups but only on VC-backed startups, which are both rare and high-growth. These startups are also presumably in the later stages because VCs tend to fund later-stage as opposed to early-stage startups. In addition, the data are based on where the founders went to undergraduate school and therefore do not track faculty-led startups.

According to Pitchbook 2022, four Australian universities are in the world’s top 100 universities in VC-backed startups: University of Sydney (78th), University of New South Wales (84th), University of Melbourne (86th), and Monash University (94th). Two of the four are Victorian universities. All four are part of the Go8, Australia’s most research-intensive universities. Because the Go8 are the best universities in Australia, it is disappointing that the University of Adelaide, Australian National University, University of Queensland, and the University of Western Australia are not ranked in the world’s top 100. It is clear that Australia has room for improvement in fostering a national innovation ecosystem conducive to more venture-backed startups.

Table 8: Australia’s Public Universities in Pitchbook’s Top 100, 2012–2022

Rank	University	Founder Count	Company Count	Capital Raised (\$M)	List	Enrollment
78	University of Sydney	189	182	4845.75	Undergraduate	30,000 or more students
84	University of New South Wales	177	160	5569.69	Undergraduate	30,000 or more students
86	University of Melbourne	174	160	4136.76	Undergraduate	30,000 or more students
94	Monash University	155	150	1809.19	Undergraduate	30,000 or more students

Source: Pitchbook (2022)

University of Melbourne

University of Melbourne's 174 founders collectively founded 160 startups and raised a total of \$4.1 billion in VC. Its top five university startups by VC raised were Airwallex (\$902 million), Canva (\$581 million), Culture Amp (\$228 million), Bibit (\$190 million), and Praxis (\$142 million).

Comparable to the University of Melbourne (86th) in VC-based startup indicators are Syracuse University (85th) and the University of Utah (87th). Surprisingly, Australia's University of New South Wales ranks nearby at 84th. Syracuse University's 176 founders collectively founded 164 startups and raised a total of \$3.4 billion, and the University of Utah's 172 founders collectively founded 157 startups and raised a total of \$4.0 billion. Interestingly, both universities are located in college towns far from urban hubs with entrepreneurial ecosystems.

The American peer matched to the University of Melbourne on key tech transfer metrics is the University of North Carolina at Chapel Hill (47th). This university's 242 founders collectively founded 224 startups and raised a total of \$5.6 billion. Its top five startups by VC raised were Zalora (\$379 million), Looker (\$281 million), Blockstream (\$243 million), and Kindbody (\$185 million).

The Canadian peer matched to the University of Melbourne on key tech transfer metrics is the University of British Columbia (44th). Its 293 founders collectively founded 254 startups and raised a total of \$5.3 billion. Its top five startups by VC raised were Securonix (\$1.2 billion), KOHO (\$364 million), CRISPR Therapeutics (\$160 million), 17 Media (\$160 million), and Svante Technologies (\$129 million).

Monash University

Monash University's 155 founders collectively founded 150 startups and raised a total of \$1.8 billion in VC. Its top five startups by VC raised were SendBirth (\$221 million), Bibit (\$190 million), Septerna (\$100 million), Prospa (\$76 million), and Grey Wolf Therapeutics (\$75 million).

Comparable to Monash University in VC-based startup indicators are Wesleyan University (joint 94th) and Imperial College London (93rd). Wesleyan is a private university close to a major metro, Boston, and its famed Route 128 entrepreneurial ecosystem. Wesleyan's 155 founders collectively founded 143 startups and raised a total of \$4.7 billion, and Imperial College London's 159 founders collectively founded 147 startups and raised a total of \$4.3 billion. Imperial College London is noted for challenging the norm of tech transfer sector's practice of universities, taking controlling stakes in spinouts by launching a new initiative known as Founders Choice™. Founders Choice gives faculty and staff the opportunity to build the business and find investors themselves. In return for the work, the founders can receive up to 95 percent of the founding equity.⁴²

The American peer matched to Monash University on key tech transfer metrics is the University of Pittsburgh, which did not break into the world's top 100 list.

The Canadian peer matched to Monash University on key tech transfer metrics is the University of Toronto (27th). Its 434 founders collectively founded 392 startups that raised \$14.9 billion. Its top five startups by VC raised were Databricks (\$3.5 billion), Compass (\$1.7 billion), OpenAI (\$1.0 billion), Wealthsimple (\$876 million), and Kriya (\$458 million).

RMIT

Although RMIT did not break into the world's top 100 universities by VC raised, its American and Canadian peers that matched on key tech transfer metrics did. This result is a testament to the fact that RMIT is already world-class in research output but lags in startup performance compared to its peers in the US and Canada.

The American peer matched to RMIT on key tech transfer metrics is North Carolina State University (88th). This university's 170 founders collectively founded 156 startups and raised a total of \$2.6 billion. Its top five startups by VC raised were Carbon (\$682 million), Inivata (\$164 million), Cdata (\$160 million), JupiterOne (\$119 million), and Front Range Biosciences (\$105 million).

To put these figures in perspective, North Carolina State University ranks on par with Australia's University of New South Wales (84th) and University of Melbourne (86th). Its success in VC-backed startups is not an accident but a result of many years of careful and deliberate planning. North Carolina State University may underperform in R&D, but it certainly far outperforms its Australian peers in startups by leveraging its location. North Carolina State University is situated right at the heart of the Research Triangle—a nickname for a metropolitan area in the Piedmont area of North Carolina, anchored by the three major research universities, Duke University, University of North Carolina at Chapel Hill, and North Carolina State University—a very robust entrepreneurial ecosystem. Over the past several decades, the Research Triangle has highly prioritized tech transfer and commercialization, resulting in an entrepreneurial ecosystem that has consistently produced great startups and has successfully attracted many large American corporations.

The Canadian peer matched to RMIT on key tech transfer metrics is the University of Waterloo (21st). This university is also frequently praised for its strong entrepreneurial ecosystem. Its 494 founders collectively founded 406 startups and raised \$19.4 billion. This is on par with Duke University's 509 founders, 483 startups, and \$20.4 billion raised. Its top five startups by VC raised were Databricks (\$3.5 billion), Instacart (\$3.0 billion), Netskope (\$1.0 billion), Clearco (\$938 million), and Arctic Wolf (\$900 million).

Swinburne University

Although Swinburne did not make it to the world's top 100 universities by VC raised, its Canadian peer York University (98th) did. York University's 151 founders collectively founded 143 startups and raised a total of \$2.4 billion. Its top five VC raised startups were Claroty (\$640 million), Side (\$267 million), Pulmocide (\$158 million), Sheertex (\$138 million), and Vigo Video (\$138 million).



CONCLUSION AND POLICY RECOMMENDATIONS

Both the Australian and Victorian governments recognize the importance of and are making greater investments in tech transfer and commercialization. The momentum is promising: the Australian Universities Accord and the National Reconstruction Fund (NRF) will bring about transformative reforms to Australia's higher education system and help diversify Australia's industry and economy. However, universities in Victoria still lag behind their peers worldwide. Policy leaders and universities in Victoria can take the following steps toward closing that gap and realizing the full potential of their tech transfer and commercialization opportunities.

- Stakeholder interviews reveal that universities in other commonwealths, such as University of New South Wales (UNSW), Australian National University (ANU), and the University of Queensland, are more advanced in tech transfer and commercialization. Victorian universities should do more to create faculty incentives to pursue tech transfer and commercialization.
- Having experienced and capable tech transfer professionals is instrumental to the success of a university's tech transfer office. Victorian universities must allocate additional funding to recruit professional, experienced staff to the accelerators, whether from within Australia or outside. Developing a clear mechanism to facilitate recruitment will benefit the universities themselves and the entrepreneurial ecosystem as a whole. A key goal should be to develop a model that enables academics and universities to hand their IP over to expert industry partners for commercialization, knowing that they will reap some benefits in the future. Establishing both the recognition of these benefits and trusted relationships is essential to advancing the process.
- Each university should identify its key areas of comparative advantage, beyond simply resources and personnel, and leverage those areas to achieve clear, tangible results. Each university should establish clear and defined success metrics to understand their needs and measure performance. Such metrics should consider local economic impact through jobs and wages created after six months, one year, three years, and beyond; value created through the amount of equity from startups; and the actual sources of tech transfer and commercialization revenue.
- Assessing and strengthening the state of research, external relationships, and faculty and staff interest and skill are essential for progressing in research commercialization. Most researchers lack either the knowledge or understanding to become startup founders or become directly involved in the technology licensing process. Universities should offer facilitation and training support to researchers and key staff. In addition, the universities should identify other academic areas (e.g., social sciences and humanities) that they can utilize to produce business partnerships, licenses, and spinouts.

- Universities should recognize the importance of partnerships with external organizations within the private and public sectors. For universities, essential steps are pooling resources with fellow institutions and engaging key external partners such as LaunchVic, the Australian Technology Network of Universities, and key private-sector organizations with expertise in startups and technology licensing.

APPENDIX

Matching Results Based on University Rank, Research Expenditures, and the Presence of Medical Schools

UNITED STATES OF AMERICA

University Name	University Peer Match	Rank	Total Research Expenditures (\$MM)	Medical School	School Type	Distance
Deakin University	University of Kansas	0.371	0.13039382	Yes	Public	0.12400789
La Trobe University	Oregon State University	0.46	0.12663794	No	Public	0.07921788
Monash University	University of Pittsburgh	0.139	0.46198908	Yes	Public	0.09456692
RMIT University	North Carolina State University	0.284	0.2752382	No	Public	0.13682962
Swinburne University of Technology	University of Delaware	0.49	0.07479569	No	Public	0.12140236
University of Melbourne	University of North Carolina at Chapel Hill	0.089	0.44620207	Yes	Public	0.0623399

Note: Using propensity score matching, we match Victorian universities to their nearest peer university in the US. The key indicators in the table are university rank from the 2020 QS World University Rankings, total research expenditures, presence of medical school (yes or no) and school type (public or private). Total research expenditures are for 2020 in US dollars. Universities self-reported this information in the SCOPR survey for Australia, and the AUTM survey for the US and Canada. The distance score is calculated on two continuous variables which are university rank and R&D expense conditional on having or not having a medical school. All Australian universities are public and so the school type was not factored into the distance score.

CANADA

University Name	University Peer Match	Rank	Total Research Expenditures (\$MM)	Medical School	School Type	Distance
Deakin University	Dalhousie University	0.28800918	0.21042475	Yes	Public	0.0161895
La Trobe University	University of Victoria	0.38439472	0.1201386	No	Public	0.17859925
Monash University	University of Toronto	0.00688468	0.92416547	Yes	Public	0.73281531
RMIT University	University of Waterloo	0.16523236	0.68421253	No	Public	0.12978269
Swinburne University of Technology	York University	0.55823293	0.08061962	No	Public	0.15277191
University of Melbourne	University of British Columbia	0.02524383	1	Yes	Public	0.92088195

Note: Using propensity score matching, we match Victorian universities to their nearest peer university in the US. The key indicators in the table are university rank, total research expenditures, presence of medical school (yes or no) and school type (public or private). The university rankings are from 2020 QS World University Rankings. Total research expenditures are for 2020 in US dollars. Universities self-reported this information in the SCOPR survey for Australia, and the AUTM survey for the US and Canada. The distance score is calculated on two continuous variables which are university rank and R&D expense conditional on having or not having a medical school. All Australian universities are public and so the school type was not factored into the distance score.



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21. In order to weight rank and expenditure equally, we scaled each variable before matching, such that the top-performing American university received a score of 1, and the bottom-performing American university a score of 0. We did not permit a North American university to match to multiple Victorian universities; if a duplicate occurred, the university with the closer match was given priority. We used 2020 data for these comparisons because many universities did not report research expenditure to SCOPR in earlier years.
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- Stephanie Morris, Director of Translation and Innovation, Adelaide Intermediary Program, and Consultant, Imperial College, London
- Bree Nicholas, Director, Research Services, Victoria University
- Alex Parker, Executive Director, Institute for Health and Sport, Victoria University
- Warren Rust, Co-founder of a robotics company
- Andrew Rowse, Melbourne Entrepreneurial Center
- Cerasela Tanasescu, Director of Innovation and Entrepreneurship, LaTrobe University
- Rohan Workman, CEO, Scholada Ventures



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Kevin Klowden is the Milken Institute's chief global strategist, a role in which he identifies key opportunities for the Milken Institute to engage with officials on global economic issues and advises stakeholders in areas of his economic specialization. He specializes in the study of key factors that underlie the development of competitive regional economies (clusters of innovation, patterns of trade and investment, and concentration of skilled labor) and how these are influenced by public policy and, in turn, affect regional economies both globally and nationally. On a national level, he is heavily involved in trade, exports, and capital access for small businesses, including serving as chair of the US Department of Commerce's Trade Finance Advisory Council. He also helps to coordinate the Partnership for Lending in Underserved Markets initiative with the US Small Business Administration, which focuses on funding for African American and Latinx small businesses. He has also been highly engaged in California's economy and workforce, including advising and writing on numerous subjects relating to California's workforce, technology, manufacturing, and export issues.

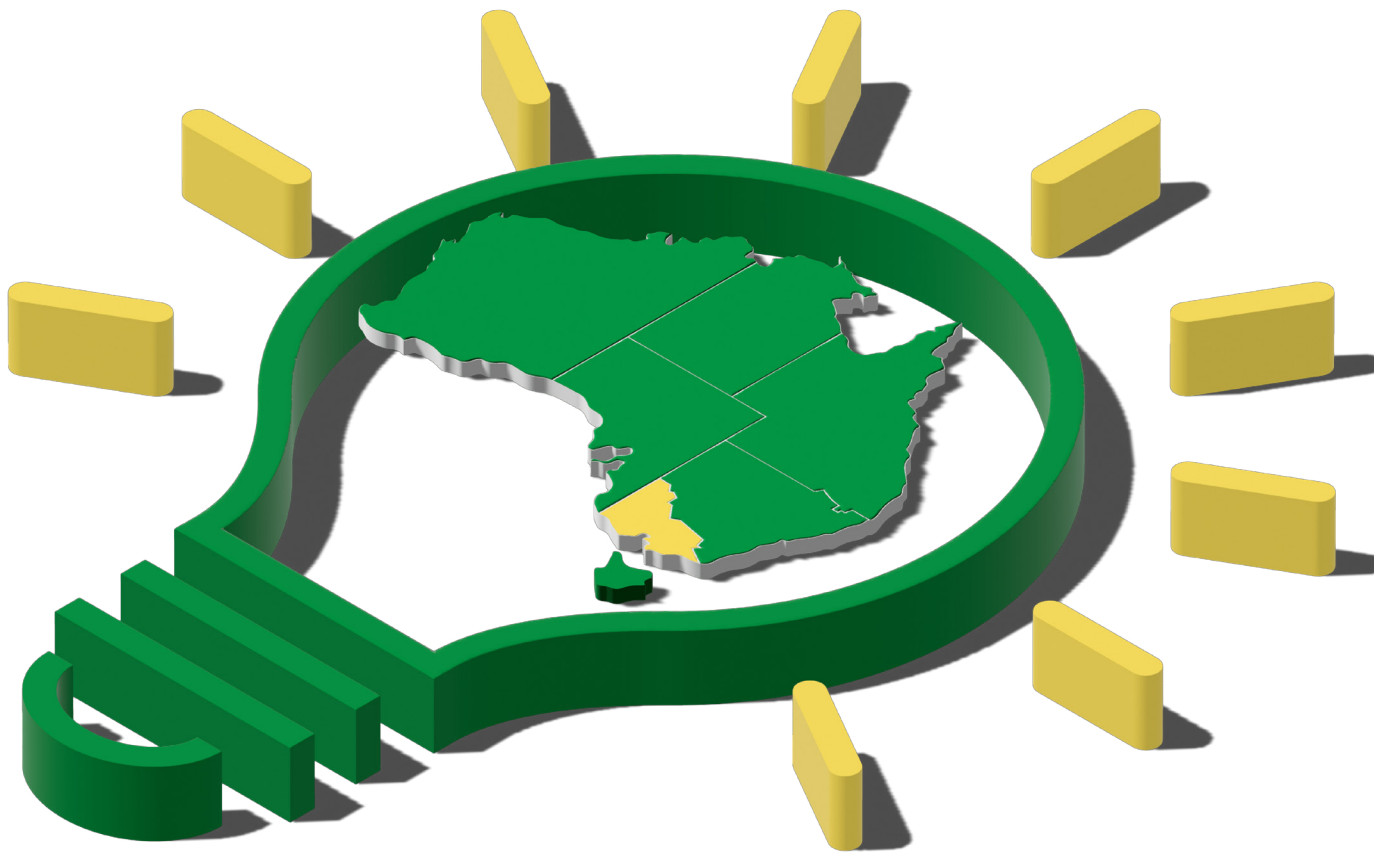
His areas of expertise include technology-based development, entrepreneurship, and the digitization of the global economy, including trade, infrastructure, media, and entertainment. Klowden was the lead author of *Strategies for Expanding California's Exports*, which examined the vital role trade and exports play in the state economy and its underperformance relative to the country over the past decade. Further work on trade and investment has included *A Golden Opportunity with China: How California Can Become an Even Bigger Destination for Chinese Foreign Investment*. He has also written on the role of trade infrastructure in economic growth and job creation in the report *Jobs for America: Investments and Policies for Economic Growth and Competitiveness*, as well as in publications including *The Wall Street Journal*. He has addressed the role of technology-based development in publications such as the biennial *State Technology and Science Index*, *North America's High-Tech Economy*, and location-specific studies in several states, including multiple pieces on job creation and opportunities in the entertainment industry.

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