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Original Research

University-Industry Collaboration and Research Commercialization in Australia: A Review Article

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Abstract

This review examines the literature on university-industry collaboration (UIC) and research commercialization in Australia, focusing on benefits, challenges, and strategies for enhancement. A structured review of 73 articles published between 2000 and 2024 was conducted using extensive database queries and targeted searches in specialized journals. The findings reveal that significant challenges persist while Australia has made progress through initiatives such as Cooperative Research Centers, University Commercialization Offices, and University Accelerators. These include cultural differences between academia and industry, resource constraints, and the need for more effective policy frameworks. This review identifies key strategies for improving UIC, including organizational restructuring, policy reforms, and educational initiatives. Emphasis is placed on balancing commercial outcomes with broader societal benefits, refining impact measurement methods, developing place-based innovation systems, and supporting academic entrepreneurship. Several research gaps are highlighted, such as the need for discipline-specific collaboration models, evaluations of policy effectiveness, and regional innovation ecosystems. The article offers recommendations for government, universities, and industry stakeholders, including developing more flexible funding models, enhancing commercialization support structures, and creating simplified collaboration frameworks. This review contributes to the field by thoroughly analyzing the UIC and research commercialization landscape in Australia and suggesting directions for future research and practice.

Keywords: University-Industry Collaboration, Research Commercialization, Incubators, Partnership, Industry Linkage, Knowledge Transfer, Innovation Ecosystem, Australia.

Introduction

The Australian research landscape has some strengths, including its strong scientific research base. The country benefits from high-quality research, with more than 90 per cent of its university research (assessed by the Government) rated as world class or higher (Universities Australia, 2019). Moreover, the diversity and growth of key actors in Australia's innovation

ecosystem (including start-ups, scale-ups, support organizations, investors, and research institutions) have contributed to the ecosystem's development (Cetindamar, Renando, Bliemel & Klerk, 2024).

However, the effectiveness of this ecosystem is affected by several challenges, including policy gaps, lack of data, aggressive goals, and insufficient collaboration (Cetindamar et al., 2024). Moreover, translating research excellence into commercially viable products and services and tangible economic benefits has been a persistent challenge in Australia. Even though research spending in Australia outstrips most advanced economies, the country's score in the global innovation index has declined in recent years (Harrison, Barnard & Pregelj, 2023) and "its ability to translate innovation capabilities into innovation outputs, is surprisingly poor" (Jackson, Runde, Dobson & Richter, 2016, p. 234). The gap between academic research and industry application is usually bridged by academic-industry collaborations that facilitate knowledge exchange and by research commercialization activities that translate research into market-ready products and services.

A fundamental challenge in the Australian context is the low rate of university-industry collaboration (UIC). Despite the general perception of Australians as collaborative and team-oriented, the country has among the lowest collaboration rates between businesses and universities in the OECD (Jackson, Mavi, Suseno & Standing, 2018). Bridging this gap is critical for the country's economic well-being. A robust research commercialization ecosystem encourages innovation, creates high-skilled jobs, and drives the development of new technologies and industries. The Australian government acknowledges the problem and has recognized the importance of enhancing university-industry collaboration. Since the 'Innovation Agenda' in 2016, there has been a greater emphasis on cooperative research, research commercialization, start-up acceleration, and entrepreneurship education in universities (Jackson et al., 2018). Policy developments have shaped the evolution of the Australian start-up and innovation ecosystem over the past two decades, and the government plays a significant role in creating an environment suitable for innovation and entrepreneurship (Cetindamar et al., 2024). Some examples of government initiatives include the Medical Research Commercialization initiative that injects $450 million into supporting innovative early-stage health and medical research over a decade (Australian Government, 2023a), and a $2.2 billion investment through the University Research Commercialization Action Plan to boost university innovation and industry collaboration (Australian Government, 2023b).

There have been ongoing efforts to address the disconnect between research and commercialization. One indication of this growing significance is the increasing number of literature reviews on UIC and research commercialization in recent years. While past reviews have contributed valuable insights to the field, they often focus on specific aspects, contexts, or methodologies, hence a gap for a thorough examination of the Australian landscape. For instance, some reviews have concentrated on particular countries like the UK (Vick & Robertson, 2018) or Malaysia (Rahima, Hanafi & Jais, 2015), while others have explored specific dimensions of UIC such as benefits (Barbosa, Fernandes & Tereso, 2023), socioeconomic impact (Lima, Torkomian, Pereira, Oprime & Hashiba, 2021), motivations and barriers (Figueiredo & Ferreira, 2022), enabling factors (Sjöö & Hellström, 2019), success factors (Rybnicek & Königsgruber, 2019), or UIC processes (Baleeiro Passos, Valle Enrique, Costa Dutra & Schwengber ten Caten, 2023; Nsanzumuhire & Groot, 2020). Some reviews have examined specific factors influencing UIC, such as proximity (Steinmo & Lauvås, 2022),

or focused on particular sectors like SMEs (Pereira & Franco, 2022). Others have examined related topics, including academics' entrepreneurial intentions (Neves & Brito, 2020) or behavior (Farrell, Mapanga, Chitha, Ashton, & Joffe, 2022). Among the broader UIC reviews, Mascarenhas, Ferreir, and Marques (2018) employed a bibliometric approach, using co-word analysis to identify research themes, which differs significantly from the present review's methodology. Ankrah and Omar (2015) provided a more holistic perspective on various UIC aspects and developed a conceptual process framework. However, their review is almost a decade old and does not specifically address the Australian context.

The Australian research and innovation landscape presents unique characteristics, including geographical isolation, a strong but geographically concentrated research base, and an economy dominated by SMEs. These factors necessitate a tailored examination of UIC and research commercialization in the Australian context. Our aim in this review is to fill this gap by offering a critical analysis of the literature to identify benefits, challenges, barriers, and strategies for the success of university-industry collaboration and research commercialization, and to understand the role of various factors such as government and funding. The review covers both commercialization and collaboration as these two areas are closely interrelated, and aims to inform future directions and research.

Materials and Methods

We developed a thorough search strategy to identify relevant literature for this review. We began by formulating an initial search query. This was done by carefully examining key terms that we extracted from a select set of relevant articles and consultation of queries employed in previous review papers, particularly Perkmann et al. (2013) and Lima et al (2021). We designed the query to be expansive and cover a wide range of pertinent keywords and themes to ensure thorough coverage in the initial literature search phase. We included query terms based on their relevance to research commercialization and university-industry collaboration.

Subsequently, we subjected this query to several refinements through iterative testing in Scopus and the Web of Science (Core Collection). This iterative process resulted in a refined search query (see Appendix A for Web of Science and B for Scopus), which we executed in the two databases in August 2024. To ensure comprehensiveness, in parallel, we conducted a targeted search by focusing exclusively on articles related to Australia published in five key academic journals: *Technovation*, *Journal of Technology Transfer*, *Research Policy*, *Industry and Higher Education*, *and Journal of Higher Education Policy and Management.*

Then we combined the results of these approaches and restricted them to English-language Articles (excluding book chapters, conference papers, etc.) published between 2000 and 2024. We chose this period because it provides a manageable timeframe. Moreover, it also ensures relevance to current practices. We downloaded the complete bibliographic records of these articles. We undertook a screening process, in which we both scrutinized each article’s title and abstract to evaluate its relevance to the study’s core themes. The results were combined, and duplicates were removed. Articles were included if they focused on research commercialization and university-industry collaboration within the Australian context. We focused primarily on empirical research and excluded opinion pieces or studies focusing on one particular technology development, studies about cooperation in education, such as developing a course in partnership with industry, or studies primarily concerned with entrepreneurship education or unrelated themes. We limited the review to English-language articles due to our linguistic limitations and

the fact that it is the formal language of Australia. After evaluating titles and abstracts that resulted in the selection of 99 articles, a full-text inspection excluded 26 more articles, and the remaining 73 articles were included in the final review. We screened the titles and abstracts to minimize bias in article selection. We ensured an acceptable level of agreement in the selection process, and discrepancies were double-checked. Data from the final set of articles were extracted using a template that captured key themes and findings related to university-industry collaboration and commercialization. Finally, we used thematic analysis to synthesize the data. Figure 1 shows the search and selection process.

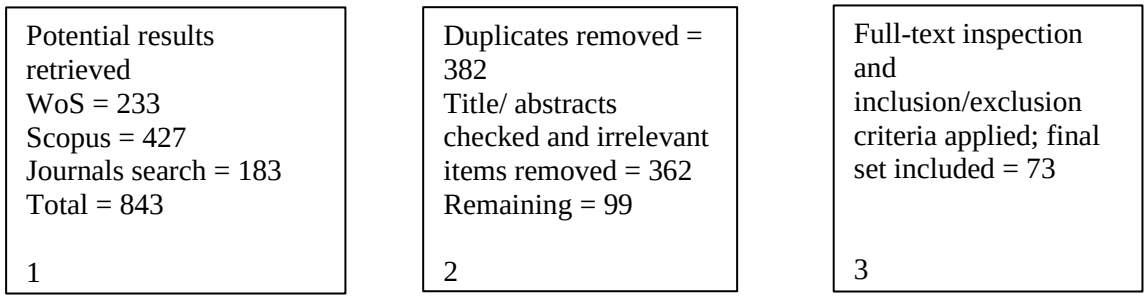

Figure 1: Study selection procedure

Results

As Figure 2 shows, the number of studies on the topic in Australia has increased over the last 25 years. Only six articles were published in the first five years (2000-2004), whereas in the last five years (2020-2024), the number increased nearly fourfold to 23 articles.

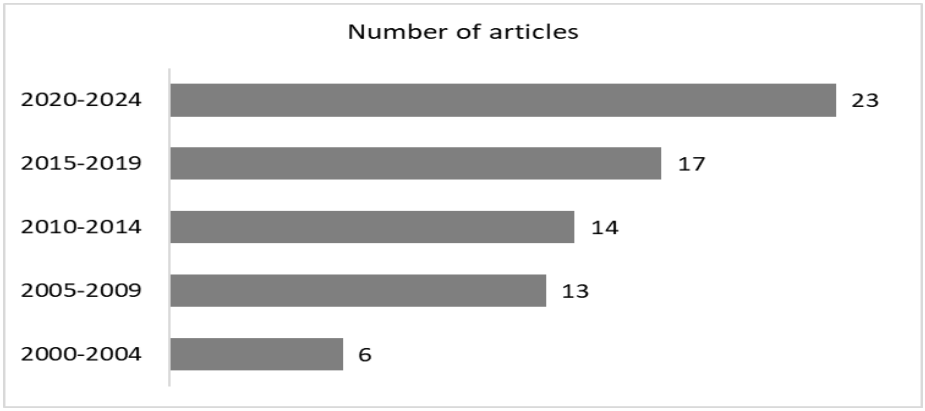

Figure 2: Number of articles included in the review by year

Table 1 shows the list of journals in which at least two articles from those included in the review were published. A few key journals, such as *the Journal of Higher Education Policy and Management and the Journal of Technology Transfer, regularly publish research on UIC. However, local Australian journals, such as Prometheus,* have published three relevant articles. The fact that 73 articles were published in 57 different journals shows the diversity of the outlets and disciplines where research on UIC and commercialization is published.

Table 1
Journals with more than one article included in the review

Journal	Number of articles
Journal of Higher Education Policy and Management	4
Journal of Technology Transfer	4
Technovation	3
Prometheus	3
Industry and Higher Education	3
Higher Education Research and Development	2
Scientometrics	2
Research Policy	2
Australian Geomechanics Journal	2

University-industry collaboration (UIC)

The relationship between universities and industry in Australia has been evolving. This evolution has been driven by changes in funding models and increased pressure on universities to demonstrate research impact. Several studies highlight the growing emphasis on university-industry partnerships to enhance research outputs, drive innovation, and contribute to economic development (Kilpatrick & Wilson, 2013; Berman, 2008). The changing funding climate in Australian higher education has encouraged universities to seek research partnerships with industry, creating opportunities and challenges (Berman, 2008). Two surveys in 1997 and 2000 indicated that about 40% of academics had industry funding for their research (Harman, 2002).

This trend is part of a broader global shift towards more collaborative approaches to innovation. In Australia, the government has implemented policies and programs to incentivize UIC, such as the Cooperative Research Centers (CRC) Program (Sinnewe, Charles & Keast, 2016). However, some studies note that while incentives exist to unite universities and businesses, Australia's innovation policy lacks place-based mechanisms to achieve this effectively (Kilpatrick & Wilson, 2013).

UICs in Australia take various forms, including collaborative research activities, sharing facilities and equipment, innovation and commercialization efforts, student projects, collaborative teaching and learning, and shared use of facilities (Evans, Miklosik & Du, 2023). A relevant area worth mentioning is the student entrepreneurship ecosystem, which has gained attention as a means to promote innovation. It includes not only traditional experiential learning but also behavioral change and entrepreneurial mindset development (Maritz, Nguyen & Ivanov, 2022).

Universities are important in promoting innovation and knowledge transfer within regional innovation systems. Their role can be considered developmental or generative (Gunasekara, 2006b). There is a growing emphasis on universities' ‘third mission’, which involves engagement with industry and the broader community. The development of the knowledge economy has led to increased interest in how universities can contribute to regional innovation systems and economic growth (Garrett-Jones, 2007).

Knowledge transfer mechanisms in UIC

Transfer of knowledge between these institutions is central to the concept of UIC. Understanding the channels and practices through which this transfer occurs is important for

comprehending the mechanics of UIC. Such understanding provides context for the benefits and challenges discussed in subsequent sections.

Australian universities utilize formal and informal knowledge transfer channels with industry partners. Formal channels include research centers, incubators, and contract-based research and commercialization, while informal channels include internships, mentoring, industry talks, transdisciplinary research platforms, collaborative PhD programs, and industry training programs (Dang, Jasovska, Rammal & Schlenker, 2019). This diversity is essential as a study by De Zubielqui, Jones, Seet, and Lindsay (2015) showed that SMEs predominantly rely on generic knowledge transfer pathways, such as accessing published research, rather than engaging in direct, relationship-intensive collaborations with universities and R&D enterprises. This suggests a need for universities to develop more flexible and diverse strategies for encouraging and supporting effective collaborations with SMEs. The study by Nnanna, Charles, Nobl, and Keast (2023) also suggested that tailoring collaboration frameworks can significantly improve partnership outcomes with SMEs. Ultimately, as Couchman and Beckett (2006) emphasized, for industry to value collaboration with the university, the knowledge produced through the cooperation needs to be directly 'usable' by industry, that is, it needs to be timely, readily accessible, and free from uncertainty.

Research centers are the most common channel for STEM knowledge transfer. Some centers focus on one-way transfer from the university to the industry; others engage in two-way knowledge transfer through partnerships with industry. Incubators found in seven out of ten sampled universities studied by Dang et al. (2019) provide funding, skills, and professional support for idea development and start-ups. Incubators facilitate knowledge flow among stakeholders, particularly in technological and market knowledge. While universities were found to have a modest role in providing new ideas to incubators, they were significant during the New Product Development and New Service Development processes, offering R&D support, laboratory facilities, and consultancy services (Rubin, Aas & Stead, 2015).

University accelerators have emerged as a significant component of the entrepreneurial ecosystem within Australian universities. These accelerators play a key role in facilitating startups and contributing to economic and social development by offering programs that provide resources, knowledge, networking, and mentorship (Maritz, Nguyen, and Hsieh, 2021; Maritz, Nguyen, Shrivastava & Ivanov, 2023). However, the study finds a sparse and inconsistent distribution of university accelerators across Australian universities. There's also a mismatch between the outcomes and alignment of entrepreneurship education and accelerators in many institutions (Maritz et al., 2023). This misalignment raises questions about the primary role of accelerators - whether they are primarily intended for educational purposes or for facilitating business startups and contributing to regional development.

Innovation districts are a new land-use type, where public and private actors work towards promoting, attracting, and retaining investment and talent to revitalize urban areas and boost knowledge/innovation economy activities. The role of universities in innovation districts extends beyond economic benefits. They contribute significantly to the politico-organizational and socio-cultural dimensions. They help develop a unique brand and identity for the innovation district, provide shared physical spaces for knowledge exchange, and act as centers for disseminating knowledge and innovation (Pancholi, Yigitcanlar, Guaralda, Mayere, Caldwell, & Medland, 2020).

Technology transfer offices are crucial in facilitating knowledge transfer and

commercialization. Technology transfer managers are highly qualified professionals, often recruited from outside the higher education sector, who focus on identifying and marketing intellectual property, patenting, and licensing IP to existing and start-up companies. Harman and Stone (2006) highlighted that technology transfer managers are generally critical of university management in research commercialization and give low effectiveness ratings to government efforts supporting research commercialization and innovation. Regarding technology transfer officers, a study by Derrick (2015) compared integrated officers (i.e., those who are part of the research organization) with separated officers (i.e., those who operate externally) and found that researchers at institutes with integrated officers viewed commercialization more positively and considered past negative associations as outdated. In contrast, researchers working with separated officers expressed more scepticism. Troshani, Rampersad, and Plewa (2011) looked at adopting e-business or innovation management tools in technology transfer offices, which can support commercialization, and found that top management support is essential for ensuring that adequate organizational resources are allocated to support adoption efforts.

The diverse channels and practices for knowledge transfer discussed above form the foundation upon which the benefits of UIC are built, as we will explore in the next section.

Benefits

Table 2 lists the benefits identified in the literature and their corresponding citations. UIC provides mutual benefits by enhancing research, innovation, and financial gains for both universities and industry. It also offers career and learning opportunities for individuals involved (Evans et al., 2023). For instance, industry-backed academics are more likely to secure national grants and achieve better publication outcomes (Harman, 2001). These partnerships significantly impact innovation and economic growth, particularly for SMEs that gain access to infrastructure and expertise essential for innovation (Jones & de Zubielqui, 2017). Knowledge transfer between universities and SMEs, even though informal methods, improves firm performance and competitiveness (De Zubielqui et al., 2015). UICs have led to industry-specific advancements, such as offshore geotechnical innovations and medical technology transfers (Randolph et al., 2021; Derrick, 2015). Regionally, UICs contribute to developing technological skills and community networks that drive local innovation (Garrett-Jones, 2007). Broader societal impacts include knowledge translation for policy relevance, and human resource development (McGrath-Champ, Gavin, Stacey & Wilson, 2022). Nonetheless, collaborations face challenges when crossing organizational and occupational boundaries due to differing norms and behaviors, though boundary crossers can mitigate these tensions (Hayes & Fitzgerald, 2009).

Table 2
Benefits of university-industry collaboration

Category	Benefit	Citations
Mutual benefits for universities and industry	Access to resources	Evans et al., 2023; Cherney, Head, Boreham, Povey & Ferguson,2012; Harman, 2001
	Enhanced research and innovation	Harman, 2001; Cherney et al., 2012; Walden, Lie, Pandolfo, Lee & Lockhart, 2018; Sohal, 2013
	Financial benefits	Evans et al., 2023; Berman, 2008
	Improved reputation	Evans et al., 2023
	Career progression and opportunities	Evans et al., 2023; Harman, 2001
	Learning and teaching opportunities	Evans et al., 2023
	Validation of work in real-world contexts	Evans et al., 2023
	Corporate learning	Godat and Atkin, 2011
Impact on innovation and economic growth	Increased R&D and patent activities	Cumming and Jordan, 2016; Harman, 2001
	Increased SME performance	Jones and de Zubielqui, 2017
	Knowledge transfer	De Zubielqui et al., 2015
	Industry-specific advancements	Randolph et al., 2021; Derrick, 2015
	Regional impact	Garrett-Jones, 2007
Broader societal impact	Knowledge translation	Harman, 2010
	Increased policy relevance of research	McGrath-Champ et al., 2022
	Human resource development	Li and Hardy, 2024; Jones and de Zubielqui, 2017
	Reduced tension in cross-occupational and organizational boundaries	Hayes and Fitzgerald, 2009

Challenges and barriers

Despite the potential benefits of UICs in Australia, several challenges damage their effectiveness, primarily due to cultural differences, organizational issues, policy ambiguities, and resource constraints. Table 3 lists the identified challenges and barriers. A key issue is the cultural divide between academia and industry, which includes mismatched timeframes, conflicting interests, and differing research focuses, with universities often favoring basic research while industry seeks immediate applications (Berman, 2008; Plewa, 2009; Cherney et al., 2012). Organizational barriers include bureaucratic processes, intellectual property disputes, and inadequate support structures within universities, which complicate collaboration (Harman, 2010; Nguyen, Maritz & Millemann, 2022). Policy challenges, particularly for regional universities, involve ambiguous engagement policies, insufficient industry demand, and limited career incentives for collaboration (Gunasekara, 2006a, 2006b; Evans and Miklosik, 2023). Additionally, despite available tools, there is a low adoption rate of virtual

collaboration technologies among Australian academics (James, 2014). Resource constraints such as limited funding, skill shortages in research commercialization, and time constraints further exacerbate these issues, particularly in specialized settings like forensic labs (Harman, 2010; Ross, 2015).

Table 3
Challenges and barriers of university-industry collaboration

Category	Challenge/Barrier	Citations
Cultural differences	Mismatched timeframes	Berman, 2008; Collier, Gray and Ahn., 2011; Plewa, 2009
	Conflicting interests and expectations	Evans and Miklosik, 2023; Gao and Haworth, 2016
	Market orientation	Plewa, 2009
	Research focus	Littleton, Townsin, and Beilby, 2023
Organizational issues	Bureaucratic processes	Harman, 2010; Berman, 2008
	Intellectual property concerns	Harman, 2010; Evans and Miklosik, 2023
	Lack of university support	Evans and Miklosik, 2023
	Knowledge acquisition and utilization ability	Nguyen, et al., 2022
Policy and systemic challenges	Policy ambiguity	Gunasekara, 2006a
	Weak demand	Gunasekara, 2006a
	Scale challenges	Gunasekara, 2006a
	Career progression limitations	Evans and Miklosik, 2023
	Adoption of collaboration tools	James, 2014
Resource constraints	Funding limitations	Harman, 2010; Ross, 2015
	Time constraints	Ross, 2015
	Skill shortages	Herman, 2010
	General limited resources	Evans and Miklosik, 2023

Enhancing UIC

To enhance university-industry collaborations (UICs) in Australia, strategies must address cultural, organizational, policy, and educational challenges. Table 4 lists both success factors and methods for enhancing UIC. Trust, communication, and shared goals are essential for successful collaborations, as evolving partnerships require mutual understanding and alignment of objectives (Plewa, Korff, Johnson, MacPherson, Baaken & Rampersad, 2013; Littleton et al., 2023). Organizational strategies include establishing technology transfer offices and supportive entities like enterprise hubs to facilitate interactions and drive innovation (Nugent & Chan, 2023; Evans & Miklosik, 2023). Intermediary organizations and collaborative research centers also play key roles, though they face governance and trust challenges (Garrett-Jones, Turpin & Diment, 2010). Policy strategies focus on simplifying legal frameworks, incentivising sustainable partnerships, and adapting support mechanisms to fit different disciplines and institutions (George & Tarr, 2024; Holley & Watson, 2017). Government initiatives like the IP Framework aim to facilitate UICs, though their effectiveness is debated. Expanding research to broader societal challenges, such as social sciences, is recommended (Ross, 2015). Educational

strategies emphasize entrepreneurship education, reframing academic entrepreneurship, and competency development to align academic and industry goals better (Nguyen et al., 2022; Giunti & Duberley, 2023). Identifying champions from academia and industry is vital, as these individuals bridge the cultural divide, facilitate communication, and drive projects forward by leveraging their understanding of both sectors (Kodikara, 2021). Effective communication, project management, and leveraging social capital are critical for enhancing UICs (Seet, Jones, Oppelaar & Corral de Zubielqui, 2018; Berman, 2008). For successful UIC, universities might consider using a framework such as the one suggested by Awasthy, Flint, Sankarnarayana and Jones (2020) that considers various factors and best practices.

Table 4
UIC success factors and strategies for enhancement

Category	Success Factor/Strategy	Citations
Key factors for successful UIC	Stakeholder trust and respect	Littleton et al., 2023; Plewa et al., 2013; Kodikara, 2021; Wohlin et al., 2011
	Business alignment and market orientation	Littleton et al., 2023; Plewa and Quester, 2006
	Mutual benefits	Littleton et al.,2023
	Shared values and goals	Littleton et al., 2023; Plewa et al., 2013
	Innovation focus	Littleton et al., 2023
	Buy-in and support from management	Wohlin et al., 2011
	Short-term results for the industry	Wohlin et al., 2011
	Importance of champions	Kodikara, 2021; Wohlin et al., 2011.
Organizational strategies for UIC enhancement	Outsourcing technology transfer offices	Nugent and Chan, 2023
	Creating supportive entities (e.g., enterprise hub)	Evans and Miklosik, 2023
	Engaging intermediary or boundary-crossing organizations	Kilpatrick and Wilson, 2013; Walden et al., 2018
	Establishing collaborative research centers	Garrett-Jones, Turpin and Diment, 2010
Policy and institutional strategies for UIC enhancement	Government initiatives (e.g., IP Framework)	George and Tarr, 2024; Cetindamar et al., 2024
	Addressing institutional factors (e.g, supportive policies)	Evans and Miklosik, 2023; Giunti and Duberley, 2023
	Tailored support mechanisms	Holley and Watson, 2017; Giunti and Duberley, 2023
	Leveraging social capital	Seet et al., 2018; Wardale and Lord, 2016; Giunti and Duberley, 2023; Awasthy et al., 2020
	Expanding research scope	Ross, 2015
Educational and cultural strategies for UIC enhancement	Developing entrepreneurship education	Nguyen, Maritz and Millemann, 2022
	Reframing academic entrepreneurship under the lens of	Giunti and Duberley, 2023

Category	Success Factor/Strategy	Citations
	social entrepreneurship	
	Developing relevant competencies	Sohal, 2013
	Improving communication and project management	Berman, 2008; Nnanna Charles, Noble, and Keast, 2024

The role of government and funding

Government policy and funding play a key role in shaping the landscape of UIC in Australia. Various contextual factors, including disciplinary and national contexts, institutional policies, and government initiatives, heavily influence the success of these collaborations.

At the federal level, the Australian government has implemented several key programs to promote UIC. The Cooperative Research Centers (CRC) program is a significant initiative to develop long-term, sustainable relationships between industry and academic institutions (Sinnewe et al., 2016). This program has been instrumental in creating collaborative research environments. Still, it has also had its challenges, including the sustainability of these collaborations beyond the initial funding period (Sinnewe et al., 2016) and the challenge of operating within an organizational cultural paradox as a hybrid industry-research organization (Hayes and Fitzgerald, 2007).

Another critical federal initiative is the Australian Research Council (ARC) Linkage Projects. These projects are designed to encourage collaboration between higher education researchers and industry partners (Cherney, 2015). Linkage projects have improved communications between academia and industry and provided the industry with a research capacity they otherwise would not have (Cassity & Ang, 2006). Linkage projects were not used by all universities and organizations at the same rate. Research showed that at least in early years for universities, the chances of collaboration were higher when approaching industry partners with high R&D expenditure and high revenue (Maldonado & Brooks, 2004).

The effectiveness of these government initiatives in promoting innovation and collaboration has been demonstrated in several studies. For instance, a comparative analysis of two Australian funding programs showed that university inventors awarded targeted grants for UIC had greater patent activity than those awarded non-targeted grants (Nugent, Chan & Dulleck, 2022). This suggests that targeted grants are more effective in promoting innovation that leads to patentable outcomes. A study of CSIRO as a public research institute showed the importance of balanced funding, combining government block grants with competitive and industry-based funding that allows such institutes to engage in long-term research and short-term industry projects (Intarakumnerd & Goto, 2018).

At the state level, policies have also played a crucial role in creating conditions that are helpful for investment in new research institutes. The study by Dodgson and Staggs (2012) highlighted the importance of the policy context at both the Federal and State levels. For example, the Smart State policy of Queensland was instrumental in fostering the development of the Smart State Institutes at the University of Queensland (Dodgson & Staggs, 2012). Another example is the Gold Coast Pacific Innovation Corridor in Queensland, which was seen more as a promotional label with modest achievements (Couchman, McLoughlin & Charles, 2008). A more positive example is Brisbane as a creative industries city. An examination of the Triple Helix model (university-industry-government relationships) in the case of Brisbane revealed diversified interactions and significant UIC that was facilitated by context-specific

government interventions (Wang, Hearn, Mathews & Hou, 2024). Several science and technology parks have been created over the years, mainly with some support from state governments. An old study showed that these parks stimulate various links between businesses, government, and universities, and companies located in these parts were likely to be more innovative (Mitra, 2000)

Despite various initiatives, Australia's innovation policy has faced criticism for its lack of place-based mechanisms to achieve effective UIC (Kilpatrick & Wilson, 2013). Some studies (e.g., Harman, 2010) have noted the need for increased government investment in research commercialization, particularly in areas like pre-seed and proof of concept funding. However, in more recent years, such funding has increased. The effectiveness of government programs has been mixed, with some studies suggesting that less than 50% of respondents rated most government programs as highly effective (Harman, 2010).

These challenges highlight the importance of understanding the broader context in which UIC operates. Giunti and Duberley (2023) argue that disciplinary, national, and institutional contexts influence the success of UICs. Academics in fields with strong industry ties (e.g., biotechnology) tend to be more open to entrepreneurship than those in fundamental sciences (e.g., physics). Seniority also plays a role, as Gallagher et al. (2023) found that more senior chemists and those with more experience became more involved in direct research contracts with industry. Additionally, institutional policies and support structures are essential in supporting entrepreneurial identities among academics. Universities that align their policies with collaborative goals and create supportive environments are more likely to promote successful UICs and address some of the shortcomings observed in current government initiatives.

Future directions in UIC

As the approaches to UIC evolve in Australia, several emerging trends are shaping its future towards a more integrated, technologically advanced, and regionally focused model.

The growing importance of place-based innovation systems is recognized, with an increasing need for mechanisms supporting regional innovation ecosystems (Kilpatrick & Wilson, 2013). This shift could lead to more targeted collaborations that address local needs and contribute to national innovation goals.

The concept of knowledge co-production is gaining traction as an effective collaboration model. It represents a shift from traditional knowledge transfer to a more integrated approach (Cherney, 2015; McGrath-Champ et al., 2022). A McCabe, Parker, Osegowitsch, and Cox (2023) showed that, although structural differences, mismanaged conflict, and traditional views on knowledge can act as barriers for knowledge co-production, the notion of ‘academic cultivation’ can help overcome obstacles. Academic cultivation is where academics actively shape practitioner engagement by developing their research capacity, legitimizing their roles in projects, and conditioning their understanding of the research process.

Emerging technologies, such as Additive Manufacturing, create new collaboration opportunities, particularly for SMEs, potentially democratising access to advanced R&D capabilities (Walden et al., 2018). The development of predictive models to assess the likelihood of successful UICs, as demonstrated in the construction industry, represents another exciting frontier (Sutrisna, Tjia & Wu, 2021). There's also growing interest in expanding collaborations beyond traditional industry partnerships. Academics increasingly engage with

diverse stakeholders, including trade unions, to influence policy and achieve societal impact (McGrath-Champ et al., 2022).

Research commercialization

Research commercialization in Australia has attracted less research attention, even though, similar to UIC, it has become an increasingly important focus for Australian universities. This criticism of Australian universities for their low proficiency in commercializing research highlights the growing emphasis on commercial outcomes. Also, it reveals a false assumption that the commercialization value of research is the same as academic productivity. An early study by Zhao (2004, 223) concluded that universities needed to address two fundamental issues concerning research commercialization: "i) adequate financial support from governments, industries, and other stakeholders; and (ii) effective innovation management with academic entrepreneurship".

To address these challenges, many Australian universities have established University Commercialization Offices. These offices connect academia and industry and operate in a distinct environment that blends the characteristics of both sectors (Gao & Haworth, 2019). A study of two commercialization offices in Australia identified two different strategic models that reflect different approaches universities take to balance their commercial objectives with their broader societal role. The models are the 'service-provider' and the 'relationship-builder' (Gao & Haworth, 2016).

According to Gao and Haworth (2016), the service-provider model focuses on providing commercial services to the university, including course development, consulting, IP management, and commercial research advice. Its primary aim is to enhance the university's economic bottom line. On the other hand, the relationship-builder model prioritizes knowledge exchange over commercialization revenues, and it emphasizes innovation, publicity, and promoting relationships between academics and industry partners. The choice of model is influenced by factors such as university leadership, CEO ideology, and academic support. Commercialization offices face challenges such as difficulty recruiting staff with both industry experience and an understanding of the educational environment (Gao & Haworth, 2019). They also need to manage the two sectors' different expectations and communication styles. Some have suggested that a national technology transfer office, similar to the German model, might be more suitable for Australia (Mondschein, Roy & Naidoo, 2021).

One of the primary challenges in this area is aligning academic and industry goals. There are often tensions between approaches that focus on research commercialization and those that acknowledge the broader activities of universities (Gaze & Stevens, 2011). This tension can lead to policies prioritizing commercial benefit, reinforcing existing disadvantages for certain academic staff, and undervaluing work towards public or community benefit.

Another significant challenge is measuring and evaluating knowledge transfer activities. Measuring these activities is inherently difficult, particularly in balancing the assessment of qualitative and quantitative aspects (Gaze & Stevens, 2011). Focusing solely on measurable, commercial outcomes can lead to undervaluing other critical aspects of knowledge transfer that contribute to societal and community welfare.

To increase the efficacy of programs that commercialize technological innovations, one must understand the factors influencing university patent holders to engage in entrepreneurial activities, including entrepreneurial attitudes, economic personal situations, and the operating

environment (Dottore & Kassicieh, 2014).

Discussion

Our review of research on UIC and research commercialization sheds some light on the complex landscape of UIC and research commercialization in Australia. Although collaboration with industry offers significant opportunities for innovation and practical application of research, it also presents challenges such as aligning academic and sector goals, managing intellectual property, and ensuring adequate funding. Effective communication and trust-building are vital. It is also necessary for academics to adapt to more entrepreneurial roles. Figure 3 illustrates the benefits, challenges, and enhancement strategies identified in the literature with UIC.

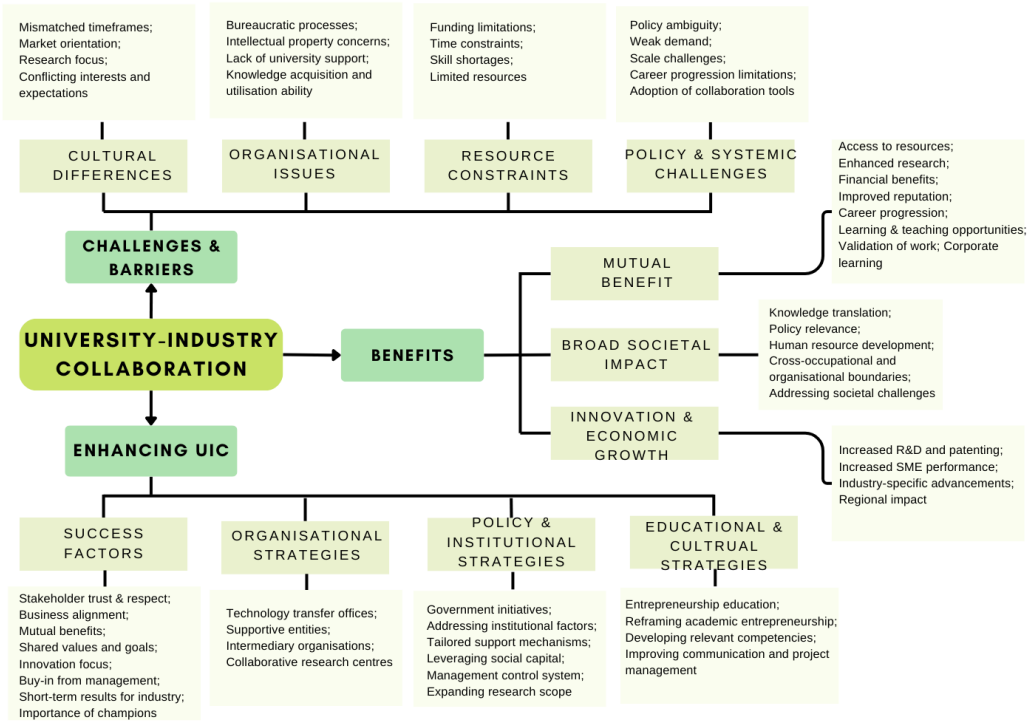

Figure 3: Benefits and challenges of university-industry collaboration and strategies for enhancement

Research commercialization in Australia faces diverse and complex challenges, including IP management, legal hurdles, funding constraints, institutional readiness, and broader policy issues. As several studies pointed out, a key challenge in research commercialization in Australia is translating academic research into market-ready products and services (Harman, 2010; Harman and Stone, 2006; Cherney, 2015; Dang, 2019). There are often significant gaps between academic research outputs and the practical needs of the industry (McGrath-Champ et al, 2022). This gap is further worsened by issues related to intellectual property rights and the bureaucratic hurdles in commercializing research (Berman, 2008; Walden et al., 2018). Funding constraints and inadequate support structures within universities are also significant barriers (Gunasekara, 2006b). Addressing these challenges requires a complex approach that includes reforming institutional structures, developing supportive policies, and building the capacity of researchers. Critically, the balance between commercial viability and the fundamental ethos of academic research must be managed carefully to ensure that commercialization efforts do not

undermine the integrity and purpose of scholarly inquiry.

Australian universities could benefit from adopting strategies and frameworks that have been successful in other countries, such as the United States and parts of Europe. In these regions, UICs and research commercialization are more deeply integrated into academic culture (Couchman, McLoughlin & Charles, 2008; Garrett-Jones, 2007). However, Australia's unique economic, cultural, and policy environment significantly influences its approach to commercialization and collaboration. When leveraging specific government initiatives and financial conditions, it is essential to understand these local subtleties and customize approaches accordingly. Australia faces unique challenges in research commercialization, such as geographical isolation, smaller market size, and different industry structures. This means that adopting models from other countries is not straightforward. For instance, adopting the same reward model for relationships with industry used in the USA (originated by the Bayh Dole Act) had marginal success in Australia because the legal framework in Australia is different (Mendes & Liyanage, 2002). There might be a need for tailored strategies that consider contextual factors. Learning from global best practices, while also considering the unique Australian context, can guide the development of a more effective strategy for research commercialization.

There is a clear need for policies that are better aligned with commercialization's practical needs. Even universities' IP policies can benefit from further clarity (Jamali, 2024). As past legal cases show (e.g., Vines & Faunce, 2008), there are challenges that policy developers need to overcome to balance between private interests and public good. National and institutional policies should better incentivize collaboration. They should also support intermediary organizations. Commercialization activities need to be recognized in academic evaluations. There must be a balance between facilitating commercialization and maintaining academic integrity and freedom. Policies should ensure that pursuing commercial interests does not compromise the fundamental missions of teaching and research.

Although there are already some funding schemes, such as the ARC funding for Linkage projects that support UIC and funding for commercialization activities, UIC can benefit from an increase and diversification. There should be incentives for industry partnerships and streamlined processes for technology transfer and IP management. Moreover, the effectiveness and success of the existing funding schemes have varied because they depend on various factors. These factors include disciplinary contexts, institutional policies, and the alignment of government programs with the needs of both academic and industry partners. To develop effective funding models, these factors need to be better understood.

The review of the literature highlights a few areas that can benefit from further research, as we discuss below:

- Long-term impact assessment: Although studies have been conducted on the impact of UIC on areas such as policy (McGrath-Champ et al., 2022) or patenting (Nugent et al., 2022), longitudinal studies are needed to evaluate the long-term impacts of UICs on innovation, economic growth, societal benefits, and research commercialization outcomes. Moreover, comprehensive metrics or frameworks must be developed to assess the quality and effectiveness of UICs beyond traditional measures.
- Discipline-specific collaboration models: Differences in disciplinary norms and characteristics mean that no one UIC model fits all disciplines. While a few studies have looked at specific disciplines, such as social sciences (Cherney, 2015), more studies are needed across

academic disciplines to develop suitable collaboration strategies.

- Cultural change strategies: Cultural differences between academia and industry are significant (Berman, 2008), and entrepreneurial culture is missing from universities' strategic plans (Nguyen et al., 2022). Therefore, in-depth studies on effective strategies for promoting cultural change within academic and industry settings will help encourage collaboration.
- Gender and diversity in UIC and research commercialization: While a few studies (e.g., Gaze & Stevens, 2011) have examined gender and diversity, more studies are needed to develop strategies to promote inclusive collaboration.
- Policy effectiveness: Comparative studies on the efficacy of different policy instruments in promoting UIC and research commercialization across various Australian states and territories can better inform policy development.
- Knowledge co-production and transfer models: Knowledge co-production (Cherney, 2015; McGrath-Champ et al., 2022) has not been adequately researched, and the implementation and outcomes of its various models in the Australian context require further research.
- Regional innovation ecosystems: regional areas play an essential role in the Australian economy, especially as seven universities are in the Regional Universities Network. While a few studies (Couchman, McLoughlin & Charles, 2008; Gunasekara, 2006a; Garrett-Jones, 2007; Kilpatrick & Wilson, 2013) have looked at some specific aspects of UIC and commercialization with regional areas, there should be more in-depth studies on the development and sustainability of regional innovation ecosystems.
- Internationalization of UIC: research, perhaps comparative studies, is needed to inform how Australian UICs can effectively engage with international partners and integrate into global innovation networks.
- University Accelerators and Innovation Districts: University accelerators (Maritz et al., 2021; Maritz et al., 2023) and innovation districts (Pancholi et al., 2020) are relatively new initiatives, and their role and effectiveness, including their impact on regional development and student entrepreneurship, need to be studied.
- Only two studies focused on technology transfer managers and offices (Derrick, 2015) and managers (Harman and Stone, 2006). Given their critical role in commercialization and the need for better human resource management in these offices, research needs to examine the career trajectories, skills development, and impact of these managers and officers on research commercialization outcomes.

Conclusion

The Australian higher education sector has made progress in promoting collaborations with industry partners and commercializing research outcomes. This is evidenced by establishing various organizational structures such as Cooperative Research Centers, university commercialization offices, and university accelerators. These initiatives have helped enhance innovation, knowledge transfer, and economic growth. However, ongoing challenges exist, including cultural differences between academia and industry, resource constraints, and the need for more effective policy frameworks to support collaboration and research commercialization activities.

We can recommend some specific actions for key stakeholders based on the findings. However, when suggesting actions, we need to bear in mind that these challenges and

opportunities are shaped by Australia's unique context, including its geographical isolation, relatively small domestic market, intense but geographically concentrated research base, and the dominance of SMEs in its business landscape. All of these necessitate tailored approaches to university-industry collaboration and research commercialization. The government needs to develop more refined and flexible funding models that account for disciplinary differences and encourage long-term collaborations. Universities should focus on creating more robust support structures for commercialization, including specialized training for academics and reforms to promotion criteria that recognize collaborative and entrepreneurial activities. Industry partners, particularly SMEs, should be encouraged to engage more proactively with universities through targeted incentive programs or simplified collaboration frameworks. All stakeholders should work towards developing a shared understanding of success metrics that go beyond traditional measures like patents and publications and include broader societal impacts.

The future of university-industry collaboration and research commercialization in Australia depends on addressing several key areas. There is a pressing need for refined approaches to measure the impact of collaborations, particularly in capturing non-commercial benefits to society. The development of place-based innovation systems and integration of universities into regional innovation ecosystems provide promising avenues for enhancing the relevance and impact of academic research. Additionally, supporting a culture of entrepreneurship at universities, improving human resource management practices in commercialization offices, and developing more flexible collaboration models with SMEs are essential for future development. Addressing the existing challenges combined with targeted policy interventions will maximize the benefits of academic research, drive innovation, enhance global competitiveness, and support sustainable economic growth across the nation.

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Appendix A:

The query used for the literature search in Web of Science

(TS=((universit* OR academi* OR "higher education institution*" OR facult*) NEAR/5 (business OR industr* OR firm OR firms OR "small-medium enterprise" OR "small medium enterprise*" OR SME OR "small-medium firm*" OR "small medium-sized enterprise*" OR "small firm*" OR "medium firm*") NEAR/5 (alliance* OR collaboration* OR cooperation* OR relation* OR link* OR bridge* OR interaction* OR partnership* OR commerciali?ation)) and TS=(Australia*)) OR (TS=((universit* OR academi* OR "higher education institution" OR facult*) NEAR/5 ("technology transfer" OR "technology commerciali*" OR "technology licensing" OR KT OR "knowledge transfer" OR entrepreneu* OR "third mission" OR "third stream" OR "fourth mission" OR "third stream activiti*" OR "third objective" OR "third task" OR commerciali?ation* OR innovation* OR spillover OR "spin?off*" OR incubator* OR "spin?out*")) and TS=(Australia*)) OR (TS=(research near/3 commerciali* NEAR/5 universit*) and TS=(Australia*))

Appendix B:

The query used for the literature search in Scopus

(TITLE-ABS-KEY ((universit* OR academi* OR "higher education institution*" OR facult*) W/5 (business OR industr* OR firm OR firms OR "small-medium enterprise" OR SME OR "small medium enterprise*" OR "small-medium firm*" OR company OR companies OR organization OR "small medium-sized enterprise*" OR "small firm*" OR "medium firm*") W/5 (alliance* OR collaboration* OR cooperation* OR contract OR relation* OR link* OR bridge* OR interaction* OR partnership* OR commerciali?ation)) AND TITLE-ABS-KEY (australia*)) OR (TITLE-ABS-KEY ((universit* OR academi* OR "higher education institution" OR facult*) W/5 ("technology transfer" OR "technology commerciali*" OR "technology licensing" OR kt OR "knowledge transfer" OR entrepreneu* OR "third mission" OR "third stream" OR "fourth mission" OR "third stream activit*" OR "third objective" OR "third task" OR commerciali?ation* OR innovation* OR "spin?off*" OR incubator* OR spillover* OR "spin?out*")) AND TITLE-ABS-KEY (Australia*)) OR (TITLE-ABS-KEY (research W/3 commerciali* W/5 universit*) AND TITLE-ABS-KEY (Australia*))