



How Public Funding Shapes University–Industry Collaboration Outcomes: A Systematic Review and Research Agenda

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Abstract: University-industry collaboration (UIC) plays an important role in regional and national innovation systems, and the relevance of funding in promoting such collaboration has been widely recognized in literature. However, the specific contribution of public resources to UIC outcomes remains underexplored. This study conducts a systematic literature review to address this gap, starting from an initial sample of 2,644 articles and narrowing it down to 25 empirical studies that explicitly examine the relationship between public funding and UIC outcomes. The findings indicate that funding generally exerts a positive influence on several dimensions of collaboration, including the performance of universities and firms, as well as the efficiency of knowledge transfer. Nevertheless, a key limitation of the current literature is the frequent lack of differentiation between public and private funding sources when analyzing their respective impacts on UIC. This study contributes by mapping existing research streams and proposing directions for future studies aimed at advancing the understanding of how specific public resources shape the outcomes of UIC.

Keywords: University-Industry Collaboration; Public Funding; Financial Resources.

Código JEL: O3

Área Temática: Redes e sistemas urbanos, regionais e nacionais

Como o Financiamento Público Molda os Resultados da Colaboração Universidade–Indústria: Uma Revisão Sistemática e Agenda de Pesquisa

Resumo: A colaboração universidade–indústria (UIC) desempenha um papel importante nos sistemas regionais e nacionais de inovação, e a relevância do financiamento para a promoção desse tipo de colaboração tem sido amplamente reconhecida na literatura. No entanto, a contribuição específica dos recursos públicos para os resultados da UIC permanece pouco explorada. Este estudo realiza uma revisão sistemática da literatura para enfrentar essa lacuna, partindo de uma amostra inicial de 2.644 artigos e restringindo-a a 25 estudos empíricos que examinam explicitamente a relação entre o financiamento público e os resultados da UIC. Os achados

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indicam que o financiamento, de modo geral, exerce uma influência positiva sobre diversas dimensões da colaboração, incluindo o desempenho de universidades e empresas, bem como a eficiência da transferência de conhecimento. Ainda assim, uma limitação central da literatura existente é a frequente ausência de diferenciação entre fontes de financiamento público e privado na análise de seus impactos sobre a UIC. Este estudo contribui ao mapear os principais fluxos de pesquisa existentes e ao propor direções para estudos futuros voltados ao aprofundamento da compreensão de como os recursos públicos moldam os resultados da colaboração universidade-indústria.

Palavras-Chaves: Colaboração Universidade-Indústria; Financiamento público; Recursos financeiros.

1. Introduction

University-industry collaboration (UIC) refers to the strategic partnership between higher education institutions and firms, aiming at the exchange of knowledge, resources, and competencies to foster innovation, technological development, and competitiveness (Sjöö; Hellström, 2019). This partnership enables universities to share their expertise and resources with firms, facilitating the transformation of academic research into practical applications (Tseng et al., 2020). At the firm level, UIC can contribute to enhanced innovative performance, productivity gains, access to specialized scientific knowledge, and the reduction of technological and market uncertainties, particularly in contexts characterized by rapid technological change.

Moreover, it is important to acknowledge that the outcomes of UIC are not limited to immediate or final innovation results, such as new products, processes or patents. Depending on the type of interaction channel adopted, including joint research projects, contract research, consultancy, training programs, or informal knowledge exchanges, UIC may also generate intermediate outcomes for firms. These outcomes include the development of absorptive capacity, learning routines, and internal capabilities for innovation, which are critical for sustaining long term competitive advantage.

Despite the substantial contributions of UIC to firms' innovation and performance (Yin et al., 2023), several challenges pose significant obstacles to this relationship, including cultural differences, divergent objectives, communication barriers, and funding constraints (Liu et al., 2019; O'Dwyer et al., 2023). Models such as the Triple Helix, which promotes dynamic interactions among universities, industry, and government, have demonstrated effectiveness in mitigating these challenges (Rantala et al., 2021). More recently, the Quadruple Helix model has extended this approach by incorporating civil society and other societal actors, thereby contributing to greater social legitimacy, closer alignment with societal demands, and a stronger impact of UIC initiatives (Shin et al., 2023).

In this context, funding plays a crucial role in enabling and sustaining UIC by providing essential resources to develop joint projects, conduct applied research, and facilitate innovation and technology transfer (Tseng et al., 2020). Without adequate financial support, some collaborative initiatives may become unfeasible or fail to achieve their expected result, particularly in sectors that require significant investments in infrastructure, equipment, and personnel training (Tartari; Breschi, 2012). Moreover, financial pressures and access to external funding can influence both the extent and nature of UIC in research and development (R&D) activities (Cunningham; Link, 2015).

From this perspective, public funding mechanisms, such as subsidies and tax incentives, are often employed to mitigate the inherent risks of innovation and to encourage firms to engage in collaboration with universities. Public support for private-sector research, for example, is justified when market failures are present (Szücs, 2018). However, as Nelson (1959) highlighted, the social value of R&D often exceeds its private returns. This discrepancy arises because research outcomes can be uncertain, unpredictable, and difficult to appropriate exclusively, enabling other firms to benefit without incurring the initial investment. Additionally, the time lag and uncertainty between research efforts and the eventual creation of a marketable product may discourage private investment. Consequently, public investment in UIC projects can promote the generation of knowledge and innovations that benefit multiple actors across society.

Despite the potential of public resources to foster UIC, few studies have explicitly examined its influence on UIC outcomes, including firms' innovation outputs, the overall performance of collaborative efforts, and the quality of the results. This study addresses precisely this gap in the literature by analyzing how public resources effectively influence the outcomes of UIC. To this end, we conducted a systematic literature review following the guidelines of Tranfield et al. (2003) and guided by three research questions (RQ):

RQ1: What is the role of public resources in UIC?

RQ2: Through which mechanisms does public funding shape UIC outcomes at the firm and university levels?

RQ3: What gaps, limitations, and future research opportunities emerge from the existing literature on public funding and UIC outcomes?

The findings reveal the multifaceted role of public funding in UIC. Beyond alleviating financial constraints, public resources also exert an indirect effect on the outcomes of collaboration. This study

contributes to a deeper understanding of how public funding can be strategically leveraged to enhance the benefits of UIC and promote innovation.

This study contributes in two main ways. First, it advances the literature on UIC by systematically synthesizing empirical evidence on the role of public funding in shaping UIC outcomes, with particular attention to the mechanisms through which public resources influence both intermediate and final results at the firm and university levels. By distinguishing public funding from other sources of financial support, this review addresses an important gap in existing research and provides an integrative framework that organizes current findings and identifies key research streams and unresolved issues. Second, this study contributes to practice and policy by offering insights into how public funding instruments can be more effectively designed and implemented to enhance the performance and impact of UIC initiatives. The findings provide guidance for policymakers, funding agencies, and university and firm managers seeking to leverage public resources to foster innovation, knowledge transfer, and sustainable collaboration outcomes.

2. Literature background

UIC is a key element of both regional and national innovation systems (Hajrizi; Shaqiri, 2024a). Previous research indicates that financial resources, particularly public funding, can reduce the inherent risks of collaborative innovation and encourage long-term partnerships between universities and firms (Szűcs, 2018). In European Union countries, programs such as Horizon Europe encourage transnational partnerships between universities and firms by providing grants for applied research and technological innovation projects (Robinson et al., 2021). In China, government subsidies act as an implicit guarantee for UIC, increasing firms' willingness to invest in R&D and stimulating innovation partnerships (Jing, 2024). In Brazil, public funding is likewise often coordinated by state agencies with the objective of enhancing industrial competitiveness and strengthening scientific capacity (Bürger; Fiates, 2024; Laplane, 2024; de Santana et al., 2019).

Nevertheless, despite the extensive and growing literature on UIC, which includes numerous studies on public investments aimed at fostering and strengthening partnerships between universities and industry, less attention has been paid to understanding the effects of public resources on UIC outcomes.

According to Xia and Jia (2023), government innovation subsidies positively influence the outcomes of cooperative projects by removing financial barriers and facilitating access to technological and human resources. Another recent study provides evidence that public funding significantly fosters the outcomes of UIC by reducing transaction costs and alleviating risk exposure for firms, particularly Small and Medium-sized Enterprises (SMEs) (Hajrizi; Shaqiri, 2024b).

On the other hand, public funding can have limited or adverse effects on UIC projects. To comply with public policies that often prioritize projects yielding quick and measurable results, UIC initiatives may focus on short-term outcomes and low-quality innovation. This tendency can lead firms to prioritize less complex and lower-risk projects to secure funding, potentially resulting in superficial collaborations or partnerships with limited innovative values (Xia; Jia, 2023). Thus, while public funding can stimulate innovation, firms may also use these resources for ordinary activities rather than engaging in effective innovation; this occurs because some firms place excessive importance on cost minimization at the expense of value co-creation with other organizations (Wang et al., 2020; Bertello et al., 2022). From an economic perspective, we understand that this dynamic may also reflect problems of information asymmetry between funding agencies and recipient firms, resembling what is understood as a "market for lemons" situation (Akerlof, 1970).

In this regard, the diversity of public funding instruments, organizational and academic contexts, and sectoral specificities and countries contexts complicates the identification of clear causal relationships between public funding and UIC outcomes. This lack of consensus underscores the need for more nuanced investigations that account for the heterogeneous nature of UICs and the varied roles public resources may play in shaping their outcomes.

3. Method

This study consists of a systematic literature review, following the protocol proposed by Tranfield et al. (2003). The review began with the delimitation of the research topic, through an exploratory analysis of the field aimed at formulating the research questions. Subsequently, the process involved the identification and collection of literature aligned with the study's objective. The documents identified were retrieved from the databases, and duplicate records were removed.

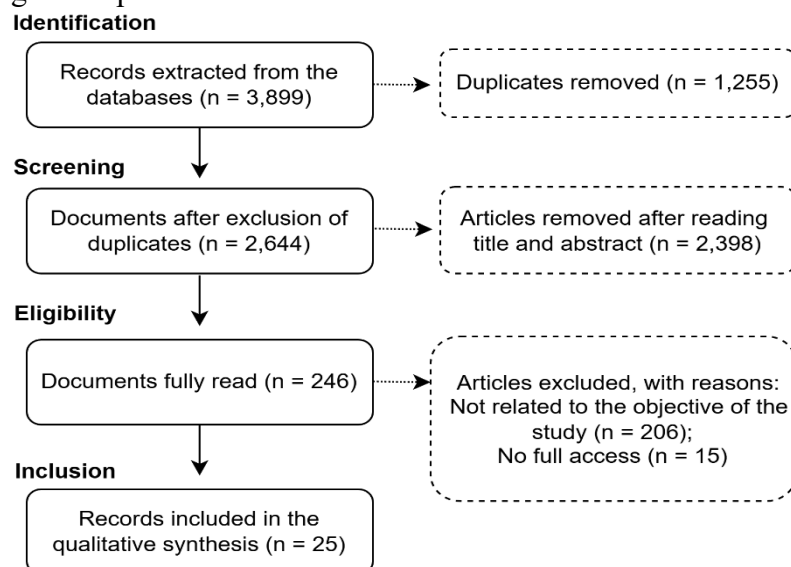
The Scopus and ISI Web of Science Core Collection databases were selected, as they are two of the leading indexed sources in the field of study. The documents were exported in June 2025. Table 1 presents the search string, filters, and selection criteria.

Table 1 - Search and Selection Criteria

Criteria	Attributes
Databases	Scopus and Web of Science
Search string	((“university-industr*” OR “university-compan*” OR “university-firm*” OR “university-enterprise*” OR “university-academ*” OR "academia-industr*") AND ("outcome*" OR "result*" OR "performance" OR "indicator*") AND ("financ*" OR "fund*" OR "support*"))
Filters	Includes Title, Abstract and Keywords
Time span	No limitation
Document Type	Peer-reviewed articles
Language	English, Portuguese, and Spanish
Inclusion criteria	Studies that present public funding in hypotheses or propositions and relate it to some element of UIC; studies that quantitatively analyze the use of public resources in UIC; studies that qualitatively analyze the use of public resources in UIC.
Exclusion criteria	Studies that do not include public funding in their hypotheses or propositions, nor relate public funding to UIC in qualitative or quantitative analyses; studies that discuss public funding in hypotheses or propositions but do not connect it to any element of UIC; studies analyzing funding sources that are neither governmental nor public agencies; studies examining funding in contexts other than UIC; editorials, conference proceedings, book chapters, and other document types were excluded; documents without full access were also excluded.

Out of the initial sample of 2,183 papers from Scopus and 1,716 from the Web of Science database, 246 documents remained after duplicate removal and a preliminary screening of titles and abstracts. These pre-selected documents were then read in full, and those deemed relevant were included for data extraction and the qualitative synthesis of results. After applying the predefined selection criteria, a total of 25 studies were retained, from which the findings were synthesized according to the previously formulated research questions. Figure 1 presents the methodological steps.

Figure 1 - Methodological steps



The selected records were tabulated in a Microsoft Excel spreadsheet for organization and information extraction. The articles were analyzed independently by two authors, and any doubts were discussed with a third author. The research team consisted of two postdoctoral researchers, one CNPq technical support fellow, and a senior researcher who coordinated the study.

4. Results

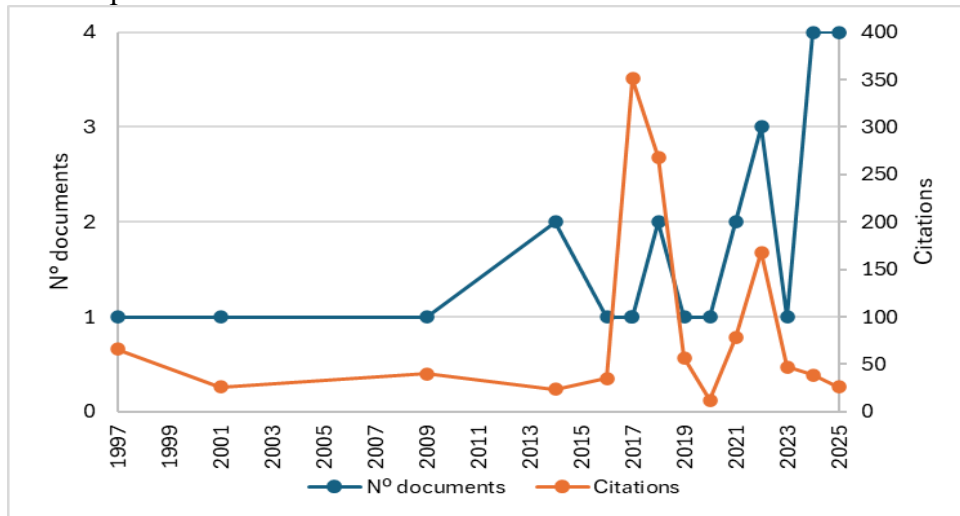
This section presents the main findings of the literature review. The results are organized into four parts: (i) bibliometric analysis, (ii) impacts of public funding on UIC outcomes, (iii) main public funding mechanisms in UIC, and (iv) macro- and micro-level outcomes of public funding in UIC.

4.1 Bibliometric Performance Analysis

Figure 2 presents the number of publications and citations of the articles identified through systematic literature review. The earliest study included in this review addressing the role of public funding in UIC was conducted by Geisler (1997), which examined common myths surrounding cross-sectoral technological cooperation. One article from 2001 (Bagchi-Sen et al., 2001) and another from 2009 (Hu, 2009) were also identified. In 2014, two articles on the topic were published (Blume-Kohout et al., 2014; Alves & Pimenta-Bueno, 2014). Overall, the volume of studies investigating UIC has remained relatively low over time, reaching a peak of four articles published in each of the years 2024 and 2025. The studies identified on public funding for UIC were published across 21 journals. The journals with the highest number of studies are Technological Forecasting & Social Change, the Journal of Technology Transfer, and Technovation, each featuring two articles.

In terms of citations, collectively the 25 articles received 1,237 citations (Google Scholar, January 19, 2026). The most cited study was Guerrero and Urbano (2017) with 351 citations, followed by Szücs (2018) with 237 citations and Song et al. (2022) with 127 citations. Articles published more recently tend to have fewer citations, likely due to their limited time since publication.

Figure 2 - Number of publications and citations over time.



The findings indicate that various UIC outcomes are influenced by public funding. These effects range from the role of public resources in initiating UICs (Geisler, 1997) to their impact on process and product innovation (Puffal et al., 2021), the efficiency of R&D collaboration (Cheng et al., 2020; Hou et al., 2021), and sustainable innovation (Song et al., 2022).

Table 2 presents a structured overview of the methodological characteristics and empirical scope of the studies included in the review. The evidence indicates a strong predominance of empirical research, with only a limited number of theoretical or modeling contributions. Quantitative approaches prevail, frequently relying on econometric analyses, regression models, and efficiency-based techniques, while qualitative or mixed-method designs appear less frequently. In terms of geographical distribution, the studies are concentrated in a relatively small set of contexts, particularly China and Brazil, alongside

selected cases from Europe and Asia, suggesting a geographically uneven development of the literature on public funding and university–industry collaboration (UIC).

Regarding sectoral scope, most studies adopt a multisectoral perspective or focus on institutional actors such as universities, rather than examining specific industries. Only a small number of contributions provide sector-specific analyses, which may limit the understanding of how public funding mechanisms operate under distinct technological and industrial conditions.

Table 2 – Article nature, method, country and sector

Article	Nature	Type of Method	Country	Sector
Geisler (1997)	Theoretical	Conceptual/analytical	—	—
Bagchi-Sen et al. (2001)	Empirical	Regional quantitative	Canada	Biotech
Hu (2009)	Empirical	Econometric	Taiwan	Multisectoral
Blume-Kohout et al. (2014)	Empirical	Longitudinal econometrics	USA	Multisectoral
Alves & Pimenta-Bueno (2014)	Empirical	Case study/qualitative	Brazil	Multisectoral
Kyung et al. (2016)	Empirical	Quantitative (mediation)	South Korea	Universities
Guerrero & Urbano (2017)	Empirical	Quantitative	Mexico/Spain	Multisectoral
Henry Junior & Odei (2018)	Empirical	Logistic regression (CIS)	Central and Eastern Europe	Multisectoral
Szücs (2018)	Empirical	Matching + DiD	European Union	Multisectoral
Fan et al. (2019)	Empirical	PLS-SEM	Taiwan	Universities
Cheng et al. (2020)	Empirical	SFA + threshold model	China	Multisectoral
Hou et al. (2021)	Empirical	DEA + bootstrap regression	China	Universities
Puffal et al. (2021)	Empirical	Regression	Brazil	Multisectoral
Song et al. (2022)	Theoretical modeling	Stackelberg model	—	—
Nugent et al. (2022)	Empirical	Longitudinal patent analysis	Australia	Universities
Zhang & Wang (2022)	Empirical	DEA + spatial model	China	Multisectoral
Figueiredo et al. (2023)	Empirical	Quantitative	Brazil	Multisectoral
Mascarenhas et al. (2024)	Empirical	Quantitative	Brazil	Multisectoral
Khachatryan et al. (2024)	Empirical	Quantitative	Japan/Asia	Multisectoral
Jing (2024)	Empirical	Quantitative	China	Multisectoral
Oliveira & Garcia (2024)	Empirical	Quantitative	Brazil	Multisectoral
Sitenko (2025)	Empirical	Descriptive + institutional analysis	Kazakhstan	Innovation system
Ushimaru et al. (2025)	Empirical	Quantitative	Japan	Multisectoral
Jonbekova et al. (2025)	Empirical	Survey	Central Asia	Multisectoral
Abu Sa'a & Asplund (2025)	Empirical	Quantitative	Middle East	Multisectoral

4.2 Impacts of Public Funding on UIC outcomes

One effective way to foster UIC is through public or private funding. However, the effects of these resources are distinct. Public funding serves as a catalytic prerequisite capable of attracting private investment and aligning the interests of universities and firms, whereas private funding acts as a complementary mechanism to address specific technological gaps (Hu, 2009). In this context, public resources allocated to R&D are frequently described as catalytic elements in the formation of UIC and as a key driver of research and technology transfer (Bagchi-Sen et al., 2001).

Increased allocation of resources to R&D raises expectations regarding its outcomes. In this context, two-directional⁴ collaborations between universities and firms are more likely to achieve superior performance compared to unidirectional flows of resources toward universities (Lee et al., 2014). Although firms tend to prefer internal sources of funding, evidence from firm-level econometric analyses indicates that, among firms without a high-growth profile, government subsidies only exert a positive effect on innovation when combined with collaboration with universities. Specifically, regression models incorporating interaction terms between public subsidies and university collaboration show that the impact of public funding becomes statistically significant only in the presence of such collaborative arrangements (Guerrero & Urbano, 2017). Supporting this view, Szücs (2018) shows that these effects are primarily reflected in both the quantity and quality of patents and technological innovations. Moreover, risk mitigation, access to funding, and knowledge spillovers further contribute to sustainable innovation outcomes, particularly by fostering an increase in green innovation patents (Jing, 2024).

There are two main types of UIC. The first is formal and research-oriented, relying on cognitive social capital and public funding. The second is informal and networking-oriented, based on relational social capital and driven by firms' interests (Sa'a; Asplund, 2025). Both types of social capital are essential for the creation and sharing of knowledge (Sa'a; Asplund, 2025). When UIC thrives, universities benefit through enhanced research output and reputation, while industries gain access to a highly skilled workforce. Public resources play a key role in fostering UIC by directly influencing the sustainability of partnerships and the development of human capital (Jonbekova et al., 2025).

According to Mascarenhas et al. (2024), academics engage in UIC primarily for financial reasons, such as research commercialization and access to funding. Thus, in the first stage, it can be inferred that public funding indirectly increases the frequency and intensity of collaborations by attracting and retaining researchers. In a later stage, once UIC is established, it enhances the performance of applied research, fostering the generation of knowledge with commercial potential.

In the context of the medical devices sector, Ushimaru et al. (2025) show that funding originating outside the firm, particularly from government sources, plays a significant role in UIC projects aimed at developing medical devices. The project success⁵ rate increased from 25% without funding to 64.3% with funding. Among the funded projects, 33.3% resulted in academic publications, and 12.5% of the developed devices were successfully commercialized internationally. Public funding also increases the likelihood of firms establishing two-directional relationships, raising the chances of SMEs collaborating with universities by 58%, compared to 27% for other firms. As a result, two-directional relationships foster cooperation in projects that are more risky, complex, and costly, while also enhancing firms' innovative capacity and knowledge absorption (Oliveira; Castro Garcia, 2024).

Puffal, Ruffoni, and Spricigo (2021) emphasize that state support can help overcome initial barriers to cooperation, particularly in environments with low firm propensity for spontaneous innovation. Geisler (1997) also explores the role of public funding in supporting the initial phase of UIC, highlighting that although government resources may be essential to initiate and sustain partnerships, the success of UIC also depends on factors such as effective leadership and appropriate institutional arrangements.

The literature also highlights that public support influences the quality and scope of UIC outcomes, revealing a positive relationship between government-subsidized funding and both innovation performance and the implementation of UIC-related regulations (Fan et al., 2019). Additionally, there may be an increase in the number of patents filed by researchers who receive grants for UIC, particularly in the initial and final years of the funded project (Nugent et al., 2022).

By analyzing how public funding, in the form of research grants, contributes to the formation of commercial alliances between universities and firms in the biopharmaceutical sector, Blume-Kohout et

⁴ Two-directional collaborations refer to the reciprocal flow of Research and Development (R&D) activities and resources between the academic and industrial sectors, whereas unidirectional collaborations are characterized by the role of universities merely as "receiving agents" of projects and funding from firms.

⁵ In Ushimaru et al. (2025), project success is methodologically defined in the Methods section and operationalized in the Results section through objective indicators, including the successful completion of device development, the generation of academic publications, and international commercialization.

al. (2014) identify that this type of support leads to a significant, albeit modest, increase in the creation of alliances, highlighting the potential of public funding to foster closer ties between academia and industry.

Studies addressing specific contexts have found divergent results regarding UIC and its financing. In the agricultural sector of Brunei, public funding and incentives engage UIC actors and drive innovation, economic diversification, and agricultural sustainability (Haji Shahlehi et al., 2024). Conversely, evidence from Kazakhstan points to more limited and context-dependent effects of public funding on university–industry collaboration outcomes. Rather than generating sustained innovation dynamics, government commercialization grants were associated with low project implementation rates and did not translate into significant improvements in patenting activity or broader innovation indicators. The study highlights that public funding mechanisms were weakened by institutional constraints, including opaque allocation procedures, weak alignment between funded projects and national development priorities, and limited integration between universities and industrial partners. As a result, funding tended to support isolated commercialization initiatives without substantially strengthening collaborative capacity or fostering long-term knowledge exchange. These findings suggest that, in contexts characterized by fragmented innovation systems and weak governance structures, the mere availability of public financial resources may be insufficient to enhance UIC outcomes unless accompanied by stronger coordination mechanisms and clearer policy targeting (Sitenko, 2025).

Additionally, research in European Union countries has shown that wealthier nations benefit more from public funds for UIC, which may hinder the development of collaborative capacities in less advantaged countries (Azagra-Caro et al., 2010).

On the other hand, the efficiency and sustainability of these interactions depend on the adequacy of funding policies. In their analysis of government subsidies for sustainable innovation, Song et al. (2022) found that varying subsidy rates lead to different levels of innovative effort between firms and universities. Excessive subsidy levels may produce adverse effects by diminishing the commitment of the involved actors. Consequently, the effort dedicated to sustainable innovation tends to increase initially but declines as subsidy rates continue to rise, indicating that it is erroneous to assume that higher subsidies necessarily result in better outcomes.

In the study by Cheng et al. (2020), conducted in China, subsidies demonstrated a greater effect on UIC efficiency compared to tax incentives. A significant threshold effect was observed regarding the intensity of subsidies, indicating that above a certain level, the positive impact increases. No threshold effect was identified for tax incentives.

The need to calibrate public support is further emphasized by Hou et al. (2021), who, in their analysis of the Chinese context, conclude that government funding for science and technology positively affects the efficiency of UIC by enhancing the ability of universities to transform given inputs into higher levels of collaborative outputs (efficiency) and by improving total factor productivity over time through changes in technical efficiency and technological progress (productivity). However, the authors note that these beneficial effects are contingent upon the implementation of appropriate policies that align public incentives with universities' organizational and structural characteristics, as reflected in variables related to R&D personnel, research resources, and the broader innovation environment in which universities operate.

In the Brazilian context, Puffal et al. (2021) offer a more critical perspective by identifying a negative and statistically significant relationship between the use of public resources and the intensity of process and product innovations in firms. According to the authors, this adverse relationship arises from the predominant financial support profile, which tends to substitute rather than stimulate private investments, thereby hindering the formation of a virtuous cycle of continuous innovation within the business sector.

Analyzing UIC in Russia, Dezhina (2018) highlights that the national innovation system remains fragmented and heavily dependent on federal funding for research and development. The study emphasizes the need for more effective public policies focused not only on enhancing funding but also on improving communication and coordination among the various actors within the innovation system. Overall, the findings indicate that the impacts of public funding on UIC are varied and depend on

multiple factors, highlighting significant challenges. Moreover, the multidimensional nature of UIC is complex, and its outcomes can be tangible or intangible, positive or negative, direct or indirect, and short- or long-term.

4.3 Main Public Funding Mechanisms in UIC

A substantial share of the reviewed studies conceptualizes public support as public funding in general, without specifying the type of instrument employed. While this approach allows capturing the overall presence of public resources in UIC, it obscures important differences in incentives, governance arrangements, and expected outcomes associated with distinct funding mechanisms (Hu, 2009; Blume-Kohout et al., 2014; Mascarenhas et al., 2024; de Oliveira & de Castro Garcia, 2024). As a result, studies adopting this aggregated perspective tend to emphasize broad positive associations between public funding and UIC outcomes—such as higher collaboration frequency, increased scientific and technological output, and improved innovative performance—while offering limited explanations of the underlying mechanisms driving these effects.

In this context, public funding mechanisms for UIC are operationalized in the literature through a limited and uneven set of analytical categories. As summarized in Table 3, most studies examine public support in a highly aggregated manner, often referring broadly to public funding or joint project funding, while only a smaller share explicitly differentiates specific policy instruments, such as subsidies, tax incentives, and grants. Joint projects generally denote collaborative R&D initiatives jointly designed and implemented by universities and firms, typically co-financed by public and private resources, and aimed at generating shared scientific, technological, and commercial outcomes. This lack of differentiation has important implications for understanding how public resources shape UIC outcomes and helps to explain the heterogeneity of empirical findings reported in the literature. Table 2 presents the main UIC funding mechanisms identified in the literature.

Empirical evidence indicates that subsidies play a central role in mitigating the risks inherent to innovation, reducing transaction costs, and stimulating firms' participation in collaborative R&D activities with universities (Guerrero; Urbano, 2017; Cheng et al., 2020; Zhang; Wang, 2022). Studies report positive effects of subsidies on innovative performance, patenting activity, and the efficiency of collaborations. However, these effects are conditional on the intensity of support and the institutional context—understood as the quality of governance structures, regulatory stability, availability of research infrastructure, and the organizational and managerial capabilities of universities and firms. Threshold effects have been identified, pointing to diminishing or even adverse returns when subsidy levels exceed certain limits, which reinforces the need for appropriate calibration of public policies (Cheng et al., 2020; Song et al., 2022).

In contrast, tax incentives receive significantly less attention in the UIC literature. Only a limited number of studies explicitly analyze their effects, generally in combination with other instruments such as subsidies. The available evidence suggests that tax incentives tend to exert weaker or less direct effects on UIC outcomes, particularly regarding collaboration efficiency and knowledge transfer. Moreover, unlike subsidies, no clear threshold effects are observed for tax incentives, indicating that their influence may be more diffuse and less targeted toward fostering structured interactions between universities and firms (Cheng et al., 2020; Zhang; Wang, 2022). The scarcity of studies on this instrument represents a relevant gap, given its widespread use in innovation policies.

Grants and funding mechanisms specifically targeted at joint projects have received greater emphasis in more recent studies, reflecting a growing interest in the governance and design of collaborative instruments. Research examining collaboration-oriented grants indicates that these mechanisms increase both the likelihood and the intensity of UIC by encouraging the formation of joint projects, promoting two-directional knowledge flows, and strengthening the sustainability of partnerships over time (Khachatryan et al., 2024; Ushimaru et al., 2025). The evidence also suggests that these instruments are particularly effective in fostering more complex, risky, and long-term collaborative projects, as they typically require formal cooperation between academic and industrial actors and incorporate monitoring and accountability mechanisms.

Table 3 - Main public funding mechanisms in UIC.

Author/year	Grants	Subsidies	Tax incentives	Financing of joint projects	Public fund/ general
Geisler (1997)		x			
Bagchi-Sen et al. (2001)	x				x
Hu (2009)				x	x
Blume-Kohout et al. (2014)					x
Alves & Pimenta-Bueno (2014)				x	
Kyung et al. (2016)				x	x
Guerrero & Urbano (2017)		x			
Henry Junior & Odei (2018)					x
Szücs (2018)		x			
Fan et al. (2019)	x				x
Cheng et al. (2020)		x	x		
Hou et al. (2021)	x				x
Puffal et al. (2021)	x		x		x
Song et al. (2022)		x			
Nugent et al. (2022)	x				x
Zhang & Wang (2022)		x	x		
Figueiredo et al. (2023)					x
Mascarenhas et al. (2024)					x
Khachatryan et al. (2024)	x			x	
Jing (2024)		x			x
Oliveira & Garcia (2024)					x
Sitenko (2025)	x			x	
Ushimaru et al. (2025).	x	x			
Jonbekova et al. (2025)					x
Abu Sa'a & Asplund (2025)					x

Overall, the evidence indicates that public funding mechanisms influence UIC outcomes through multiple channels, including risk sharing, partner selection, interaction intensity, and the structuring of knowledge exchange processes. However, the predominance of aggregated measures of public funding and the scarcity of comparative analyses across instruments limit a more precise assessment of their relative effectiveness. This finding reinforces the need for future research to move beyond the simple presence or absence of public resources and adopt more refined analytical approaches that account for the design, intensity, and conditionalities of different funding mechanisms when evaluating their impacts on UIC outcomes.

4.4 Macro- and Micro-Level Outcomes of Public Funding in UIC

Analyzing the effects of public funding on UIC at both the macro and micro levels is essential to capture the full complexity of these collaborations. Macro-level analyses allow researchers to identify systemic patterns, broad trends, and aggregate impacts on universities, firms, and cooperation structures, such as technology transfer offices, joint research centers, science parks, incubators, formal R&D networks, and other institutional arrangements that organize and sustain university–industry interactions within innovation systems. At the same time, micro-level analyses are crucial for understanding how public funding operates in practice, influencing organizational behavior, project

execution, and individual actors. By focusing on firms, universities, researchers, and specific collaborative projects, micro-level studies uncover the mechanisms through which public resources translate into concrete outcomes, such as learning processes, capability building, and knowledge transfer.

Integrating macro and micro perspectives therefore enables a more comprehensive and nuanced understanding of UIC, bridging policy-level objectives with operational realities and providing more robust evidence.

Table 4 presents the macro-level outcomes identified in the literature. The objective is to show which actors are most strongly affected by public funding at a broader scale—universities, firms, or the cooperation process.

Author/year	University	Firm	Cooperation
Geisler (1997)	x	x	
Bagchi-Sen et al. (2001)	x	x	x
Hu (2009)	x	x	x
Blume-Kohout et al. (2014)			x
Alves & Pimenta-Bueno (2014)			x
Kyung et al. (2016)	x	x	x
Guerrero & Urbano (2017)		x	
Henry Junior & Odei (2018)	x	x	
Szücs (2018)	x	x	
Fan et al. (2019)	x		
Cheng et al. (2020)			x
Hou et al. (2021)	x		x
Puffal et al. (2021)		x	
Song et al. (2022)			x
Nugent et al. (2022)	x		
Zhang & Wang (2022)			x
Figueiredo et al. (2023)			x
Mascarenhas et al. (2024)			x
Khachatryan et al. (2024)	x		
Jing (2024)		x	
Oliveira & Garcia (2024)			x
Sitenko (2025)			x
Ushimaru et al. (2025).	x	x	
Jonbekova et al. (2025)			x
Abu Sa'a & Asplund (2025)		x	

Table 4 - Macro-level outcomes identified in the literature.

At the university level, studies analyzing the effects of public funding mainly highlight impacts on research capacity, scientific and technological output, and institutional strengthening. Evidence indicates that public resources contribute to increasing researchers' participation in collaborative activities, expanding patenting and publication output, and reinforcing the scientific infrastructure required for interaction with the productive sector (Geisler, 1997; Hu, 2009; Kyung et al., 2016; Khachatryan et al., 2024; Ushimaru et al., 2025).

At the firm level, the literature indicates that public funding is associated with improvements in innovative performance, R&D effort, and absorptive capacity, particularly among firms with a lower initial propensity to innovate or more severe financial constraints. Studies suggest that public support can stimulate firms' engagement in collaborative activities with universities, foster the development of new products and processes, and reduce risks associated with technological innovation (Geisler, 1997;

Kyung et al., 2016; Henry Junior; Odei, 2018; Jing, 2024; Ushimaru et al., 2025; Abu Sa'a; Asplund, 2025). However, these effects are generally examined in an aggregated manner, without a detailed analysis of the internal organizational mechanisms through which funding influences firms' strategic decisions and innovative behaviors.

The cooperation level is the most frequently emphasized in the reviewed studies, as evidenced by the recurrence of the "cooperation" category in the table. At this level, outcomes are not attributed primarily to universities or firms as individual organizations, but rather to the characteristics and performance of the collaborative relationship itself, including its structure, stability, intensity, and governance. Public funding is associated with increases in both the frequency and intensity of collaborations, the formation of more stable and long-term partnerships, and the expansion of the scope and complexity of joint projects (Hu, 2009; Blume-Kohout et al., 2014; Alves & Pimenta-Bueno, 2014; Kyung et al., 2016; Cheng et al., 2020; Figueiredo et al., 2023; Mascarenhas et al., 2024; de Oliveira & de Castro Garcia, 2024; Sitenko, 2025; Jonbekova et al., 2025). More specifically, cooperation-level outcomes encompass changes in coordination mechanisms, communication routines, trust-building processes, and formal and informal governance arrangements that shape how universities and firms interact. These studies indicate that public funding plays a central role in enabling UIC by reducing coordination and transaction costs, sharing risks, and aligning incentives among actors with distinct objectives and institutional logics, thereby strengthening the relational infrastructure that sustains collaboration.

At the micro level, Table 5 (*a* and *b*) systematizes the outcomes of public funding in UIC, focusing on the direct effects on universities, firms, researchers, and collaborative projects. These outcomes reflect observable changes in organizational performance, knowledge production, and the dynamics of interactions, allowing for a more fine-grained understanding of how public resources affect UIC at the operational level.

At the firm level, studies indicate that public funding is associated with outcomes such as increased product innovation, strengthened technological capabilities, and reduced risks inherent to collaborative R&D activities. Access to public resources facilitates firms' participation in joint projects with universities, enhances their capacity to absorb scientific knowledge, and supports the transformation of that knowledge into practical applications.

For universities and researchers, Table 5 highlights micro-level impacts related to increases in scientific and technological output, including publications, patents, licenses, and the development of practical applications of knowledge. In addition, several studies indicate that public funding contributes to improved research conditions through access to infrastructure, equipment, and resources for training students and research teams. Outcomes associated with academic mobility, career opportunities, and organizational learning suggest that the effects of public funding extend beyond traditional outputs, also influencing professional trajectories and institutional capabilities.

Finally, the reviewed literature highlights that public funding significantly affects relational dynamics and collaboration efficiency at the micro level. Gains in coordination, interaction intensity, and knowledge transfer are frequently observed in projects supported by public resources, especially when funding instruments encourage shared objectives and long-term cooperation. However, the diversity of reported outcomes suggests that the micro-level effects of public funding depend strongly on program design, partner alignment, and the prior capabilities of the actors involved, reinforcing the importance of contextual and comparative analyses.

Table 5a – Micro-level outcomes of UIC.

Author/year	Product innovation	Chance of cooperation between companies	Chance of cooperation between companies and universities	Chance of cooperation between companies and the government	Publications	Collaboration efficiency	Patents or licenses	Commercialization of developments
Geisler (1997)			x	x	x			
Hu (2009)		x	x					
Blume-Kohout et al. (2014)			x					
Alves & Pimenta-Bueno (2014)			x					
Kyung et al. (2016)					x		x	x
Guerrero & Urbano (2017)	x							
Henry Junior & Odei (2018)		x	x	x				
Cheng et al. (2020)						x		
Figueiredo et al. (2023)		x	x	x				
Mascarenhas et al. (2024)			x					
Khachatryan et al. (2024)					x		x	
Oliveira & Garcia (2024)			x					
Sitenko (2025)			x					x
Ushimaru et al. (2025)	x				x		x	x
Jonbekova et al. (2025)			x					
Abu Sa'a & Asplund (2025)		x	x					

Table 5b – Micro-level outcomes of UIC.

Author/year	Incomes from technology transfers	Infrastructure and equipment for researchers and students	Networking, career and employment opportunities	Training and mobility of university employees and researchers	Regional and international reputation of the university	Reduction of corporate financing constraints	Reduction of innovation risks	Practical application, knowledge and technology transfer
Geisler (1997)		x		x				
Hu (2009)			x	x				
Kyung et al. (2016)	x							
Zhang & Wang (2022)								x
Khachatryan et al. (2024)		x	x	x	x			x
Jing (2024)						x	x	
Oliveira & Garcia (2024)								x
Jonbekova et al. (2025)			x		x			
Abu Sa'a & Asplund (2025)			x					

5 Discussion

The results of this systematic review reinforce the consolidated understanding that public funding plays a relevant role in promoting university–industry collaboration (UIC), while also revealing persistent analytical limitations in how this relationship has been investigated in the literature. Although both classical and contemporary studies point to positive effects of funding on cooperation, innovative performance, and knowledge transfer, the findings of this review suggest that such effects are often treated as almost automatic, with limited problematization of the causal mechanisms and the conditions under which public funding effectively generates desirable outcomes.

A key insight emerging from the review is the predominance of highly aggregated approaches to public funding in literature. Many studies identify positive associations between public support and UIC outcomes without distinguishing among different funding instruments, intensities, or conditionalities. This aggregation obscures important differences in how subsidies, tax incentives, and collaboration-oriented grants operate, helping to explain mixed and sometimes contradictory empirical results. While subsidies and targeted grants tend to play a more direct and catalytic role—by sharing risks, reducing transaction costs, and structuring formal cooperation—tax incentives appear to exert more diffuse and indirect effects. These findings align with the arguments of Hu (2009) and Blume-Kohout et al. (2014) that the governance and design of funding instruments matter as much as the availability of resources themselves.

The discussion of macro-level outcomes highlights that public funding exhibits its strongest and most consistent effects on the cooperation dimension of UIC. Across diverse national and sectoral contexts, public resources are shown to increase the frequency, stability, and scope of collaborations, suggesting that funding acts as a coordination mechanism that aligns incentives between universities and firms despite their distinct institutional logics. At the same time, macro-level evidence regarding firm- and university-level outcomes remains more heterogeneous. While many studies report positive impacts on research capacity, innovative performance, and absorptive capabilities, others—particularly in contexts characterized by weak governance or substitution effects—identify neutral or even negative outcomes. This reinforces the concerns raised by Szücs (2018) and Puffal et al. (2021) that poorly designed public support may crowd out private investment or encourage low-risk, short-term collaborations.

At the micro level, the literature provides more granular insights into how public funding translates into concrete outcomes, such as increased patenting, publication output, knowledge transfer, and learning processes within collaborative projects. These findings suggest that public resources are particularly effective when they support formalized, long-term partnerships and when participating actors possess sufficient prior capabilities to absorb and exploit external knowledge. However, the diversity of reported micro-level effects also points to strong contextual dependence. Differences in partner alignment, project complexity, and institutional capacity significantly shape the extent to which funding leads to meaningful innovation outcomes. This variability highlights the limits of one-size-fits-all policy approaches and reinforces the need for more context-sensitive analyses.

Taken together, the findings suggest that understanding the role of public funding in UIC requires an integrated macro–micro perspective. Macro-level analyses are essential for assessing systemic impacts and policy effectiveness, while micro-level studies reveal the organizational and behavioral mechanisms through which funding affects collaboration outcomes. The lack of integration between these levels in much of the existing literature represents a critical gap. Future theoretical and empirical work would benefit from explicitly linking funding design and policy objectives to micro-level processes and behaviors.

Moreover, the reviewed literature still presents a predominantly instrumental view of UIC, centered on measurable outputs such as patents, publications, and product innovation, to the detriment of more qualitative and process-oriented dimensions of collaboration. Although authors such as Bozeman and Perkmann et al. have highlighted the importance of relational factors, mutual learning, and trust-building, these elements continue to be treated marginally in empirical studies on public funding. As a result, the assessment of UIC outcomes remains excessively oriented toward short-term indicators, limiting the understanding of long-term effects on organizational capabilities, technological trajectories, and broader public missions.

Finally, the findings of this review resonate with more recent mission-oriented innovation policy approaches, which advocate a more active and strategic role for public funding in coordinating actors and shaping directions for technological development. However, the empirical UIC literature still appears weakly connected to this debate, treating public funding more as a neutral input than as a normative and directional instrument. This disconnect reinforces the need to advance analyses that integrate outcomes, mechanisms, and policy intentionalities, moving beyond descriptive approaches and enabling a more critical assessment of the role of the state in shaping university–industry collaborations.

6 Conclusion, Limitations and Research Agenda

This study highlights the multifaceted and complex role of public funding in UIC. As a strategic partnership, UIC fosters innovation, technological development, and competitiveness by enabling the exchange of knowledge, resources, and competencies between higher education institutions and firms. Our systematic literature review reveals that public resources are critical not only in alleviating financial constraints but also in indirectly influencing the intensity, quality, and sustainability of UIC outcomes.

Public funding acts as a catalytic mechanism that attracts private investment, aligns interests between universities and firms, and supports both formal, research-oriented collaborations and informal networking-based interactions. However, the effectiveness of public resources varies significantly depending on multiple contextual factors, such as the sector, country, organizational characteristics, and the nature of funding instruments. For instance, while subsidies often enhance collaboration and innovation performance by reducing financial risks and transaction costs, excessive or poorly designed funding schemes may discourage firm commitment or induce short-term, low-impact projects.

Our findings confirm that two-directional collaborations tend to yield superior performance compared to unidirectional resource flows, especially when public funding supports such interactions. Moreover, public resources contribute to expanding innovation outputs, including patenting activity, academic publications, and technology transfer, thereby benefiting both universities' research capacity and firms' innovative capabilities. At the same time, challenges persist, such as uneven distribution of public funds across regions and firms, potential substitution of private investment, and governance issues that undermine the sustainability of UIC.

This study has some limitations that should be acknowledged. First, as a systematic literature review, the research depends on the availability and accessibility of existing studies published in academic journals. Relevant insights contained in gray literature, technical reports, or unpublished documents may not have been captured. Second, the analysis was limited to documents indexed in Scopus and Web of Science and to publications in English, Portuguese, and Spanish. While these databases are widely recognized, this scope may have excluded studies from other sources or languages that could provide additional perspectives, particularly from less represented countries or regions. Third, the diversity of research designs, analytical approaches, and contextual settings among the selected studies posed challenges to direct comparison and generalization. Differences in how UIC is conceptualized, the types of funding instruments analyzed, and the performance indicators used may limit the consistency of the findings.

The results of this systematic review reveal important advances in understanding the role of public funding in university–industry collaboration (UIC), while simultaneously exposing persistent theoretical, empirical, and methodological gaps that open fertile avenues for future research. A first promising direction concerns the need for greater conceptual refinement in how public funding is analyzed. Much of the existing literature still treats public support in a highly aggregated manner, without clearly distinguishing among different policy instruments—such as direct subsidies, tax incentives, competitive grants, public procurement, or reimbursable financing—and the specific mechanisms through which they operate. Future studies would benefit from comparative analyses that examine how distinct funding designs shape different UIC configurations and intermediate outcomes, thereby enabling a more precise identification of causal channels.

A second avenue relates to the multidimensional and dynamic nature of UIC outcomes. While the literature continues to privilege conventional indicators—such as patents, publications, and product innovation—it pays considerably less attention to intangible and long-term outcomes, including

organizational learning, absorptive capacity development, trust-building, and network consolidation. Longitudinal and process-oriented approaches could significantly advance the field by examining how public funding influences different stages of collaboration, from initiation to consolidation or dissolution. Such designs would allow researchers to capture cumulative, non-linear, and potentially contradictory effects over time, which are often obscured in cross-sectional analyses.

A third important direction involves the more systematic incorporation of institutional and territorial contexts. The evidence synthesized in this review indicates that the effects of public funding on UIC vary substantially across countries, sectors, and levels of innovation system maturity. Comparative cross-country or cross-regional studies could explore how factors such as policy governance, institutional capacity, university maturity, and local industrial structure moderate the effectiveness of public funding. In this respect, research focusing on emerging economies and peripheral regions is particularly needed, as these contexts may exhibit dynamics that differ markedly from those observed in core economies and thus challenge dominant assumptions in the literature.

Finally, there is considerable scope for methodological advancement. The predominance of quantitative studies based on secondary datasets highlights the need for greater methodological pluralism. Qualitative and mixed-methods approaches can provide deeper insights into the strategic behaviors of universities and firms in response to public incentives, including risks of subsidy dependence, coordination failures, and the substitution of private investment. Moreover, the adoption of quasi-experimental designs and more rigorous causal inference strategies would strengthen the empirical basis for assessing the true impacts of public funding on UIC outcomes. Such advances are essential not only for theoretical progress, but also for informing the design of more effective, context-sensitive innovation policies.

In sum, while public funding remains an indispensable instrument for fostering university–industry collaboration, future research must move beyond broad correlations and adopt more nuanced, integrative approaches that connect funding design, institutional context, and micro-level mechanisms. Doing so will be crucial to better understand when, how, and under what conditions public funding enhances the societal and economic returns of UIC.

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