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Towards a Governance of Technology Transfer: Fostering Impact Through Goals, People, and Resources

Abstract

This study investigates the governance mechanisms that universities and Public Research Organizations (PROs) can implement to foster the impact of technology transfer initiatives. While maximizing the technology transfer impact has been widely explored both in research and practice, our understanding of the role that governance can play in this process remains limited. This paper addresses this gap by identifying specific governance mechanisms that universities and PROs can implement to achieve greater impact in their technology transfer initiatives. We performed a qualitative analysis of technology transfer professionals in the Italian context. We relied on interviews and secondary sources accessed through Netval, the National Association for Technology Transfer. Our findings reveal three critical governance levels: (i) the political level, which leverages goals as key elements, (ii) the relational level, which leverages people, and (iii) the technological level, which leverages resources. Drawing on goal setting, stakeholder, and resource dependence theories, we create a governance framework to maximize technology transfer impact. This study contributes to the governance literature by integrating and extending these three theories in the technology transfer domain, illustrating their interplay across political, relational, and technological governance levels. For each, we present a series of formal and informal governance mechanisms that universities and PROs should adopt to strengthen the societal and economic impact of their technology transfer initiatives.

Keywords: Technology Transfer; Governance; Goal Setting Theory; Stakeholder Theory; Resource Dependence Theory.

INTRODUCTION

Nowadays, the maximization of the social, economic, and cultural impact of technology transfer initiatives from universities and Public Research Organizations (PROs) has become a topic of growing and passionate debate (European Commission, 2018; Kruger and Steyn, 2020). Traditionally, technology transfer has been recognized as the effective process of conveying results stemming from scientific and technological research to the external environment, along with the associated skills and procedures as part of the technological innovation process (Siegel and Phan, 2005; Link et al., 2007). However, in recent times, the definition of technology transfer has shifted its focus from a performance-based view (Chapple et al., 2005) to a more impact-oriented perspective (Guerrero and Siegel, 2024).

Beyond measures such as the number of academic spin-offs or licensing agreements, the potential societal, economic, policy, and health impacts of science-based knowledge and technology have gained significant attention among researchers and policymakers, both for individuals and organizations (Bozeman et al., 2015; Fini et al., 2018; Compagnucci and Spigarelli, 2020). Several studies in technology transfer have explored these phenomena (Perkmann et al., 2013; Hockaday and Piccaluga, 2021), mainly investigating the interactions between universities and PROs with industry (Perkmann and Walsh, 2007; Striukova et al., 2015). In this regard, new metrics have emerged, including job creation, the introduction of services, the promotion of policies, and the development of new and improved processes benefiting civil society, particularly in health and well-being (Campbell et al., 2023).

However, the complex task of impact delivery may be constrained by a series of obstacles that prevent Technology Transfer Offices (TTOs) from effectively transferring technologies to external entities. This, in turn, hinders the potential of universities and PROs' knowledge and technologies to deliver societal benefits. Key obstacles include misaligned incentives among internal and external stakeholders (Pohle et al. 2022), difficulty in recruiting and training skilled technology transfer professionals (Villani and Grimaldi, 2024), limited acceptance of a technology transfer culture among researchers and practitioners (Soares and Torkomian, 2021), and rapidly evolving technologies with differing timelines, modalities, and sector-specific needs (Abreu and Grinevich, 2013). These challenges underscore the crucial role of technology transfer governance, defined as the mechanisms through which universities and PROs influence technology transfer performance, ensure stakeholder alignment, and efficiently manage and valorize assets (Carney, 2005; Bleiklie and Kogan, 2007). Effective governance, therefore, is key to enhancing technology transfer efficiency and fostering societal impact (Schoen et al., 2014).

Prior literature has extensively investigated the impact of technology transfer from a variety of perspectives, including individual (D'Este and Perkmann, 2011), organizational (Micozzi et al., 2021), and outcome-related factors (Bornmann, 2017). However, research on the governance of technology transfer initiatives remains limited due to the inherent complexity of the phenomenon (Geuna and Muscio, 2009) and its evolving nature (Audretsch et al., 2014). Notably, differences in universities' business models correspond to differences in governance mechanisms (Baglieri et al., 2018), and those differences are related to multiple dimensions that affect governance and that are often overlooked (Schoen et al., 2014). While the governance perspective remains key to fostering

the impact of technology transfer initiatives on society at large (Wright, 2014), studies on the governance of the technology transfer process within an impact-oriented framework for valorizing university assets remain scarce (Schoen et al., 2014). Although obstacles at the intra-organizational (Pohle et al., 2022; Villani and Grimaldi, 2024) and the inter-organizational level (Gilsing et al., 2011) are generally acknowledged, we still lack a governance framework that enables universities and PROs to navigate the technology transfer process, address its inherent challenges, and foster impact.

Therefore, we pose the following research question: *What governance mechanisms can universities and Public Research Organizations implement to foster the impact of their technology transfer initiatives?* To explore this question, we performed a qualitative study on technology transfer professionals in the Italian context (Yin, 2003). Specifically, our primary data sources included transcripts from 37 interviews with representatives of TTOs from major Italian universities and PROs (i.e., Universities, Research Hospitals, and Research Centers), complemented with secondary sources such as internal reports and external documents accessed through Netval, the National Association for Technology Transfer. We inductively coded primary sources via the Gioia methodology (Gioia et al., 2013), and we triangulated them with secondary sources to identify a set of aggregated dimensions that would answer the research question.

Italy is recognized as a unique case in technology transfer literature (Cesaroni and Piccaluga, 2016; Civera and Meoli, 2024). In fact, despite its status as a latecomer in comparison to other countries (Algieri et al., 2013), it has undergone rapid growth over the past two decades (Grimaldi et al., 2021). This transformation process has been shaped by two key factors: an internally driven restructuring of technology transfer initiatives and organizational structures by universities and PROs (Battaglia et al., 2017; Pohle et al., 2022) and an externally oriented policy push to enhance the ecosystem and strengthen actors and infrastructures operating in this field (Meoli et al., 2020; Micozzi et al., 2021). The evolution over time of the Italian technology transfer context and its peculiar characteristics presents a set of knowledge and processes that are recognized to be informative in all those national settings still in their early stage of the technology transfer development and that are looking at other cases to build and enhance their capabilities, technological infrastructures, and policy initiatives (Algieri et al., 2013; Villani and Lechner, 2021).

Our analysis was informed by a set of theoretical lenses that we integrated into a single theoretical framework: goal setting (Locke and Latham, 2002), stakeholders (Freeman, 1984), and resource dependence theory (Pfeffer and Salancik, 1978). We found this perspective particularly useful because these constructs have been widely recognized in the literature as guiding organizations in the governance of initiatives in contexts with high knowledge intensity and complexity (Chrisman et al., 2013). For this reason, we suggest that they can serve as a valuable framework for navigating the inherent challenges in similar settings, such as technology transfer, where prior studies have considered those theories independently (Abreu and Grinevich, 2013; Giones, 2019; Aerts et al., 2022).

Our study reveals three levels of governance that are essential for overcoming technology transfer barriers and fostering impact: political, relational, and technological. Each level is characterized by a predominant core element: goals, people, and resources. Additionally, for each level, we also present

formal and informal governance mechanisms that can be implemented to maximize the impact of technology transfer initiatives.

THEORETICAL BACKGROUND

2.1. Fostering the impact of technology transfer initiatives

Over the past decades, the impact of technology transfer has become a central concern for innovation management researchers and a primary objective for practitioners engaged in the third mission activities of universities and PROs (Feller et al., 2022). In this context, the term “impact” related to technology transfer, refers to the effects and outcomes that directly or indirectly result from the transfer of knowledge, technologies, or innovations from universities to external entities that are not part of the university’s organizational structure (Bornmann, 2017).

The literature firmly establishes that the effective transfer of scientific assets from academic institutions to the external environment is essential for societal advancement (Fini et al., 2018). Examples range from perovskite solar cells to vaccines developed for the treatment of the novel coronavirus, showing how scientific research can contribute to societal well-being when successfully transferred from academic laboratories to society, in a manner that ensures the utilization of new scientific discoveries in real-world applications (Li et al., 2019; Tian et al., 2022). In this regard, the literature on technology transfer deeply investigates pathways to foster impact from multiple perspectives.

From an individual perspective, various barriers can inhibit impact, affecting researchers and TTO professionals. Researchers’ attitudes toward valorization may vary based on factors such as seniority, age, and risk propensity (Abreu and Grinevich, 2013) potentially limiting the commercialization of technology beyond departments’ laboratories (Fabrizio and Di Minin, 2008). Often, researchers prioritize industry collaborations to further their research rather than aiming to make a societal impact through commercialization or other valorization paths (D’Este and Perkmann, 2011). Consequently, scientific productivity frequently takes precedence over technology transfer and its potential impact. Conversely, even technology transfer managers may act as impediments to this process. This is because their incentive system is often misaligned with that of researchers, being guided by different goals, learning opportunities, and ambitions (Pohle et al. 2022; Villani and Grimaldi, 2024). Skills disparities among technology transfer managers can further complicate matters; for example, while some possess more research-oriented capabilities, others tend to be more marketing-oriented (i.e., high business skills but low technological ones), lacking the technological knowledge necessary for initial dialogues about research valorization (Soares and Torkomian, 2021).

From an organizational perspective, TTOs are recognized as the central element of any technology transfer initiative and their overall efficacy is contingent upon their effectiveness (Battaglia et al., 2017; Micozzi et al., 2021). Examining macro, meso, and micro factors that affect their performance, O’Kane et al. (2021) identified TTOs as crucial brokers in fostering impact between universities and their surrounding ecosystems. TTOs can enhance the impact of the technologies they commercialize by tailoring agreement terms (e.g., licensing contracts, collaborative research contracts, innovation consulting contracts) to align more closely with the features of the technologies involved (Shen et al., 2022) and managing the negotiation process to achieve optimal terms (Soares and Torkomian, 2021).

However, TTO literature accounts for critical perspectives that recognize that TTOs' support is not always adequate due to undersized administrative and technical staff as a lack of investments in universities and PROs' third mission activities (Huyghe et al., 2016). This may lead academics to find alternative approaches to enjoy higher flexibility and freedom in managing the technology transfer process such as funding non-technology spin-offs that require less support from the parent organization (Meoli and Vismara, 2016) or directly bypassing the TTOs in the valorization process (Halilem and Diop, 2025) to enjoy higher flexibility and more freedom to manage human and financial resources. Therefore, TTOs must develop specialized skills and adjust business models to claim legitimacy and contribute to generating value in all those collaborative initiatives they engage with external actors (Baglieri et al. 2018).

From an outcome perspective, one of the most significant challenges lies in the measurement of the impact of technology transfer initiatives. In the past, it was commonly accepted that this impact could be measured by revenue generated through licensed technologies, with successful TTOs identified as those yielding the highest returns from valorization activities. However, this approach fails to account for financial losses inherent in research activities and their related technology transfer initiatives (McDevitt et al., 2014). In fact, by its nature, scientific research is characterized by randomness, anomalies, the right to make mistakes, and unpredictability which cannot be fully captured by traditional impact metrics (Bornmann, 2017). Consequently, the process is rarely linear, requiring both quantitative and qualitative metrics to understand throughput and impact comprehensively (Campbell et al., 2023). This complexity grows since those processes take a long time to settle (Scarrà and Piccaluga, 2022). It is now widely accepted that impact extends beyond economic returns, encompassing social, environmental, and cultural dimensions as well (Bornmann, 2017). Thus, for technology transfer to achieve a meaningful impact, it must also address pressing societal challenges (Fini et al., 2018; Compagnucci and Spigarelli, 2020).

Despite the growing body of literature on technology transfer and its impacts, which has analyzed the phenomenon across individual, organizational, and outcome perspectives, studies on the governance of the technology transfer process specifically aimed at successful valorization of the assets developed within universities and PROs remain limited (Audretsch et al., 2014; Schoen et al., 2014; Wright, 2014). Baglieri et al. (2018) suggest that different university business models may lead to distinctive governance mechanisms. However, as far as we know, there is still a scarcity of knowledge regarding these mechanisms (Geuna and Muscio, 2009; Schoen et al., 2014), and a comprehensive framework to guide universities and PROs in navigating the complex process of technology transfer to achieve impact from a governance perspective remains absent (Wright, 2014). Therefore, our paper aims to answer the following research question: *What governance mechanisms can universities and PROs implement to foster the impact of their technology transfer initiatives?*

2.2. Looking for a governance perspective

The literature suggests that a one-size-fits-all approach is inadequate for addressing the complexities of technology transfer and its governance (Baglieri et al., 2018). Consequently, there is a pressing need to elucidate the role of tailored governance mechanisms in addressing the distinctive challenges and opportunities confronted by each organization. Despite the recognition of governance as a critical dimension in maximizing the impact of technology transfer (Schoen et al., 2014), the question of which governance mechanisms can drive this effectively remains unanswered. In fact, effective

governance involves the establishment of structures and processes that align the objectives and activities of different stakeholders, ensure accountability, and optimize the use of resources (Wellens and Jegers, 2014). While technology transfer governance mechanisms can vary significantly, they aim to create an environment where technology transfer can thrive (Wright, 2014). To deal with the complex governance of these initiatives, we draw upon a set of theoretical constructs commonly recognized in the governance literature. They may serve as a guide in navigating the inherent challenges associated with this type of phenomenon. It is widely acknowledged that they are effective in guiding the governance of similar initiatives in contexts that are characterized by high levels of knowledge intensity and complexity (Chrisman et al., 2013).

The first strand of theory we draw upon is the goal setting theory. Goals have always been recognized as an important concept in governance studies. Goal setting theory posits that actors and organizations are driven by goal-oriented actions, and that specific and challenging goals may enhance tasks' performance by focusing attention, increasing effort, and fostering persistence (Locke & Latham, 2002). In dealing with goal setting, inherent challenges exist, such as the potential for overly specific goals to limit the freedom to act and think, the imbalance between short-term and long-term objectives, the risk of focusing narrowly on a few goals while neglecting others, and the danger of unethical behavior when goals are overly challenging or poorly managed (Locke and Latham, 2006; Ordoñez et al., 2009), to mention a few of them. From a governance perspective, goals represent the common ground upon which each actor within the organization can strategically align toward a common and measurable path (Kotlar et al., 2018). Indeed, this may be true for universities and PROs which are complex organizations comprising a variety of actors operating at a variety of levels (e.g., deans, chancellors, general directors, professors, researchers, administrative staff, and students) and require well-defined goals to ensure cohesive action and effective collaboration throughout the organizations (Giones et al., 2019). In technology transfer contexts, goals are often misaligned: (i) in the interactions among researchers due to diversity in academic status and career positions (Civera et al., 2024); (ii) in the interactions between researchers and TTOs, due to misaligned incentives and incompatible capabilities, especially when it comes to academic entrepreneurship initiatives (Sandström et al., 2018); and (iii) in the interactions between researchers and the external environment, due to adverse information leaks and a lack of academic motivation to pursue research agendas shaped by corporations (Perkmann and Schildt, 2015; Fini et al., 2018). However, goal alignment is crucial for achieving not only educational and research objectives but also for reaching a societal impact through successful technology transfer initiatives (Perkmann et al., 2011; Compagnucci and Spigarelli, 2020). In light of these considerations, it becomes evident that the articulation of goals should be a primary focus within the governance of technology transfer.

A second strand of theory that we draw upon is the stakeholder theory. Stakeholder theory holds that organizations should consider the interests of all individuals or groups affected by their actions, not just their internal shareholders (Freeman, 1984). From a governance perspective, this theory implies that decision-making process within organizations should account for the needs of diverse stakeholders, and try to balance them, thus shifting some decision-making power from shareholders to other stakeholders (Stieb, 2008; Parmar et al., 2010). However, this approach gives rise to certain intrinsic challenges, including the difficulty of identifying which individual or entity qualifies as a stakeholder and determining the relative importance of each stakeholder's interests (Key, 1999). These aspects illustrate the paramount importance of stakeholders in the governance of technology

transfer initiatives. TTOs occupy a pivotal role in this process. They are responsible for defining the stakeholders, assigning them an importance level, and identifying the best strategy for engaging with them. This is because the interactions with stakeholders represent a primary channel for influencing societal outcomes (Aerts et al., 2022). In addressing the needs of different individuals and balancing the roles and interests of both internal and external stakeholders (Schenkenhofer et al., 2024) (Bukhari et al., 2021), proper governance of the relationships that underpin technology transfer initiatives may improve the efficiency and effectiveness of these interactions, thereby fostering their impact towards the external environment (Kreiling et al., 2020).

A last strand of theory that we draw upon is the resource dependence theory. This theory acknowledges that organizations are not autonomous entities but rather interdependent with other entities (Pfeffer and Salancik, 1978). To manage these dependencies, organizations control critical resources to reduce uncertainty and ensure their continued survival over time. From the perspective of governance, resource dependence theory highlights the strategic role of appropriate and effective governance mechanisms that are required to surround the resource exchange relationship and incentivize efficiency gains when interacting with external partners (Dyer and Singh, 1998). However, resource dependence theory is characterized by the dynamic nature of resources' interdependencies, which can give rise to novel patterns of dependence and interdependence despite efforts to manage them (Hillman et al., 2009). This emerges particularly in the context of technology transfer, where each interaction is centered on an asset (i.e., a technology) that is often the result of years of research activities and the integration of numerous resources. The valorization of this asset will depend on the use of other technologies that may not be necessarily in the possession of universities and PROs (Abreu and Grinevich, 2013). Therefore, from a perspective of resource dependency, technology transfer requires governance mechanisms to deal with the interdependency of actors and technologies, when valorizing assets in an external environment (Drees and Heugens, 2013).

While the existing literature has been effective in highlighting the importance of these theories in explaining the governance of technology transfer (see Table 1), there has been a paucity of studies that have taken an integrated multi-level approach to examine whether those governance mechanisms may foster the impact of these initiatives. For each of these elements, key aspects are recognized that can be leveraged when dealing with the governance perspective (i.e., goals, people, and resources). Therefore, drawing on Chrisman et al. (2013), we build upon the three theoretical lenses to answer our research question and develop a framework to guide universities and PROs in navigating the complex process of technology transfer to foster impact from a governance perspective.

[Table 1 – Technology transfer and governance theories]

Theoretical lenses	Key elements to leverage	Description	Theoretical and empirical referents
Goal-setting theory	Goals	It focuses on aligning the objectives of stakeholders through well-defined goals, ensuring cohesive action and effective collaboration in technology transfer.	Locke and Latham, (2002); Locke and Latham (2006); Ordoñez et al. (2009); Perkmann et al. (2011); Perkmann and Schildt (2015); Giones et al. (2019); Civera et al. (2024).

Stakeholder theory	People	It emphasizes the importance of considering diverse stakeholders' interests and needs, and of balancing them to improve the efficiency and effectiveness of technology transfer initiatives.	Freeman (1984); Key (1999); Stieb (2008); Kreiling et al. (2020); Aerts et al. (2022).
Resource dependence theory	Resources	It highlights the need for governance mechanisms to manage interdependencies and control critical resources and their valorization, ensuring efficiency in technology transfer interactions.	Pfeffer and Salancik, (1978); Dyer and Singh (1998); Hillman et al. (2009); Abreu and Grinevich (2013); Drees and Heugens (2013); Fini et al. (2018).

RESEARCH METHODOLOGY

3.1. Research setting

In understanding the governance mechanisms that can be implemented by universities and PROs to foster the impact of their technology transfer initiatives, we conducted a qualitative analysis with an inductive and exploratory approach (Yin, 2013). In fact, our research aims to elucidate the “how” of a certain phenomenon - i.e., the governance of technology transfer – by analyzing the context in which it occurs (De Massis and Kotlar, 2014). Therefore, we opted to include a peculiar context of investigation as our research setting, which is the Italian technology transfer ecosystem, including professionals dealing with technology transfer in Italian universities and PROs.

Technology transfer literature has always recognized Italy as a relevant setting due to its rapid growth and peculiar discontinuities in technology transfer legislation (Grimaldi et al., 2021; Civera and Meoli, 2024). Technology transfer scholars extensively investigated the Italian context by focusing on its unique characteristics at the individual (Micozzi et al., 2021), organizational (Algieri et al., 2013), and contextual levels (Meoli et al., 2020), revealing the unique characteristics of such a national setting.

Notably, the introduction of the "professor privilege" in 2001 nominally transferred all intellectual property (IP) rights over academic research results from universities to faculty members (Lissoni et al., 2013). However, this privilege was abolished in 2023, profoundly affecting technology transfer and valorization. Despite being a latecomer compared to other countries, Italy has seen a significant rise in technology transfer initiatives over the past two decades (Grimaldi et al., 2021). This transformation has been driven by an internal restructuring of the TTOs of universities and PROs (Meoli and Vismara, 2016; Battaglia et al., 2017) that better defined their scope, goals, and the range of activities to implement (Cesaroni and Piccaluga, 2016), as much as the skills required by technology transfer managers (Pohle et al., 2022; Villani and Grimaldi, 2024). Alongside, this transformation was guided by external policy instruments aimed at enhancing ecosystem opportunities and strengthening the involved actors and infrastructures (Meoli et al., 2020; Micozzi et al., 2021). Therefore, the co-presence of internal pull and external push restructuring dynamics

combined with rapid growth in universities' technology transfer initiatives within vibrant and various regional ecosystems (Grimaldi et al., 2021) allow the authors to isolate rare or unique qualities that make Italy a logical candidate for "theoretical sampling" (Eisenhardt and Graebner, 2007). Furthermore, in terms of transferability of the results, the Italian case presents valuable insights for universities and PROs that operate in national contexts still in their early stage of development and that are looking for exemplary cases to evolve further their technology transfer capabilities, infrastructures, and policy initiatives (Algieri et al., 2013; Villani and Lechner, 2021).

According to standard practice in technology transfer studies as such (Villani and Lechner, 2021; Civera and Meoli, 2024), our inductive approach is considered an appropriate method to build new theoretical interpretations to address challenging issues. We build upon the prescriptions of Eisenhardt and Graebner (2007) to elaborate on existing theories to better comprehend the governance mechanisms that can be implemented by universities and PROs to foster the impact of technology transfer initiatives. The aim is to make analytical and theoretical generalizations upon the existing and fragmented body of knowledge on technology transfer governance. In this regard, findings may inform future theoretical and empirical studies investigating this challenging topic.

3.2. Data collection

In alignment with the findings of previous qualitative technology transfer studies, our research delves into the Italian national technology transfer setting. We have chosen to examine TTOs as the level of analysis for our research and professionals operating within TTOs and in the technology transfer field as the unit of analysis. Specifically, we consider Netval (i.e., the National Network for Research Valorization) as a conduit for data access. Netval represents the Italian association of TTOs professionals. Founded in 2002, the association now has more than 104 TTOs affiliated. The association's activities can be broadly classified into three main categories: (i) the sharing and strengthening of the technology transfer competencies among universities and PROs, (ii) the promotion of technology transfer culture and best practices of technology transfer through the provision of an institutional interface; and (iii) the support of TTOs in their valorization and dissemination activities.

Within the context of national technology transfer, the Netval initiative represents an exemplary case study (De Massis and Kotlar, 2014). In fact, the activities of Netval over the past two decades are clearly discernible, rendering it Netval one of the oldest associations of its kind in Europe. Throughout its existence, Netval has produced annual reports and other documentation that trace its evolution on an annual basis. Furthermore, two of the authors have had the opportunity to collaborate with the association for a long period, facilitating access to key informants.

The data collection process lasted throughout the first semester of 2024. According to the prescriptions of Cloutier and Ravasi (2021), relied on multiple primary and secondary sources that we collected in Table 2 and iteratively triangulated. As primary sources, we conducted 37 interviews with professionals and Netval affiliates who are representative of all the major Italian universities and PROs. The list of informants can be found in Appendix A. To mitigate the potential influence of retrospective interpretation bias, we included secondary sources (Yin, 2013) such as reports directly provided by our respondents, and external documents accessed through our informants.

The primary sources were collected using a semi-structured interview protocol to make it easier to compare the interviews. The interviews were recorded and transcribed within 48 hours and were mostly conducted by the last two authors of the paper. Following standard practice (Yin, 2013), the selection of informants was primarily based on snowball sampling. We started the process with eight informants as suggested by the association staff. During the interviews, we requested that each of these informants recommend potential new candidates for inclusion in the study.

[Table 2: Data sources]

Primary sources		
Data source	Type of data	Use in the analysis
Interviews	37 interviews with technology transfer professionals (e.g., TTO managers, Vice Chancellors for technology transfer, and Directors of technology transfer units). Questions regarded background information about the respondents and the organizations involved; the barriers to fostering the impact of technology transfer; the governance structures of their organizations and their technology transfer process.	Expanding the topics that emerged in the literature review. Understanding the governance mechanisms that underpin the technology transfer initiatives of universities and PROs. Exploring the relationship between technology transfer and impact.
Secondary sources		
Data source	Data source	Use in the analysis
Association annual reports	18 Annual reports (2005-2023) Netval's reports describing the annual association activities and the Italian evolution of the national technology transfer scenario.	Expanding our understanding of the technology transfer process in the national setting. Triangulating facts and observations emerged from interviews with informants.
Universities impact reports	12 Impact reports Universities and PROs' reports disclosing impact metrics and case studies of technology transfer initiatives of different universities and PROs committed to dissemination.	Expanding our understanding of the technology transfer process and impact measurement in some of the organizations considered. Triangulating facts and observations emerged from interviews with informants.
Slides	27 Decks of slides Decks of slides used as official documents to present universities and their technology transfer initiatives.	Expanding our understanding of the setting up of the association and its overall evolution over time. Triangulating facts and observations emerged from interviews with informants.

3.3. Data analysis

In analyzing data sources, we adopted an inductive and iterative approach (Eisenhardt and Graebner, 2007), building upon similar technology transfer studies (Cunningham et al., 2017). According to standard practice in qualitative research (Cloutier and Ravasi, 2021; Saldaña, 2021, pp. 26-27), the first two authors carried out three separate rounds of data analysis independently, applying a line-by-line in-vivo approach. They first isolated interviewees' statements related to recurring concepts and then aggregated them into emerging governance mechanisms. Each author performed this activity manually, collecting data in Excel spreadsheets. To reinforce the reliability of the findings, whenever information obtained from primary sources was unclear, incomplete, or contradictory, the authors relied on secondary sources to clarify the interpretation of the interviews' transcripts. To enhance

data analysis and to foster intercoder reliability (i.e., the degree to which coders agree on codes) (Hruschka et al., 2004), the authors drew on the definition of impact and governance provided in our theoretical background. Each author carried out this process individually until data saturation was reached (i.e., no new connections among sources emerged). This process led to the identification of a preliminary set of governance mechanisms aggregated into common levels that should be accounted for by universities and PROs to foster the impact of their technology transfer initiatives from a governance perspective.

For example, the governance mechanism “proposing structural interventions with other universities and PROs” builds upon statements recognizing the importance of deliberately building bottom-up strategic partnerships with other institutions operating in the same region to share goals and drive impact in a specific context. This includes initiatives such as the co-financing of programs to implement technology transfer initiatives with local SMEs, which share the objective of accelerating local development and innovation. Similarly, at the national level, we considered statements related to establishing a national Proof-of-Concept program aimed at increasing the technological maturity of research-based inventions and intensifying the number of licensing contracts with firms. Those statements were supplemented and contextualized also through secondary sources such as universities’ impact reports and slides describing the organization of the initiatives and measuring their outputs. In our findings, we specify whether the governance mechanisms identified in interviews with technology transfer professionals were corroborated by the secondary sources described in Table 2.

Then, all four authors came together to compare the governance mechanisms that emerged from the individual analysis. They aggregated them within a single scheme, paying attention to similarities and differences. This process led to the isolation of a unified set of governance mechanisms and their refinement until the procedure did not provide further insights. In this process, to further strengthen the findings’ reliability, the other two authors validated the mechanisms identified with a separate round of analysis in collaboration with a few of our key informants in an online workshop. This represented a chance to refine the interpretation of our data and validate the final version of the findings that we schematized in Table 3, Table 4, and Table 5.

FINDINGS

The coding procedure led us to identify three different levels that should be accounted for by universities and PROs to foster the impact of their technology transfer initiatives (i.e., political, relational, and technological). Drawing on Chrisman et al. (2013), for each of the three levels we built upon the theoretical lenses that are recognized to guide the governance of initiatives as such in revealing a set of formal and informal governance mechanisms. For each set of mechanisms, we identified a “seat of governance”, i.e., the place in which governance decisions are made and governance mechanisms are activated, and the key element to leverage. In this regard, we refer to “universities and PROs” when governance mechanisms can be activated by managers and decision makers at the central level of those organizations (i.e., executives, deans, vice-deans, and managing directors). We refer to “TTOs” when the mechanisms can be activated by actors operating inside those internal functions of universities and PROs that daily deal with operational and field-based

technology transfer initiatives. We schematized our preliminary findings in a table for each governance level identified (Table 3, Table 4, Table 5).

4.1. Leveraging goals at the political level

The first level that emerges in our data analysis is the political one (Table 3). Within this level, we recognize a set of governance mechanisms that refer to the political sphere of the interaction, and, therefore, to the realm of how different actors interact to shape processes, policies, and initiatives related to the technology transfer domain. This sphere concerns interactions occurring within and beyond the boundaries of universities and PROs, i.e., between the core function of the universities or PROs and their offices (i.e., TTOs), as well as between those organizations and actors operating within their local or national contexts. We associate to the political level a set of mechanisms related to interview transcripts in which continuously emerged sentences and references to words such as “goals”, “objectives”, “aims”, “targets”, or “indicators” in the explanation of the technology transfer governance and impact-related aspects.

[Table 3: Governance mechanisms – Political level]

Governance levels	Key elements to leverage	Formal Governance Mechanisms	Informal Governance Mechanisms	Seat of governance
Political Level	Goals	Maintaining a proactive dialogue with local and national policymakers.	Building mutual trust with local institutions.	Universities and PROs
		Proposing structural interventions in association with other universities and PROs. (*)	Contributing to a shared vision of the local development. (*)	
		Setting clear objectives related to technology transfer initiatives. (*)	Fostering informal lobbying and advocacy with firms and institutions.	
		Aligning TTOs’ goals with other organizational goals. (*)		TTOs
		Developing a balanced portfolio of technology transfer contracts. (*)		

All the data were derived from the interviews with technology transfer professionals; () indicates “supplemented with secondary sources”.*

The governance mechanisms at the political level are both formal and informal in nature. In terms of formal operations, universities and PROs centrally engage in proactive dialogue with local and national policymakers to ensure that technology transfer initiatives are aligned with broader economic and innovation goals. Such mechanisms may be activated through the establishment of thematic tables at the regional and national levels that make researchers and universities or PROs’ managers sit together with policymakers, groups of interests, and politicians of every level. Formal interventions often include proposing structural reforms in association with other universities and

PROs such as the implementation of coordinated policy initiatives at the national level, as well as setting clear objectives to measure the effectiveness and the impact of technology transfer initiatives on a national basis. Regarding this topic, a respondent reported:

“Targets related to technology transfer appear to be increasingly ambitious nowadays It seems quite unlikely that this growth process can be accompanied without leveraging interventions proposed and managed by universities such as ours. In this regard, many of the initiatives have been put in place by our national association for technology transfer and by the political will to collaborate for a common goal”. [ID2, Big University B]

In this regard, our respondents stressed the importance from a governance side of setting clear technology transfer related objectives and properly measuring them. As stated by the dean of a small university:

“When we reached out technology transfer objectives, those goals were always associated with specific KPI targets that were built upon the university’s five-year strategic plan and aligned with the performance trend of the prior years. [...] much does the political capacity to act as a conduit between different levels and integrate everything into a coherent plan to guide the impact of the organization”. [ID23, Small university C]

Informally, governance at this level also entails fostering mutual trust with local institutions by engaging universities and PROs in collaborative projects with local and regional trade and professional associations, as well as local municipalities which are recognized as a pivotal gateway for fostering the valorization of the assets of researchers and students. Local institutions as such are recognized by our respondents as “multipliers” in the sense that intentionally investing in a process of trust-building with them may result in the multiplication of opportunities for the transfer of technology and knowledge while also contributing to the formation of a shared vision for local development. Other informal governance mechanisms are related to the fostering of informal lobbying and advocacy efforts with firms and institutions around specific strategic topics pertinent to a particular territory. For instance, some universities and PROs have established detached research laboratories in peripheral areas also to foster the emergence of technology transfer initiatives in less prone contexts.

When we consider the mechanisms that may be activated by TTOs, we recognize the importance of aligning TTOs’ goals with other organizational goals. Once more, the political dimension of governance strongly relies on goals interconnection between different levels. One of the riskiest aspects identified by several respondents is the lack of coherence between the top-down macro-objectives identified at the university level informed by an overall strategic vision and the operative micro-objectives informed by an operational vision. This also aligns with the need to develop a balanced portfolio of technology transfer contracts. In fact, many of our TTO managers recognized the need to differentiate the technology transfer initiatives. As one of the respondents stated:

“When we plan our technology transfer activities, it is all about exploring different options in parallel and creating more shots on goal”. [ID27, PRO - Research Center C]

4.2. Leveraging people at the relational level

The second level that emerges from our data analysis is relational (see Table 4). At this level, we recognize a set of governance mechanisms pertaining to the human side sphere of interaction, and, therefore, to the realm of how different actors built upon social capital and personal relationships when dealing with the governance of technology transfer and the impact of those initiatives. In addition, in this case, we refer to relationships in the intra and inter-organizational domains. We associate to the relational level a set of governance mechanisms that build upon sentences that constantly refer to “people”, “professionals”, “relations”, “interactions”, “stakeholders”, and “networks”.

[Table 4: Governance mechanisms – Relational level]

Governance levels	Key elements to leverage	Formal Governance Mechanisms	Informal Governance Mechanisms	Seat of governance
Relational Level	People	<p>Bolstering the retention of technology transfer professionals.</p> <p>Engaging firms through dissemination events. (*)</p>	<p>Participating in local and national events. (*)</p> <p>Coordinating the various internal stakeholders.</p> <p>Recognizing and valorizing the expertise of people working in the TTOs.</p>	Universities and PROs
		<p>Designing and activating joint research programs between researchers and industry. (*)</p> <p>Engaging researchers through education. (*)</p>	<p>Opening communication channels with firms and institutions. (*)</p> <p>Fostering dialogue with other universities and PROs' offices.</p> <p>Coordinating the various external technology transfer-related stakeholders. (*)</p> <p>Leveraging personal relationships between researchers and industry professionals.</p>	TTOs

All the data were derived from the interviews with technology transfer professionals; () indicates “supplemented with secondary sources”.*

Also, at this level, we observed different formal and informal governance mechanisms. Universities and PROs implemented specific mechanisms to incentivize the retention of technology transfer professionals. Our respondents recognized that in the context of significant employee turnover, it is not uncommon for roles that rely heavily on tacit knowledge, such as those of technology transfer managers (Micozzi et al., 2021; Villani and Grimaldi, 2024), to experience challenges in potential “loss of efficiency” or “bottlenecks in the technology valorization pipeline”. This is due to the absence of individuals who are expected to facilitate the process, as well as an imbalance between the workload and the number of available personnel.

“Needless to say, it is all about people at the end of the day. The kinds of projects in which we are involved sometimes may be long and require very specific knowledge. This is why it is key to identify the proper professionals to be involved and ensure that he or she leads the whole process. [...] as a PRO we allocated budget to activated incentive schemes including financial bonuses, training courses, and flexible working conditions”. [ID14, Large university A]

However, it is not always like this. The question of the incentives system in the context under discussion remains unresolved. One of the respondents claimed that:

“TTO should have a more commercial structure. If people working at TTO received a reward they would be more encouraged to manage more projects”. [ID16, Medium University A]

Informally, in this sense, it is also of great importance to facilitate the coordination of internal stakeholders through the constant monitoring of the efforts and competencies of TTOs’ professionals.

“Not everyone can do everything. The main governance efforts should be related to aligning project pipelines and people with the proper expertise to manage the valorization process. We are a generalist university; our technologies span many different domains. [...] the challenge is to connect the dots between people and technologies”. [ID25, Medium University A]

Regarding the people involved, the governance mechanisms were established with the dual objective of engaging both internal and external stakeholders. Often respondents reflected upon the importance of dissemination events, and public engagement activities such as festivals or networking opportunities in collaboration with key partners related to specific topics for the purpose of engaging with new people in technology transfer initiatives and “getting a foot in the stakeholders’ door” as one of the professionals interviewed asserted. This may be seen when considering the informal mechanisms.

On the other hand, TTO managers are responsible for the formal design and activation of joint research programs between researchers and industry partners. Such collaborative schemes are frequently proposed to universities and PRO stakeholders to place people at the center and stimulate collaborations. Those are often fully funded or co-funded. Examples of this nature include research initiatives such as co-financed doctoral programs or professional exchanges with firms. Concurrently, our respondents recognized the importance of instructing researchers on technology transfer initiatives. Many TTO professionals recounted similar experiences, including the following anecdote:

“Our approach is to begin with the researchers and the relationships we can establish with them. For this reason, we organize and provide a variety of training courses on IP management and collaborative technology development wherein we present potential avenues for technology valorization [...] In many cases, this represented the first chance to meet scientists with whom we later collaborated.”. [ID24, PRO - Research Center B]

When we consider TTOs as the seat of governance, many informal mechanisms emerge. The first mechanism is related to opening communication channels with firms and institutions, this may take the form of newsletters or online portals, with the objective of stimulating the flow of information

among stakeholders and, therefore, the emergence of initiatives. At the same time, it is recognized the importance of fostering dialogue with other universities and PROs' offices. Many TTO professionals complained about the lack of integration from the central level among different offices, feeling "isolated" and "disconnected", thus reflecting upon the importance of identifying informal communication channels within organizations such as online groups in social media.

At the relational level, a final remark is related to the need to coordinate all the various external technology transfer-related stakeholders. In some cases, TTOs build their community or network of firms and other partners. This process may be also fostered by leveraging personal relationships between researchers and industry professionals. The quality of technology transfer interactions has frequently been the subject of criticism, with the process often described as sporadic and unsystematic. This has led to a reliance on the personal relationships of professors and researchers. This issue frequently arose during our interviews. Many professionals claimed the need to identify "champion" scholars (for a definition, please see Schenkenhofer et al., 2024) and collaborate with them to learn from the best in class and reproduce such models with other internal actors.

4.3. Leveraging resources at the technological level

The third and last level that emerges from our analysis is the technological (see Table 5). At this level, we recognize a set of governance mechanisms pertaining to the technological sphere of the interaction, and, therefore, to the realm of how different actors leverage the uniqueness of technologies and knowledge-intensive assets internally developed to foster a more effective technology transfer governance. We associate to the technological level a set of governance mechanisms related to informants' sentences that constantly accounted for words such as "technology", "patent", "IP", "knowledge", "prototypes", and "assets" while discussing their perspectives on the governance of the technology transfer process and its related impact.

[Table 4: Governance mechanisms – Technological level]

Governance levels	Key elements to leverage	Formal Governance Mechanisms	Informal Governance Mechanisms	Seat of governance
Technological Level	Resources	Activating organizational solutions to support TTOs.	Documenting best practices guide the technology transfer process. (*)	Universities and PROs
		Activating impact-oriented universities and PROs' boards and councils for technology valorization. (*)		
		Developing formal IP management schemes to protect and manage IP rights effectively. (*)	Fostering knowledge sharing through informal interactions and meetings among researchers.	TTOs
		Enabling various valorization and investment paths based on the sectors.		

		<p>Mapping and monitoring the technologies developed in universities and PROs' laboratories.</p> <p>Increasing flexibility in managing the technology valorization process. (*)</p>		
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All the data were derived from the interviews with technology transfer professionals; (*) indicates "supplemented with secondary sources".

Even at the latter level, we observed the emergence of several formal and informal governance mechanisms. Universities and PROs at the central level collaborated to implement organizational solutions that would support TTOs by reducing their workload and facilitating market access through more streamlined operating models. One solution that has been implemented is the outsourcing of TTO activities to an investee company while maintaining a minimal organizational structure internally at the university. As a technology transfer general director stated:

"In our case, the rationale behind the decision to externalize the commercial activities to an external organization under our control was to facilitate a more efficient and streamlined operational structure. At the time, the external organization was a limited company that has since evolved into a foundation. The administrative and routine aspects of the operations were maintained within our internal structure. So, while TTOs dealt with patent applications, order vouchers, and invoices, the managers of our subsidiary engaged in direct interactions with external entities. These interactions involved the promotion of our technologies and the negotiation of contractual terms". [ID30, Large University C]

In many cases, special committees were constituted with the objective of providing support to this process and selecting which patents to pursue and which to decline. This resulted in the activation of impact-oriented universities and PROs' boards and councils for technology valorization. Such boards convene regularly and comprise both industrial and academic members. The respondents identified these entities as valuable in facilitating connections with prospective industrial partners and in recommending optimal strategies for technology commercialization.

At this stage, the TTOs end up playing a more central role in the governance of technology transfer initiatives. In terms of governance mechanisms, respondents recognized the relevance of developing formalized IP management schemes to protect and manage IP rights effectively. This pertains to the standardization of the technology transfer process at the initial stage of many interactions between TTOs and researchers as well as collaboration between researchers and external partners. Being technologies the very heart of those initiatives, many professionals pointed out the need to formalize multiple steps from their novelty and technological maturity assessment to the identification of their market potential before patenting those solutions or identifying other possible paths for protecting and managing those technologies. As a director of a technology transfer-related area explained:

"Our IP management process is highly structured; this helps us avoid inefficiencies in the subsequent technology valorization. We start with a meeting with the research team, after

which we then start with a technological assessment, to ascertain not only the novelty of the technology but also its true potential [...] once we clarify these issues, we proceed with the patent application. Only at that point, the IP is taken over by one of our managers who will be responsible for its valorization”. [ID21, Large University B]

The activation of these governance mechanisms is often related to the fact that most of the time, the researchers who file the patents tend to cease at the application stage, without subsequently advancing the product to the market. As one of our respondents stated:

“No one talks about whether researchers actually produce innovative technologies or whether the patents are just a plan B for projects that they fail to publish, thus, asking the TTO to patent, perhaps urgently”. [ID8, PRO - Research Center E]

Another challenging issue faced by TTOs is related to the design and establishment of different valorization and investment paths based on different technological sectors. In sectors in which the time-to-market of technologies is shorter, different collaborative initiatives have been established with the objective of increasing technologies’ maturity and fostering their validation. Among the possible cases, the one of a national polytechnic university in the south of Italy may be of interest:

In our university, public-private laboratories worked. These arise through agreements, at least five years, in which there is a minimum funding of €200,000 per year from the company. Through these labs, faculty, researchers, fellows, doctoral students, and the company's own staff collaborate on technology development activities that may be of interest to the company R&D”. [ID5, Medium University B]

At the same time, many TTOs identified specific investment paths according to different sectors. In this regard, many collaborations with investment funds emerged with verticality in life science sectors, unambiguously recognized by our respondents as the most complex to deal with.

Another challenging issue is related to the need to effectively access the knowledge and technologies developed inside universities and PROs’ research laboratories. Therefore, TTOs implemented procedures to constantly map and monitor the technologies, thereby improving the technology valuation process and carrying out systematic scouting of innovative solutions with market potential. This is the case for many TTOs such as the one of a large university we considered:

“On a monthly basis, we schedule meetings within departments, facilitating direct interactions with individual research groups to gain insight into their current projects. Each department is assigned a dedicated PM who knows the technological trends prevalent in the labs, organizes training activities, and serves as a liaison for researchers seeking to transfer technology.” [ID7, Large university E]

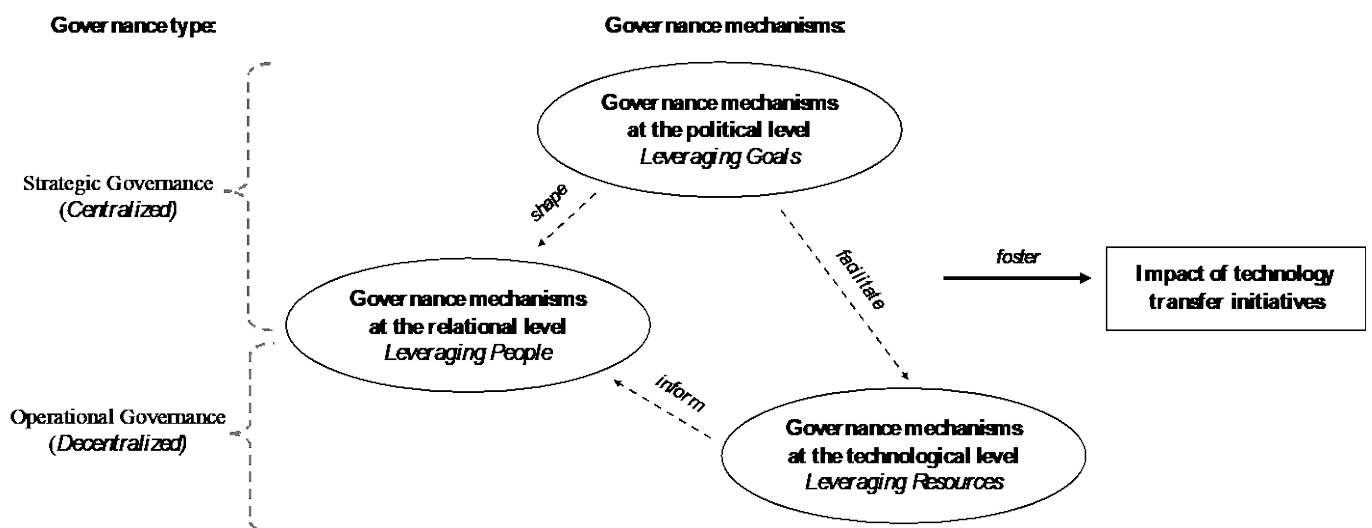
Furthermore, from a governance perspective, respondents claimed that universities and PROs’ timelines are not always aligned with the market ones due to high levels of bureaucracy. More flexibility in managing the technology valorization process is recognized as of utmost importance. In this regard, technology transfer procedures should be streamlined and their timelines shortened, to align them more closely with those of the market and, in some cases, outsourcing procedures.

From an informal perspective, some TTO professionals recognized the importance of fostering knowledge sharing internally, this may happen through informal interactions and meetings among researchers that can share their technology transfer experience and stimulate a more impact-oriented mindset.

FOSTERING TECHNOLOGY TRANSFER IMPACT BY LEVERAGING GOALS, PEOPLE, AND RESOURCES

In investigating the governance mechanisms that universities and PROs can implement to foster the impact of their technology transfer initiatives, we identify the emergence of three different levels in which those mechanisms take place. Those levels are not isolated but often appear to mutually depend on each other as emerged from our respondents' claims. In many cases, technology transfer experts and professionals overlap them to explain their daily activities or their perspectives about what impact-oriented technology transfer governance should look like. In answering our research question, we schematized the governance mechanisms' levels and how they interact in Figure 1.

[Figure 1: Governance mechanisms to foster the impact of technology transfer initiatives]



First, it emerges the key role of governance mechanisms at the political level that act as enablers for the activation of those mechanisms at the relational and technological levels. Specifically, our respondents recognized that many governance mechanisms that formally or informally leverage goals shape those that leverage people. In other words, considering internal relations, more political mechanisms drive the growth of TTOs and the types of professionals to be involved. At the same time, the goal system and its widespread integration within Universities and PROs have been found to activate professional incentives, enhance their skills, and stimulate their retention. Considering external relations, our respondents recognize that Universities and PROs play a role in “intervening with programs that incentivize companies to interact with research groups” (e.g., ID28, Medium University B) or in “creating large-scale events that allow the involvement of a wide range of stakeholders” (e.g., ID21, Large University B).

Furthermore, mechanisms at the political level also facilitate the emergence of mechanisms at the technological level, in the sense that the constant dialogue with public and private institutions in the context in which universities and PROs operate paves the way to all those governance mechanisms that leverage technologies. Specifically, we have identified mechanisms at the policy level when our respondents recognize the central role of Universities and PROs that need to be proactive in “opening channels of exchange and dialogue for technology exploitation” (e.g., ID20, PRO - Research Center A), “working on the ground to spread a culture of technology transfer” (e.g., ID10, Large University D), “developing policy initiatives that help negotiate technologies” (e.g., ID33, PRO – Research Hospital B), and “financing collaborative development programs with businesses” (e.g., ID35, Small university B).

Finally, it emerges that the technological level informs the relational one. In fact, governance mechanisms that leverage universities and PROs’ resources by valorizing them on the market appear to be strongly related to the people side of the coin, both in terms of professionals being involved in TTOs and relationships with industry.

An increasing strategic and operational awareness of these three levels and their constant interaction can foster the impact generation from technology transfer initiatives. Specifically, this impact depends on the proper activation of interdependent governance mechanisms that can leverage three distinctive elements, i.e., goals, people, and resources. As one of our respondents claimed:

“I realized how difficult but essential it is to piece actors and resources together. It is not only an issue of needs and goals but also of knowing how to cultivate relationships rooted in the distinctive characteristics of people and technologies. We often forget how interdependent all these aspects are.” [ID12, Small university C]

Furthermore, we recognize the presence of two different governance dimensions that foster the impact of technology transfer initiatives. The first is strategic governance, in the sense that those mechanisms are activated by central positions of universities or PROs and are associated with a long-term scope. This is the case of managers such as area managers or directors of specific units, and decision makers such as the deans, the vice deans, or the delegates to technology transfer or similar third mission-related initiatives such as research valorization or industry engagement. Given their nature, those mechanisms seem to belong more to the political and relational level of governance. The second is operational governance which deals with the ordinary life of TTOs or other designated offices. In this case, the governance mechanisms are activated by actors such as technology valorization managers, IP managers, and similar professionals that operate inside TTOs or internal functions of universities and PROs that daily deal with operational and field-based technology transfer initiatives. Those mechanisms seem to belong more to the relational and technological level of governance. However, there are no double standards. Both strategic and operational governance dimensions are required and can inform each other. Many of our respondents recognized the need to increasingly alienate these two governance dimensions to foster the impact of technology transfer initiatives. We accounted for this distinction while schematizing the findings in Figure 1.

DISCUSSION AND CONCLUSION

6.1. Theoretical implications

This paper focuses on those governance mechanisms that can be implemented by universities and PROs to foster the impact of their technology transfer initiatives. In addressing this issue, we conducted an inductive and empirical analysis of the Italian technology transfer setting as an exemplary case. Our study identifies a set of governance mechanisms associated with three different levels of governance, i.e., political, relational, and technological. In terms of theoretical implications, this work aims to make two broad contributions.

First, this work contributes to the extant debate on technology transfer and impact in two ways. First, we engage with the technology transfer literature by providing a governance perspective on a topic mostly addressed from an individual, organizational, and performance perspective (Audretsch et al., 2014; Schoen et al., 2014; Wright, 2014).

Specifically, with the identification of the seat of governance (i.e., the place in which governance decisions are made and governance mechanisms are activated) we shed light on the inherent complexity that underpins the governance of technology transfer. Drawing upon Schoen et al. (2014) and their call for studies to foster the effectiveness of the technology transfer governance, we unveil that each organization involves in the governance process different actors that take part in various seats of governance, revealing which kinds of governance mechanisms each of them can activate alone or in synergy with other internal and external actors. The current TT debate stresses the importance of identifying the role of each actor in the technology transfer value chain of universities and PROs (Pohle et al., 2022; Siegel et al., 2023; Villani and Grimaldi, 2024). We argue that acknowledging the seat dependency of those mechanisms and specifically delineating the role of different actors, may foster the effectiveness of the governance of these initiatives and, therefore, foster the impact of technology transfer initiatives. For example, at the political level, many more governance mechanisms can be activated by core people at the central level than by TTO professionals at the peripheral level. On the other hand, at the technological level, many more governance mechanisms can be implemented by TTO professionals.

Furthermore, we distinguish at every level between formal and informal mechanisms. This represents an attempt to categorize all those informal mechanisms, by their nature, traditionally recognized to be more difficult to codify (Link et al., 2007). We find that there are different levels at which governance takes place and that at each level different emphasis is associated with the formal and informal dimensions. For example, the relational level is where the informal dimension emerges with higher intensity, while it is not the same for the technological level. This is mainly because the governance of technology transfer emerges to still rely on loosely standardized processes when it comes to considering personal interactions (Freitas et al., 2013) but it still requires high formalization when it comes to addressing the governance issues in technology scouting, protection, and valorization.

Second, we contribute to the governance literature by integrating and expanding the understanding of three key theories (i.e., goal setting, stakeholders, and resource dependence theory) from a governance perspective in a setting such as technology transfer that has been overlooked by scholars (Audretsch et al., 2014; Schoen et al., 2014). Our findings enrich the understanding of these three

theoretical constructs by identifying the emergence of three different levels of governance (i.e., political, relational, technological) and how their respective distinctive elements (i.e., goals, people, and resources) may be combined and leveraged to foster technology transfer effectiveness and impact.

From a goal setting theory perspective, it is widely established in the literature that clear goal definition in the governance process ensures strategic alignment by providing a common and measurable path for actors within universities and PROs (Fini et al., 2018; Giones et al., 2019), our findings show that this alignment is often challenged by the coexistence of multiple and conflicting objectives at different internal levels. Therefore, we present a set of mechanisms at the political level that explain how actors interact to shape processes, policies, and initiatives. These mechanisms help mitigate tensions by establishing formal mechanisms such as national policy coordination and strategic planning, as well as informal mechanisms such as trust-based collaborations with local institutions. Furthermore, while goal setting theory highlights the risks of overly specific goals limiting flexibility (Locke and Latham, 2006; Ordoñez et al., 2009), our findings suggest that universities and PROs may manage this challenging issue by fostering goals' interconnection across governance layers. This reinforces the need for governance mechanisms that connect macro- and micro-objectives, fostering the effectiveness of technology transfer initiatives.

From a stakeholder theory perspective, our findings provide a set of governance mechanisms related to how universities and PROs navigate the relational level of technology transfer initiatives. The importance of balancing diverse stakeholder interests in governance is no new to stakeholder theory scholars (Stieb, 2008; Parmar et al., 2010). In this regard, our findings reveal that universities and PROs implement formal and informal mechanisms to better address the complex nature of human capital and social networks. While persistent challenges remain in coordinating people's interests (Schenkenhofer et al., 2024), we shed light on possible pathways to bridge internal and external stakeholders, reinforcing the need for governance mechanisms at the relational level to foster the impact of technology transfer initiatives.

Finally, from a resource dependence theory perspective, our findings underscore the relevance of managing interdependencies with external partners at the technological level. Traditionally, scholars have emphasized the role of governance mechanisms in facilitating resource control and exchanges (Pfeffer and Salancik, 1978; Drees and Heugens, 2013). This centrality is confirmed by our respondents, who highlighted the technological level of governance. However, in the specific context of technology transfer, where technologies result from years of research and collaboration (Abreu and Grinevich, 2013; Drees and Heugens, 2013), we observed that universities and PROs often externalize certain functions, such as commercialization, to leverage external resources and expertise more effectively. These findings suggest a strong interdependence between the technological and relational levels, as in technology- and human capital-intensive settings, these two aspects are closely linked. In this regard, formalized IP management schemes and market-oriented investment paths were identified as key to address the dynamic nature of these interdependencies, ensuring transfer from research to broader market and societal impact.

By answering the call for more governance studies of this sort on different institutional settings than those of family firms (Chrisman et al., 2013), the integration of these three strands of theory offers a unified framework to understand and navigate the challenges inherent in technology transfer

governance. For each level of governance, we specify the mechanisms that should be activated, and by which type of actors, providing a flexible and modular outlook that can be applied according to the business model of universities and PROs (Baglieri et al., 2018).

6.2. Practical implications

Our study raises important managerial implications for Universities and PROs decision makers, and TTO managers considering how to create better conditions to foster the impact of technology transfer initiatives through governance mechanisms. Particularly, our work shed light on the need to better integrate the different actors that deal with technology transfer not only from a communication perspective (Freitas et al., 2013; Villani and Grimaldi, 2024) but also from a goal integration and a relational one. This requires universities and PROs to rethink the centrality of their third mission activities in their organizational and strategic model by leveraging governance mechanisms related to people and goals, but also by governing the valorization of their resources through tailored technology transfer initiatives.

At the same time, another implication is to create the organizational conditions that support the governance mechanisms hereby described to meet the expectations of internal and external stakeholders. In this sense, goals, people, and resources may represent a common ground to implement more widespread and impact-driven technology transfer initiatives both at the strategic and operational levels.

Furthermore, for potential external stakeholders such as industry or institutional partners, our findings suggest different levels to access the technology transfer governance domains of universities and TTOs. This work may be informative to understand where to focus their interaction and negotiation efforts according to the seat of governance and the different key elements to leverage. The model we propose may provide an instrument to further understand the inherent complexity that underpins organizations such as universities and PROs whose technology transfer initiatives are characterized by a multitude of actors (both strategic and operational), and offices.

A key practical implication concerns the applicability and scalability of the governance framework, and its related governance mechanisms, beyond the Italian context. As previously mentioned, such a case may be informative for all those national contexts in which universities and PROs technology transfer capabilities are still in their early stage of development and have not reached their full potential yet (Algieri et al., 2013; Villani and Lechner, 2021). In this sense, the various mechanisms may serve as a foundation for university and PRO's administrators seeking to establish or assess their own governance models. At the same time, such a governance framework may be applied to analyze and compare the governance mechanisms implemented in more developed contexts, providing insights into best practices and potential areas for improvement to foster the impact of technology transfer initiatives.

In conclusion, our observation may alert policymakers concerned with the development of technology transfer capabilities and infrastructures in a specific national setting (Striukova and Rayna, 2015; Schenkenhofer et al., 2024). In the last decades, universities and PROs have experienced major changes that have affected how they implement technology transfer initiatives (Perkmann et al.,

2013). These transformations forced policymakers to design and implement technology transfer policy initiatives by relying on benchmarking and experimentation rather than grounded in evidence-based frameworks (Geuna and Muscio 2009). While there is still much to be investigated by researchers, this work represents a preliminary attempt to integrate disparate mechanisms into a conceptual framework that may inform policymakers about the inherent complexity in the governance of technology transfer initiatives and the mechanisms implemented to foster their impact. Specifically, each policy designed should account for these three levels (i.e., political, relational, and technological) that can make coherent and consistent the various national, regional, local, and university-level measures implemented.

6.3. Limitations and avenues for future research

Our work is not free from limitations that we believe may represent a starting point for future studies on the governance of technology transfer initiatives. While we accounted for multiple actors and organizations in our case study at the national level, the generalizability of an inductive study of this nature could be further strengthened. Therefore, we suggest validating the proposed framework in different national and organizational settings. Indeed, the study may be replicated under a multiple-case design that accounts for cross-national differences. In considering different national contexts, it would also be relevant to observe how such a framework evolves according to the maturity of the technology transfer context in which universities and PROs' TTOs operate.

Second, this study accounts for the governance mechanisms, but it does not consider the different business models of TTOs. While it is true that the Italian context follows very standardized models with few exceptions (Battaglia et al., 2017), if we extend the geographical scope of the study, we observe different patterns (Baglieri et al., 2018). Future studies may account for a wider integration and validation of the governance mechanisms within different organizational settings (i.e., centralized, semi centralized, or decentralized TTOs' structures) (Battaglia et al., 2017). Such a research approach would be advisable to strengthen the reliability and validity of our findings.

In conclusion, while achieving broader societal impact has become a top priority for universities and PROs (Fini et al., 2018; Guerrero and Siegel, 2024), this process still has a long way to go. We believe that the technology transfer governance for impact approach that we illustrate in this paper still requires a set of indicators to enhance its operability and better guide the decision-making process of those institutions. Therefore, future researchers may implement quantitative studies that propose and validate impact metrics informed by the three governance levels we present in this study. This approach may lead to a more granular and process-oriented understanding of the phenomenon.

Appendix A: Informants' list.

ID	Informant role	Affiliation	Duration	Date
1	Director Technology Transfer Area	Big University B	1 hr 15'	02/02/2024
2	Director Technology Transfer Area	Big University B	1 hr	03/02/2024
3	Vice Chancellor for Research Valorization	Large University D	50'	03/02/2024
4	Director of Research and Business Relations Area	Large University B	50'	15/02/2024
5	Area Manager Research Valorization	Medium University B	1 hr	16/02/2024
6	Vice Chancellor for Technology Transfer	Small university D	1 hr	16/02/2024
7	Technology Transfer Manager	Large university E	1 hr 10'	23/02/2024
8	IP Manager	PRO - Research Center E	45'	23/02/2024
9	Technology Transfer Manager	PRO - Research Center E	45'	23/02/2024
10	Technology Transfer Manager	Large University D	1 hr 15'	20/02/2024
11	Technology Transfer Manager	Small university B	45'	28/02/2024
12	General Director	Small university C	50'	28/02/2024
13	Vice Chancellor for Technology Transfer	Medium University A	50'	28/02/2024
14	Research Valorization Sector Manager	Large university A	1 hr 10'	28/05/2024
15	Head of BioTechnology Transfer Office	PRO – Research Hospital A	45'	28/05/2024
16	TTO manager	Small university A	1 hr 15'	29/05/2024
17	Technology Transfer Manager	PRO - Research Center E	1 hr	29/05/2024
18	Technology Transfer Manager	Small university B	1 hr 10'	30/05/2024
19	Vice Chancellor for Technology Transfer	Big University A	50'	30/05/2024
20	IP Manager	PRO - Research Center A	1 hr	31/05/2024
21	Director of Research and Business Relations Area	Large University B	1 hr	31/05/2024
22	Vice Chancellor for Research Valorization	Large University D	1 hr 15'	03/06/2024
23	Dean	Small university C	1 hr	03/06/2024
24	Technology Transfer Manager	PRO - Research Center B	1 hr	31/05/2024
25	Vice Chancellor for Technology Transfer	Medium University A	1 hr 10'	03/06/2024
26	IP Manager	PRO - Research Center E	1 hr	03/06/2024
27	TTO Manager	PRO - Research Center C	50'	03/06/2024
28	TTO Manager	Medium University B	1 hr	05/06/2024
29	Director of Research Valorization Unit	PRO - Research Center D	50'	11/06/2024
30	Director of Technology Transfer Unit	Large University C	1 hr	11/06/2024
31	Director of Technology Valorization Area	Large University D	1 hr	11/06/2024
32	Technology Transfer Manager	Large University D	1 hr 15'	11/06/2024
33	IP Manager	PRO – Research Hospital B	1 hr	11/06/2024
34	Technology Transfer Manager	PRO – Research Hospital C	1 hr	11/06/2024
35	Vice Chancellor for Third Mission Activities	Small university B	1 hr	12/06/2024
36	Vice Chancellor for Technology Transfer	Large University E	1 hr 15'	12/06/2024
37	Technology Transfer Manager	Large university D	1 hr	12/06/2024

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