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University technology transfer offices' capabilities in responding to societal challenges: lessons from an exploratory study during the COVID-19 pandemic

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Abstract
Over the last decades, the University Technology Transfer Offices (UTTOs) literature has focused on how technology transfer contributes to economic development and only a few studies have focused on social development. This study explores how UTTOs transform into ambidextrous organizations capable of simultaneously addressing economic and social challenges, during external crises such as the COVID-19 pandemic. Particularly, we explore which dynamic capabilities and strategies should be developed or reconfigured by UTTOs to respond to complex societal challenges. We conducted an exploratory qualitative study using semi-structured interviews with 20 UTTO officials from universities across Europe, North America, and Latin America, carried out in 2020 and 2021. Our findings show that UTTOs reconfigured their dynamic capabilities and implemented inclusive strategies, such as flexible intellectual property models, inclusive technology transfer practices, and newmetrics that integrate social value. These adaptations enable UTTOs to respond effectively to the COVID-19 pandemic by facilitating the translation of impactful technologies to societal needs. We propose a theoretical framework that incorporates the role of dynamic capabilities—sensing, seizing, and transforming—into how UTTOs align economic and social goals by translating knowledge-creation processes to make discoveries that address social needs and financial opportunities. This study highlights some strategic implications based on the emergence of ambidextrous UTTOs, which focus on simultaneously driving both economic and social impacts.

Keywords University technology transfer offices · COVID-19 pandemic · Social entrepreneurship · Academic Entrepreneurship · Cross-cultural comparisons · Dynamic capabilities

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1 Introduction

University Technology Transfer Offices (UTTOs) play a critical role in bridging the gap between academic research and industry, focusing on the commercialization of innovations through patenting, licensing, and the creation of spin-off companies (Grimaldi et al., 2011; Siegel & Wright, 2007). UTTOs significantly contribute to regional economic development by transferring technology from universities to the market (Wright, 2014). Over the last decades, the UTTOs literature has mainly focused on economic outputs, such as revenue generation and fostering entrepreneurship within academic institutions (Etzkowitz, 2016), therefore, their role in creating economic value is generally accepted (Etzkowitz, 2016; Fischer et al., 2020). However, this economic focus often overlooks the broader potential of UTTOs to also address complex societal challenges, an aspect that has become increasingly relevant in light of external crises such as the Global Financial Crisis or the COVID-19 pandemic (Siegel & Guerrero, 2021), as well as motivated by multiple stakeholders pressures (Guerrero & Siegel, 2024).

The focus of UTTOs on economic contributions has led to a limited exploration of their role in addressing the big societal challenges. The COVID-19 pandemic exemplifies the need for a social orientation by highlighting the urgent need to leverage academic knowledge and to reconfigure organizational capabilities to meet pressing social needs (Guerrero & Pugh, 2022). While prior research has provided some insights into how universities are responding to big societal challenges, there is still a gap in understanding the potential of UTTOs to address social challenges and manage external crises (Etzkowitz, 2016; Fischer et al., 2020; Siegel & Guerrero, 2021). In this regard, the COVID-19 pandemic has revealed organizational limitations and potential opportunities in mobilizing resources and capabilities to address urgent social needs (Ibáñez et al., 2022; Yáñez-Valdés et al., 2023). Assuming UTTOs are ambidextrous organizations (Audretsch & Guerrero, 2023), the research question is: which dynamic capabilities and strategies should be developed or reconfigured by UTTOs to seize economic and social opportunities during external crises?

To address the research question, this paper has two research objectives. First, we explore the scope and nature of UTTOs' dynamic capabilities to respond to complex social challenges and external crises. Second, we explore strategies for enhancing these dynamic capabilities to address large-scale social challenges and external crises. To achieve these goals, we employ an exploratory qualitative research approach grounded in the dynamic capabilities framework. This framework, as outlined by Teece et al. (1997), is useful theoretical approach for understanding how UTTOs can reconfigure resources or develop capabilities to adapt to rapidly changing conditions (Guerrero et al., 2021; Guerrero & Menter, 2024). We use this framework to data gathered from 20 semi-structured interviews with UTTO officials, in Europe, North America, and Latin America, from 2020 to 2021. This methodological design provides a wide range of in-depth insights on how UTTOs manage external crises (e.g., the COVID-19 pandemic) as well as aligned resources and capabilities to address economic and social goals simultaneously (Gioia et al., 2013; Teece, 2010; Guerrero & Pugh, 2022).

The remainder of this paper is structured as follows: First, we provide a critical overview of the value-creation activities of (ambidextrous) UTTOs, examining both commercial and social contributions. Second, we provide an overview of the dynamic capabilities framework and its implications to UTTOs. Third, we describe our methodological design, including research settings, case selection criteria, data collection, and data analysis. Fourth, we present the results and discuss the results in light of our proposeddynamic

capabilities framework. Then, we include some practical implications and future research directions. Finally, we conclude with the study's contributions, emphasizing how UTTOs can enhance their strategic resources, capabilities, and impacts by effectively integrating economic and social goals while managing external crises.

2 Theoretical foundations

2.1 Value creation at UTTOs

UTTOs are essential in converting academic research into economic and societal value, acting as intermediaries between universities and external stakeholders. They drive economic development, enhance institutional competitiveness, and stimulate regional innovation by commercializing academic research outputs (Grimaldi et al., 2011; Porter, 1991; Rasmussen, 2008). Acknowledging this role, governments have implemented policies within national innovation systems to support the integration of universities, industries, and society, thus facilitating technology transfer (Clarysse et al., 2011a, 2011b; Link & Siegel, 2009; Siegel et al., 2004). Universities, responding to these policies, have invested strategically in UTTOs to maximize research commercialization and value creation (Good et al., 2019).

UTTOs facilitate value creation mainly through patents, licenses, and spin-offs, serving as crucial conduits for translating research into societal applications (Grimaldi et al., 2011; Siegel & Wright, 2007; Guerrero & Siegel, 2024). Beyond commercialization, UTTOs influence various aspects of innovation systems, including the intentions of academics to commercialize research, the creation of spin-offs, and the dynamics of university patents (Goethner et al., 2012; Huyghe et al., 2016; Morales-Gualdrón et al., 2009; Neves & Brito, 2020). Their ability to align academic research with societal needs enhances the relevance and impact of transferred technology, positioning them as mediators between academia and the broader community (Urbano et al., 2019).

However, UTTOs must navigate and adapt to technological advancements and changing market conditions to maximize the impact of university research (Etzkowitz, 2008; Grimaldi et al., 2011). This adaptability allows them to focus on high-potential technologies and explore new applications, driving value creation in a dynamic landscape (Audretsch et al., 2014; Taylor Aldridge & Audretsch, 2017). Effective multi-stakeholder engagement further enhances their ability to align research outputs with societal demands, improving the relevance and impact of technology transfer (Ali et al., 2019; Clarysse et al., 2011a, 2011b).

Despite their effectiveness in economic value creation, UTTOs often emphasize commercial projects over social value creation due to the challenges in measuring social impact and a preference for clear commercial outcomes (Cameron, 2012; Matheson et al., 2008). To address this, robust frameworks for evaluating social impact and integrating social value metrics into UTTO performance assessments are necessary (Santos, 2012a; Siegel & Wright, 2015). UTTOs also shape their host universities' strategic visions by aligning with institutional goals and interacting with external actors to identify market opportunities (Ali et al., 2019; Clarysse et al., 2011a, 2011b). Nonetheless, their focus on commercial viability can lead to the neglect of social innovations aimed at addressing systemic social and environmental challenges (Breznitz et al., 2008; Crescenzi et al., 2017; Wright et al., 2007a, 2007b).

To fully grasp the complexities and potential of UTTOs, it is essential to analyze them through the lens of dynamic capabilities. While theories like the Resource-Based View (RBV) and the Theory of Planned Behavior offer insights into the factors driving technology transfer (O'Shea et al., 2005; Perkmann et al., 2013), these frameworks are limited in addressing the continuous adaptation required in today's fast-paced environment. Similarly, the Human Capital Theory and Knowledge-Based View highlight the importance of entrepreneurship and knowledge transfer as competitive advantages (Guerrero & Urbano, 2012; Kirkman, 2013; Powers & McDougall, 2005), and the Theory of Organizational Learning explains how UTTOs achieve goals through technology transfer (Abdul Wahab et al., 2012). However, none of these perspectives adequately address the dynamic, iterative processes necessary for UTTOs to respond to rapid technological changes and market shifts.

Dynamic capabilities provide a more comprehensive framework for understanding how UTTOs can integrate, build, and reconfigure internal and external competencies to address environmental changes effectively. This approach enables UTTOs to remain agile and responsive, ensuring that they can manage the uncertainties associated with emerging technologies and shifting market demands (Teece, 2010; Guerrero et al., 2021; Guerrero & Menter, 2024). By leveraging dynamic capabilities, UTTOs can better align their strategies with both economic and societal goals, thus enhancing their dynamic capacity to create value in a constantly evolving landscape. This theoretical lens sets the stage for a more detailed exploration of dynamic capabilities in the context of UTTOs, as discussed in the next sub-section.

2.2 Linking dynamic capabilities and UTTOs

Dynamic capabilities are fundamental in strategic management and are critical for organizations, including UTTOs, to adapt to rapidly changing environments (Teece, 2010; Teece et al., 1997). Although the application of dynamic capabilities to UTTOs is relatively recent, this framework is essential for understanding their adaptability and strategic agility (O'Reilly et al., 2019). Dynamic capabilities encompass the processes of sensing new opportunities and threats, seizing these opportunities, and transforming organizational structures and strategies to address identified changes (Teece et al., 1997; Teece et al., 2016). For UTTOs, these processes manifest through strategic visioning, negotiation routines, technological capabilities, stakeholder engagement, and talent management (Kuuluvainen, 2012; Guerrero et al., 2021; Guerrero & Menter, 2024).

Adopting a dynamic capabilities approach allows UTTOs to continuously reassess and adapt their strategies, ensuring they remain effective in transferring technology from academia to industry (Agarwal & Shah, 2014; O'Reilly et al., 2019; Guerrero & Menter, 2024). This adaptability enhances UTTOs' ability to manage uncertainties associated with emerging technologies and shifting market demands, thereby contributing to both economic and societal goals (Pisano, 2015). Dynamic capabilities also support UTTOs in navigating complex regulatory and policy environments, enabling them to anticipate and respond to regulatory changes, ensuring compliance while leveraging new opportunities that arise from policy shifts (Rao & Weintraub, 2013; Teece et al., 2016). Internally, dynamic capabilities foster innovation within UTTOs, allowing them to continuously refine processes, develop new services, and enhance their value propositions to stakeholders (Agarwal & Shah, 2014). This intrapreneurial innovation capacity is vital for sustaining UTTOs' competitive advantage and ensuring they can effectively support the

commercialization and social impact of university research (O'Reilly et al., 2019; Pisano, 2015; Guerrero et al., 2021).

Conversely, UTTOs influence their host universities' strategic directions by interacting with external entities such as industry, government, and other academic institutions (Clarke, 2002; Teece et al., 2016). This interaction, whether proactively or reactively, enables UTTOs to anticipate market demands and environmental changes, guiding universities to adjust their strategies accordingly (Markman et al., 2005; Schaeffer & Matt, 2016). For instance, the COVID-19 pandemic has driven universities to develop technology-driven social initiatives, challenging UTTOs to support these initiatives despite their focus on economic value creation (Balasubramanian et al., 2020; García-Morales et al., 2020; Rojas & Simon, 2020; Guerrero & Pugh, 2022).

UTTOs' dynamic capabilities include unique commercial expertise for technology transfer, unique business development strategies, and extensive social capital to connect academic entrepreneurs with external stakeholders (Neves & Franco, 2016; Rubin et al., 2015). These dynamic capabilities support the commercialization of research and the creation of spin-offs, contributing to their sustainability (Chen & Lin, 2015; Erikson et al., 2015; Etzkowitz, 2008). Empirical research suggests that UTTOs with significant and unique experience in technology commercialization have a substantial impact on the success of spin-offs (Siegel et al., 2007).

The literature on technology transfer also highlights UTTOs' emphasis on capturing economic value through patents, licenses, and high-growth potential spin-offs (Drivas et al., 2014; Fischer et al., 2020). Ambidextrous organizations that balance economic and social objectives attract a broader range of stakeholders, enhancing their legitimacy and performance (Audretsch & Guerrero, 2023; Chen & Lin, 2015; Lang & Fink, 2019; Soria et al., 2016). Empirical evidence also shows that university-driven technology initiatives can simultaneously address social issues and create economic value (Buera et al., 2020; Rojas & Simon, 2020).

3 Methodology

Given the nature and the scope of our study, an exploratory qualitative analysis is the most appropriate method to achieve our research question and objectives (Yin, 2018). To this end, we conducted semi-structured interviews among individuals serving as university technology transfer officers, and experts in entrepreneurship and innovation. Each participant was actively involved in the decision-making processes within their respective UTTOs. To minimize bias, we selected UTTOs from different regions (Europe, North America, and Latin America) that operate under comparable regional rules, economic settings, and policies. This approach recognizes that while there are overarching similarities within regions, such as shared regulatory frameworks and economic environments, there are inherent variations between regions that affect UTTO operations (Bingham et al., 2007; Eisenhardt, 1989).

For example, European UTTOs adhere to the guidelines, regulations and standards set by the European Commission, which fosters a somewhat consistent approach to technology transfer across European Union member states. These guidelines emphasize open innovation and collaboration with industry, which can influence European UTTOs to prioritize partnerships and collaborative projects. In contrast, North American UTTOs might be influenced by the Bayh-Dole Act, which encourages the commercialization of federally

funded research and often leads to a focus on patenting and licensing. Meanwhile, Latin American UTTOs may operate within national frameworks that emphasize technology transfer as a means of economic development, often resulting in initiatives that support local industries and address regional needs. By adopting this selection criteria, we expect to capture a diverse range of practices and contextual influences, allowing for a richer analysis of UTTO behaviors and strategies in different regional contexts.

In the following sections, we describe the research setting, followed by the case selection, data collection, and data analysis employed in this research.

4 Research setting

University UTTOs, as we have argued in previous sections of this study, have already established capabilities that allow them to promote the creation of knowledge from the commercial opportunities they identify in the marketplace. We also explain that it is not yet clear whether such capabilities also promote the creation of knowledge from social opportunities or global crises. In this sense, it is important to examine in a variety of UTTOs, identified in different geographies, how they take advantage of or deal with social opportunities, which often present themselves in the form of crises. Accordingly, we take advantage of the COVID 19 pandemic to try to shed light on the knowledge gap of this research and to discuss the inadequacy or otherwise of UTTOs when it comes to addressing major crises.

Revisiting the dynamic capabilities theory, one of its central arguments revolves around the adaptive capacity of organizations in the face of abrupt changes in the environment (Leih & Teece, 2016; Teece, 2010). A clear example of an abrupt change in the environment is the global COVID-19 pandemic. Such a pandemic created several challenges due to the massive unemployment, the closure of large, small, and medium-sized companies, the change in the way business is done, thousands of people falling into conditions of extreme poverty, and millions of people dying from the COVID-19 pandemic (Bacq et al., 2020; Buera et al., 2020; Guerrero & Siegel, 2024). Likewise, the pandemic also affected the way in which universities reached out to students and continued to operate with all of their different departments (e.g., faculties and offices with specific functions), including UTTOs, which were also affected.

In this study, we gather data from UTTOs officials and experts situated in Latin America, Europe, and North America, which populations experienced a signiticative number of cases during the COVID-19 pandemic (Guerrero & Pugh, 2022). The selection criteria lie in the variations in R&D investment (inputs) and productivity/efficiency in technology transfer (outputs) observed in these three regions (see Table 1). Each criterion is crucial given that the COVID-19 pandemic crisis renders the ambidextrous profile of UTTOs (economic and social strategic goals), particularly in developed economies. However, Most societal challenges are prevalent in developing economies with lower R&D investment and lower technology transfer outcomes.

The Appendix shows the interview protocol used in the data collection process, which covers topics related to the UTTOs mechanisms already in place to identify and exploit market opportunities, as well as those under development to address social challenges and mitigate the COVID-19 pandemic. Prior to conducting the interviews, the interview protocol was revised/improvedby seven experts in innovation and entrepreneurship.

Table 1 R&D investment and the effectiveness of technology transfer in Latin America, Europe, and North America

Region	Inputs: Investment in R&D	Outputs: Technology Transfer Effectiveness	Observations
Latin America	In 2021, the investment in R&D fell from 0.7% in 2015 to 0.6% in 2021, with significant differences between countries. In terms of absolute amounts, Argentina and Mexico spend the equivalent of 1.2% of its GDP on R&D. Meanwhile, Colombia and Ecuador spend less than 0.2% of their GDP on R&D	Very Low	Lack of investment affects human capital and technological capacity bulding of UTTOs and SMEs, increasing competitiveness gap (ECLAC, 2024)
Europe	In 2021, the Euroean Union (EU)'s R&D expenditure rose to €331 billion, marking a 6.9% increase from the nearly €310 billion spent the previous year. This represents a 45.0% growth since 2011	High	UTTOs are more effective than expected. Outperforms the US in licenses and startups (Eurostat, 2023)
North America	In 2020, the US invested $708 billion in R&D. This investment was contributed by the private sector-businesses ($517.4 billion), the public sector ($142.8 billion), universities ($22.6 billion), and nonprofit organizations ($25.1 billion)	Very High	US UTTOs are leaders in patents, startups, and license revenue. Less effective than Europe in licenses and startups per investment (West, 2022)

4.1 Case selection

Following our research question and objectives, we collected the views of UTTOs in different contexts to understand the transformation of these organizations during the COVID-19 pandemic. As reported and justified in the previous subsection, three regions were selected: North America, Latin America, and Europe. Concretely, the selected UTTOs' participants were located in Europe (Belgium, France, Spain, and Italy), Latin America (Colombia, Ecuador, Brazil, and Argentina), and North America (the United States and Mexico). Participants included UTTO officers and experts in innovation and entrepreneurship. This diversity of participants located in different geographical areas is useful for understanding the dynamic capabilities of UTTOs related to commercial activities ando those that emerged during the COVID-19 pandemic (see Table 2). The selection criterion of participants was based on the similarities between universities to reduce biases due to organizational and contextual factors (Corbin & Strauss, 1998).

4.2 Data collection

In this study, we follow Lincoln and Guba (1986) in terms of how information is interpreted in order to elucidate from a diverse group of participants the meaning of their experiences and comments. For this reason, the opinions of experts and UTTOs officials are very useful in the research.

Table 2 List of Participants

Participant (P)	Code	Institution—Organization	Country
Participant 1	P1	TTO Universidad de Antioquia	Colombia
Participant 2	P2	Expert—Entrepreneurship and Innovation	USA
Participant 3	P3	TTO—Vrije Universiteit Brussel	Belgium
Participant 4	P4	TTO—University of Duke	USA
Participant 5	P5	Expert- Intellectual Property—Ministry of Science	Argentina
Participant 6	P6	Expert- Intellectual Property—Ministry of Science	Argentina
Participant 7	P7	TTO—Universidad de la Sabana	Colombia
Participant 8	P8	TTO—Macondo Lab	Colombia
Participant 9	P9	Business Incubator—Universidad Javeriana	Colombia
Participant 10	P10	Social Innovation Expert—Government	Colombia
Participant 11	P11	Scientist—Alexander Von Humbolt	Germany/Colombia
Participant 12	P12	TTO—Universidad del Valle	Colombia
Participant 13	P13	TTO—Universidad de Caldas	Colombia
Participant 14	P14	TTO—Know Hub Chile	Chile
Participant 15	P15	TTO—Universidad Politécnica de Madrid	España
Participant 16	P16	TTO- University of Mons	Belgium
Participant 17	P17	Innovation Expert – ESPOL*	Ecuador
Participant 18	P18	TTO—Université de Lyon*	France
Participant 19	P19	TTO—Tecnológico de Monterrey*	Mexico
Participant 20	P20	TTO—Universidad Nacional de Colombia*	Colombia

*Participants who did not consent to being recorded but agreed to the interview

We then used the semi-structured interview technique to facilitate the exploration of the phenomenon in question described in the previous sections of this paper. The data collection was based on the results of 20 semi-structured interviews conducted between the second semester of 2020 and the first semester of 2021. Due to the complexity of the social situation during this period, the interviews were conducted online using MS. Teams software. They were also recorded and transcribed in Word to increase reliability and reduce bias in the analysis (Brink, 1993; Golafshani, 2003). Each interview lasted between 40 and 60 min.

4.3 Data analysis

As a measure of validity (Brink, 1993), participants were informed about the research purpose and encouraged to ask questions during their interviews to establish trust and transparency. Each interview was recorded and transcribed to enhance the study's reliability. For data analysis, we followed Eisenhardt's (1989) methodological guidelines. We employed Atlas.ti 9.0 software for coding, which facilitated the systematic organization of the data according to the dynamic capabilities framework outlined earlier in this paper.

To ensure a rigorous qualitative analysis, we adopted a coding process that included open, axial, and selective coding techniques, similar to those used in prior studies of innovation and entrepreneurship (Lincoln & Guba, 1986; Roncancio-Marin et al., 2022a, 2022b). We applied the Gioia methodology to maintain methodological rigor. This structured approach systematically identifies first-order concepts, aggregates them into second-order themes, and ultimately forms broader aggregate dimensions (Gioia et al., 2013). This methodology enabled a nuanced exploration of how UTTOs manage both economic and social value creation, particularly in the context of crises (e.g., Global Financial Crisis, COVID-19 pandemic).

Atlas.ti 9.0 software was instrumental in this process, ensuring a comprehensive and organized analysis. Table 3 presents our coding structure, exemplifying how UTTOs balance economic and social value creation through illustrative quotes (Corbin & Strauss, 1998; Zahra, 2007). This table demonstrates the application of our coding framework and how it reflects the dual/ambidextrous objectives of UTTOs in addressing both economic and social challenges.

The procedure described above was repeated until data saturation was reached in interview 12; however, we continued with the following 8 interviews to verify that what was observed did not change (Brink, 1993; Golafshani, 2003).

5 Findings

5.1 Value creation by UTTOs: economic and social

Our analysis reveals that UTTOs play a crucial role in both economic and social value creation in the analyzed regions, specially in Europe and North America. The COVID-19 pandemic has underscored this dual (ambidextrous) role, highlighting how UTTOs facilitate the development of social innovations alongside economic endeavors. For instance, UTTOs contribute to the formation of multiple collaborations with NGOs and civic organizations based on university technologies that promote distributed knowledge for social

Table 3 Coding Structure

1st Order Concepts	2nd Order Themes	Aggregate Dimensions
- Technology-based NGO creation	Social Value Creation	Triggers of Social Value Creation
- Impact assessment of social innovations	Social Opportunities and Market Pull	
- Open technology introduction in crisis	Creation of New Value Not Dependent on Intellectual Property	Emerging Value Creation Mechanisms
- Technological absorption capacity	Addressing Slow Technological Absorption	
- Accelerated technology transfer needs	Necessity for Accelerated Technology Transfer Processes	
- Hybrid social and economic goals pursuit	Pursuit of Hybrid Goals	Transformation to Hybrid Value Creation
- Implementation of new internal regulations	New Internal Regulations Implementation	
- Recruitment and training of social venture talent	Recruitment and Training of New Talent	
- Development of alternative performance indicators	Development of New Indicators	
- Integration of social entrepreneurship	Embracing Social Entrepreneurship	
- Utilization of social crises for knowledge creation	Creation of New Knowledge	

purposes (Abreu & Grinevich, 2013). These activities demonstrate how UTTOs enhance social value while also driving economic growth through technology commercialization.

In economic terms, UTTOs focus on metrics such as patenting rates, revenue from licensing, and the number of spin-offs. These existing metrics capture the financial returns and the commercialization success of university research (Albats et al., 2018). However, UTTOs also generate significant social value by fostering innovations that address societal challenges, especially during the COVID-19 pandemic. This focus requires an evolution in performance measurement methodologies to include metrics that assess both economic and social impacts (Siegel & Guerrero, 2021).

The interconnection between economic and social value creation is particularly evident when UTTOs balance commercial goals with the promotion of social innovations, specially in developed economies. This balance is crucial for ensuring that innovations with significant social benefits are not overlooked in favor of those with immediate economic returns (Agarwal & Shah, 2014). For example, UTTOs support technologies that may not be immediately lucrative but have substantial potential to address social issues, thereby integrating economic objectives with societal needs (see representative quotes in Table 4).

Navigating this dual/ambidextrous value creation involves strategic adaptations in technology transfer processes. UTTOs are exploring approaches that retain control over intellectual property while facilitating broader access for social purposes. This balance ensures that technologies are accessible for addressing social needs without compromising their financial viability. During the COVID-19 pandemic, UTTOs have adapted by employing flexible intellectual property mechanisms that allow for open distribution while maintaining essential control, aligning with the suggestions of Abdul Wahab et al. (2012) and Siegel and Guerrero (2021). These adaptations highlight UTTOs' ability to leverage their resources for social good, even under challenging economic conditions.

5.2 Dynamic capabilities of UTTOs: inadequacies and opportunities

Expanding on the ambidextrous role of UTTOs in value creation, the COVID-19 pandemic has highlighted the necessity for reconfiguring capabilities to address emerging societal needs. This reconfiguration aligns with dynamic capabilities theory, which emphasizes the importance of organizational agility in adapting to rapid environmental changes (Teece et al., 1997). UTTOs have been compelled to pivot strategically, incorporating new methods for technology absorption and aligning their initiatives with the societal challenges posed by the pandemic (Bacq et al., 2020; Guerrero & Pugh, 2022; Guerrero & Siegel, 2024).

The dynamic capabilities identified in our analysis include:

Accelerated Technology Transfer Processes: The pandemic has necessitated a faster turnaround in transferring technologies from universities to societal applications. This capability involves streamlining processes to reduce the time from research to application, crucial for addressing urgent societal needs (Bingham et al., 2007).

Adaptation to Socially Oriented Grants: UTTOs have had to align their strategies with grant opportunities that prioritize social impact over economic outcomes. This alignment requires UTTOs to integrate social criteria into their technology transfer strategies, ensuring access to funding aimed at solving societal issues.

Enhancing Technological Absorption: Slow technological absorption remains a challenge, as some stakeholders struggle to adopt new technologies rapidly. UTTOs need to

Table 4 Representative Quotes

Subsection	Quote
5.1	"An NGO was created based on a technology that was created at the university. It is possible, and in the case of foundations or NGOs, we are looking to create a movement in which technology serves as a basis for enabling a social purpose, more than social is a purpose of distributed knowledge."
5.1	"It is crucial for universities to be motivated to assess the impact of social innovations. If UTTOs focus solely on return on investment, their prioritization criteria will naturally lead them to collaborate with licensees offering higher margins. This approach could result in the neglect of certain inventions or the failure to execute initiatives designed to spotlight inventions that typically go unnoticed."
5.1	"Indeed, the practical strategy is largely determined by the allocation of resources. While some choose to focus on patenting, others prioritize the number of collaborations with industry, the creation of spin-off companies, and so forth."
5.1	"UTTOs are primarily focused on managing intellectual property control to ensure proper utilization of technologies. Concurrently, they aim to recoup research and protection investment costs. The latter objective is less aligned with the exigencies of the pandemic. However, the former is crucial. With maintained control, the financial aspect can be made more adaptable."
5.2	"In light of the pandemic, many universities have pledged to help alleviate its impact, compelling UTTOs to adapt and introduce technologies in a manner that allows for open absorption."
5.2	"The main barrier is the capacity for technological absorption. Training is needed to develop a repeatable enterprise model, ensuring that resources, processes, and revenue formulas operate efficiently, even in social businesses."
5.2	"Transfers to NGOs are possible using existing contracts, as current laws allow for such agreements. The real gap lies in training both researchers and technology transfer officers about this possibility."
5.2	"University regulations are crucial. Besides having competent transferors, it's important for universities to have external support units, like incubators, or individuals who specialize in developing new businesses."
5.2	"A balance between top-down and bottom-up approaches is essential. Ideas often originate from the bottom-up, but top-down guidance is needed to foster and identify these ideas early on, preventing them from being overlooked."
5.2	"Certain UTTOs assess their impact by the number of jobs created or the duration of technology use in the environment, which can be challenging to quantify. Some institutions, particularly in Chile, are attempting this."
5.3	"In social entrepreneurship scenarios, a product-market fit and a scalable business model are essential. I believe it's feasible, especially with clear guidelines in place."
5.3	"The ability to complete a project is crucial. Many researchers can advise on research but lack a project champion, who may have the initiative but not the talent or training for social ventures."
5.3	"The impact of UTTOs depends on their metrics, which vary from revenue returns to impact, to the number of companies created. These metrics are dictated by the institution, not the UTTO. We need alternative metrics, as measuring social impact remains a challenge"
5.3	"A common issue in UTTOs is that team members often aren't entrepreneurs themselves, leading to confusion about the concept of social entrepreneurship, which is sometimes mistaken for charity."
5.3	"Universities now experience a kind of market pull, which, while not a traditional market, is an environment rich with social crises. When viewed from the right perspective, these crises can also present opportunities."

develop capabilities that facilitate easier integration of technologies into social applications, overcoming barriers to adoption (Kafouros et al., 2020).

Creation of New Value Not Dependent on Intellectual Property (IP): In response to the crisis, UTTOs are exploring value creation mechanisms that do not rely heavily on existing IP models. This approach includes open-source and collaborative models that allow for rapid dissemination and application of technologies to meet societal needs (Rasmussen, 2011).

The pressure to develop these capabilities has led to several adaptive measures:

Development of New Indicators: UTTOs are developing new performance indicators that capture the broader impact of their activities, including social value creation. These indicators provide a more comprehensive assessment of their contributions (Clarysse et al., 2011a, 2011b).

Recruitment and Training of New Talent: To meet emerging challenges, UTTOs are recruiting new talent with expertise in social entrepreneurship and related fields. This infusion of skills helps UTTOs adapt to the demands of the current crisis (Leih & Teece, 2016).

Implementation of New Internal Regulations: UTTOs are revising internal regulations to facilitate quicker decision-making and more flexible approaches to technology transfer. This regulatory agility is crucial for responding to rapidly evolving societal needs (Bacq et al., 2020; Guerrero & Siegel, 2024).

Pursuit of Ambidextrous Goals: UTTOs are increasingly pursuing ambidextrous goals that balance economic and social value creation. This approach ensures that UTTOs remain aligned with both their financial objectives and their broader societal missions (Albats et al., 2018).

In general, these dynamic capabilities and adaptive measures are responses to the crisis.

5.3 UTTOs adaptation: to meet emerging societal needs

Building on the need to adapt dynamic capabilities, UTTOs are transitioning their resources and strategies to align with the evolving needs driven by the COVID-19 pandemic. This involves exploring diverse technology transfer approaches, including the establishment of social enterprises as vehicles for hybrid value creation (Leih & Teece, 2016). These approaches highlight the necessity of clear guidelines and training for initiating social enterprises, extending beyond technology transfer paradigms to address new societal challenges.

Challenges in transferring technology for social enterprises are compounded by a lack of necessary knowledge and experience among UTTO personnel. Effective training and development programs are crucial for bridging this knowledge gap, enabling UTTOs to support social ventures more robustly (Bienkowska et al., 2016). Training includes clarifying the concept of social entrepreneurship, often conflated with charitable activities, ensuring UTTO personnel can effectively facilitate social ventures.

To adapt effectively, UTTOs are reconfiguring their business models and strategies to offer cost reductions for companies adopting technologies with a social focus. This approach ensures the viability of social initiatives without imposing heavy financial burdens on stakeholders (Guerrero & Urbano, 2012). Additionally, UTTOs are leveraging social activism to validate technologies in the market, aligning technological solutions with societal needs and enhancing their relevance (Cameron, 2012).

Reconfiguring human capital within UTTOs is essential for supporting social entrepreneurship and reducing barriers to technological absorption. This involves developing

repeatable enterprise models that ensure efficient operation of resources, processes, and revenue formulas even within social ventures (Teece et al., 2016). Connecting technological initiatives with external funding sources is crucial for scaling social enterprises, particularly in regions with limited access to existing funding mechanisms (Chen & Lin, 2015). This connectivity enables UTTOs to support the growth of social ventures effectively, aligning with broader societal objectives.

In general, the inadequacies of UTTOs in responding to social crises represent a fertile ground for improvement and adaptation. These challenges necessitate the reconfiguration of dynamic capabilities, emphasizing the development of new indicators, recruitment and training of new talent, implementation of internal regulations, and pursuit of hybrid goals (Siegel & Guerrero, 2021). Based on our findings, we propose the theoretical framework (Fig. 1).

6 Discussion

In this study, we pursued two main objectives: exploring the nature of UTTOs' capabilities in responding to social challenges and exploring UTTOs' strategies for developing dynamic capacities that enable to tackle social challenges and to manage external crises. Our findings, along with the proposed framework (Fig. 1), provide insights into how UTTOs have adapted and reconfigured dynamic capabilities and strategies in response to the COVID-19 pandemic.

6.1 Dynamic capabilities configuration during the COVID-19 pandemic

According to the interviewees, the COVID-19 pandemic pressured UTTOs to reevaluate and enhance their existing dynamic capabilities. Over the last decades, UTTOs have relied on well-established technology transfer mechanisms, such as commercializing

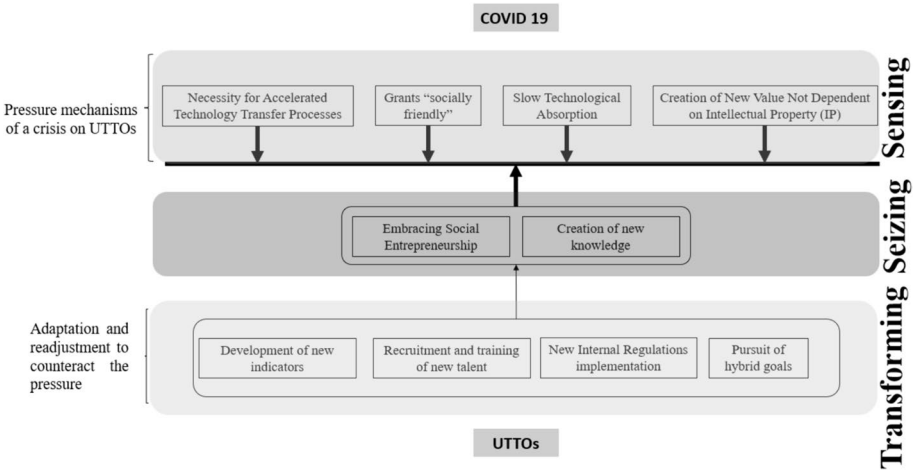

Fig. 1 Proposed Theoretical Framework: UTTOs' dynamic capabilities configuration in response to the COVID-19 pandemic

intellectual property, licensing agreements, and facilitating spin-offs to generate economic returns (Guerrero & Urbano, 2012; Rasmussen & Wright, 2015). However, the pandemic forced the emergence of ambidextrous UTTOs, which strategically address social and economic goals simultaneously (Gaudig et al., 2020; Nicola et al., 2020). The framework in Fig. 1 illustrates the UTTOs' operational shif, requiring them to incorporate more agile and responsive technology transfer strategies to mitigate the impacts of the COVID-19 pandemic.

The dynamic capability of "transforming" has emerged as particularly crucial in this context. This capability involves adapting and evolving organizational processes and strategies to better align with the rapidly changing external environment (Teece et al., 2016). For UTTOs, transforming capabilities meant reevaluating their value propositions to include not only economic gains but also significant social contributions (Guerrero et al., 2021). The COVID-19 pandemic's demands have prompted UTTOs to develop new indicators that reflect both social and economic impacts, to ensure a more holistic evaluation of their contributions (Clarysse et al., 2011a, 2011b; Siegel & Guerrero, 2021). This transformation is evident in UTTOs' efforts to collaborate with NGOs and other civicorganizations to create entrepreneurial andtechnology-based initiatives (Ibáñez et al., 2022), as well as in their exploration of flexible intellectual property mechanisms that allow for broader technology dissemination without compromising financial sustainability (Perkmann & Walsh, 2007b; West & Bogers, 2014).

Moreover, the COVID-19 pandemic underscored the importance of the "sensing" capability for UTTOs. Sensing involves the ability to identify emerging opportunities and threats in the environment, particularly those that require a rapid technological response to mitigate societal challenges (Teece, 2010). During the COVID-19 pandemic, UTTOs had to swiftly discern shifts in funding priorities, which began to emphasize rapid technological solutions for alleviating the human and economic impacts of COVID-19 pandemic (Ibáñez et al., 2022; Guerrero & Pugh, 2022). This dynamic capability required UTTOs to stay attuned to changes in grant calls and funding opportunities that now prioritized social impact over commercial metrics, ensuring their strategic initiatives remained aligned with the evolving needs of society (Bacq et al., 2020; Guerrero & Siegel, 2024). Sensing capabilities are therefore essential for UTTOs to adapt their strategies promptly and effectively in response to the dynamic demands of crises like the COVID-19 pandemic.

Complementing the sensing capability, the "seizing" capability is also critical for UTTOs' effective response. Seizing entails mobilizing and deploying resources and capabilities to capitalize on identified opportunities and mitigate emerging threats (Teece , 1997). For UTTOs, seizing involved adapting technology transfer processes to facilitate the rapid deployment of technologies with social benefits, often requiring a reduction or elimination of intellectual property barriers to ensure open access (Kafouros et al., 2020). This adaptation enabled UTTOs to leverage their technological assets more effectively to address urgent social needs, aligning with the broader goal of hybrid value creation that balances economic and social impacts (Albats et al., 2018). The necessity to adapt swiftly and efficiently underscores the importance of developing robust seizing capabilities to enhance UTTOs' responsiveness to crisis-induced pressures.

6.2 Theoretical contributions

Our proposed framework (Fig. 1) integrates the dynamic capabilities of sensing, seizing, and transforming to illustrate how UTTOs have adapted to the pressures exerted by

the COVID-19 pandemic. This framework not only aligns with but also extends existing theories by addressing the specific challenges faced by UTTOs in a managing external crises. In this regard, this study contributes to the UTTOs literature as follows:

Firstly, the "sensing" capability within our framework underscores the importance of identifying opportunities. In the context of the COVID-19 pandemic, this involved recognizing the immediate demand for technological solutions that could address the urgent challenges posed by the crisis (Bacq et al., 2020; Guerrero & Siegel, 2024). The ability to sense and respond to these needs is crucial for organizations to adapt to rapidly changing environments (Teece, 2010). However, sensing in a crisis context also requires a proactive approach to identifying shifts in funding priorities and societal expectations (Ibáñez et al., 2022). In the proposed framework, sensing is not merely about reacting to external signals but also about anticipating the changing organizational landscape (Perkmann & Walsh, 2007b).

The "seizing" capability within our framework highlights the necessity of effectively mobilizing resources and capabilities to capitalize on identified opportunities. Existing literature, such as the work by Teece et al. (1997), emphasizes the importance of this capability in ensuring that organizations can respond effectively to opportunities and threats. Our findings contribute to this discussion by illustrating how UTTOs adapted their technology transfer processes to facilitate the rapid deployment of socially impactful technologies. This adaptation often involved reducing or eliminating intellectual property barriers to ensure broader and faster access to these technologies (Kafouros et al., 2020). While the literature acknowledges the role of seizing in organizational adaptation, our framework specifically highlights the importance of flexible IP models and open access strategies in enhancing UTTOs' ability to meet societal needs during a crisis (West & Bogers, 2014). This approach reflects a shift from purely economic considerations to a more balanced view that integrates social value creation, a perspective that is increasingly relevant in the context of global crises (Siegel & Wright, 2015; Siegel & Guerrero, 2021).

The "transforming" capability, as presented in our framework, involves adapting and evolving organizational processes to better align with the changing environment. This aligns with existing theories on dynamic capabilities, which suggest that transforming is crucial for organizations to remain agile and responsive (Teece et al., 2016). Our framework extends this concept by detailing how UTTOs developed new performance indicators, recruited and trained personnel with expertise in social entrepreneurship, implemented new internal regulations, and pursued hybrid goals that balance economic and social value creation (Albats et al., 2018). These transformative actions illustrate how UTTOs can restructure their strategies and operations to enhance their impact on society, beyond economic metrics (Leih & Teece, 2016).

In contrast to the traditional focus on commercializing intellectual property and maximizing economic returns, our framework emphasizes a more nuanced approach that includes the development of new value not tied to conventional IP mechanisms. This shift is critical for ensuring that technologies can be deployed rapidly to address social needs, bypassing the delays often associated with traditional IP models (Perkmann & Walsh, 2007b). By advocating for open-source models and reducing IP costs, our framework supports a more inclusive approach to technology transfer that prioritizes societal benefits over economic gains (Bacq et al., 2020; Guerrero & Siegel, 2024). This perspective challenges the conventional wisdom that equates successful technology transfer with economic profitability, suggesting instead that UTTOs can achieve a broader impact by embracing more flexible and socially oriented strategies (Guerrero & Urbano, 2012).

Moreover, the framework addresses the often-neglected aspect of slow technological absorption, which we observed during the pandemic. Existing models frequently focus on the speed of technology transfer, but our findings highlight that the absorption rate is equally crucial. UTTOs had to develop capabilities to support stakeholders in adopting new technologies rapidly, overcoming barriers to absorption (Kafouros et al., 2020). This aspect of our framework provides a more comprehensive view of the challenges faced by UTTOs, suggesting that successful technology transfer involves not only efficient transfer processes but also effective support for technology adoption (Rasmussen & Wright, 2015).

In summary, the proposed framework offers a comprehensive approach to understanding the development the dynamic capabilities of UTTOs, integrating sensing, seizing, and transforming capabilities to address both economic and social goals. This study provides insights for UTTOs, suggesting the emergence of ambidextrous organizations that integrates economic and social value creation (Etzkowitz et al., 2021; Audretsch & Guerrero, 2023).

7 Implications

7.1 Implications for academic research

Our study contributes to the academic debate on innovation, entrepreneurship, and technology transfer by providing insights into the mechanisms and strategies employed by UTTOs to tackle societal challenges and to respond to external crises (e.g., the COVID-19 pandemic) (Roncancio-Marin et al., 2022a, 2022b). This research extends our knowlegde about how dynamic capabilities are crucial in the emergence of more ambidextrous UTTOs to simultaneously meet economic and social objectives (Audretsch & Guerrero, 2023), as well as contributes to the interdisciplinary intersection between dynamic capabilities, innovation management, technology transfer and crisis management literature (Teece, 2010; Siegel & Guerrero, 2021; Siegel & Wright, 2015; Erikson et al., 2015; Bingham et al., 2007; Montgomery et al., 2012).

7.2 Implications for practitioners

For practitioners, especially for the interviewed UTTO staff and university administrators, our findings offer some insights on how to adapt UTTOs technology transfer practices to better align with the societal challenges and manage external crises. The study reveals the feasibility of adapting existing intellectual property protection measures to foster social innovations (Perkmann & Walsh, 2007b). These insights provide an idea to develop/implement strategies that balance economic and social objectives, ensuring that technology transfer processes are responsive to crises or stakeholders needs (Albats et al., 2018).

In the analyzed Latin American research settings, our findings underscore the importance of modifying organizational regulations and culture to facilitate decision-making and support economic and social value creation. These modifications are essential for ensuring that UTTOs can respond effectively to sudden environmental shifts and emerging societal needs (Leih & Teece, 2016). Additionally, recruiting personnel with intrapreneurial expertise is crucial for enhancing dynamic transformation processes. These skills and knowledge are crucial to navigate the complexities of technology transfer in a crisis context and provide a more comprehensive evaluation of their impact (Albats et al., 2018).

Practitioners, in the analyzed research settings, should also consider the role of university leadership in providing top-down guidance to UTTOs, particularly in unfamiliar situations involving technology transfer for both economic and social purposes. Leadership is critical for aligning UTTOs' strategic initiatives and for ensuring an effective response to contemporary challenges (Graça & Camarinha-Matos, 2017).

Furthermore, practitioners should implement new models of intellectual property that allow for the rapid dissemination of technologies with social benefits in the analyzed research settings, including open-source approaches and reduced-cost IP frameworks (Siegel & Wright, 2015). These new models should focus on maximizing economic and social returns (Albats et al., 2018; Bacq et al., 2020).

7.3 Implications for policymakers

For policymakers, the study highlights the critical role of supportive policy frameworks in the analyzed research settings, specially in Europe and the United States. Policies that encourage the adaptation of intellectual property models and provide incentives for technology transfer initiatives (focused on social impact) are essential for fostering a more sustainable and inclusive entrepreneurial and innovative ecosystem (Guerrero & Urbano, 2012; Guerrero & Siegel, 2024) and for promoting the development of technologies that address societal challenges (Etzkowitz et al., 2021).

Policymakers should also consider developing funding programs and grant opportunities that translate innovations into social benefits, especially in the Latin American context. These programs should implement funding initiatives and impact mechanisms that enhance the social translation of technology transfer and inventions implemented in Europe and in the United States (Bacq et al., 2020; Guerrero & Siegel, 2024). In this way, policymakers can create an enabling environment that supports the rapid development and dissemination of socially impactful technologies, enhancing the role of academic institutions in driving positive social change (Nicola et al., 2020).

Additionally, in Europe and in the United States, policymakers play a crucial role in fostering collaborations between universities, industry, and government to support the development of technology-based solutions to societal challenges. These collaborations can provide valuable resources, intrapreneurial expertise, and networks that enhance capacity building of UTTOs across different regions (Etzkowitz et al., 2021). By promoting co-creation process with stakeholders, policymakers can facilitate the co-creation development of innovative solutions and inclusive ecosystems that are both economically viable and socially beneficial in the analyzed research settings (Cameron, 2012).

Finally, policymakers should also consider the relevance of technology in crisis management and create guidelines to address future external crises (Buera et al., 2020; Siegel & Guerrero, 2021; Ibáñez et al., 2022).

8 Conclusions

From our exploratory analysis, we draw two conclusions:

First, our analysis reveals that UTTOs are increasingly transformed into ambidextrous organizations and adopting flexible intellectual property models, inclusive technology transfer practices, and novel metrics that incorporate both social and economic value. This transformation enables UTTOs to respond effectively to the COVID-19 pandemic by facilitating

the rapid development and dissemination of impactful technologies with social benefits. We propose a theoretical framework integrating dynamic capabilities—sensing, seizing, and transforming—into UTTO operations. This framework also provides UTTOs' strategies to align their economic and social objectives, as well as to expand their current roles tocontribute to a more resilient and responsive society.

Second, our analysis provides how UTTOs could generate and apply knowledge/technologies to simultaneously address economic growth and societal well-being. The knowledge creation process at universities proves most effective when UTTOs focus on technologies that effectively tackle societal challenges while also driving economic progress.

Appendix

Interview protocol

1. Please describe how your work at the UTTO/University is related to entrepreneurship and the transfer of research results.
2. What type of resources and mechanisms does your UTTO/University currently have to support entrepreneurship and carry out the transfer of research results?
3. How do you currently consider the role of the UTTO/University to have a positive impact on society and economic growth?
4. Currently, what do you think is the role of the UTTO/University in terms of supporting social innovations within your university?
5. How do you think the COVID-19 pandemic will impact entrepreneurship, social entrepreneurship, and the transfer of research results from universities?
6. What do you think the role of your UTTO is, in promoting social enterprises creation with research results at your university to mitigate the impact of the COVID-19 pandemic?
7. In the framework of the COVID-19 pandemic, how do you think your UTTO can contribute to the transfer of research results to society (which are protected by IP and not intended for commercial purposes)?
8. In your opinion,—in the framework of the COVID-19 pandemic- what mechanisms or resources can be mobilized from the UTTOs to support social entrepreneurs?
9. How do you think stakeholders in your local ecosystem can help streamline and facilitate technology transfer from university to society during and after the COVID-19 pandemic?
10. What do you consider to be the main barriers that prevent: a) Creating social enterprises with research results, b) the transfer of non-commercial research results to society?

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