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Industry and Innovation

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ciai20

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To cite this article: David B. Audretsch & Maksim Belitski (2021): A strategic alignment framework for the entrepreneurial university, Industry and Innovation, DOI: 10.1080/13662716.2021.1941799

To link to this article: https://doi.org/10.1080/13662716.2021.1941799

Published online: 20 Jun 2021.

INDUSTRY AND INNOVATION
https://doi.org/10.1080/13662716.2021.1941799

Routledge
Taylor & Francis Group

A strategic alignment framework for the entrepreneurial university

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ABSTRACT

The Open Innovation in Science literature suggests university knowledge creation should be followed by knowledge dissemination to industry and the public. Although several entrepreneurial university models have been proposed in the literature explaining the role of knowledge production, extant studies generally assume that the elements required by and involved in university outbound innovation are automatically aligned. This conceptual piece introduces the corporate-inspired strategic alignment framework for entrepreneurial universities.

In addition, this paper examines the strategic congruence among the individual, organisational and system levels and the functional congruence between knowledge and entrepreneurial capitals. It demonstrates how they can fulfil the increasingly complex role that they must play in science, industry, and society.

KEYWORDS

Entrepreneurial university; open innovation; public; strategic alignment; entrepreneurial capital

1. Introduction

The role of the university has changed considerably over time (Audretsch 2014), with open innovation changing the way universities promote the dissemination and commercialisation of their research to industry and the general public (OECD 2013; Vicente-Sáez and Martínez-Fuentes 2018; Beck et al. 2019).

Since the creation of Humboldt University, with its primary emphasis on academic freedom and independence of inquiry, universities have become more entrepreneurial (Urbano and Guerrero 2013; Guerrero, Urbano, and Fayolle 2016). They now contribute to the Open Innovation in Science and related concepts such as Responsible Research and Innovation (Chesbrough and Bogers 2014; Beck et al. 2020). The concept that universities are fuelling the entrepreneurial ecosystem and driving regional growth is emerging as a popular topic worldwide, as entrepreneurial universities are perceived to act as catalysts for national and regional economic development (Etzkowitz et al. 2000; Bramwell and Wolfe 2008; Abreu et al. 2016).

In many developed countries such as the United Kingdom and the United States, universities are encouraged to contribute to regional and national economic

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development and assume responsibility for transferring knowledge from university to industry and the public. This widens the gap between research-led and teaching-led universities in their ability to create and disseminate knowledge as well as engage with the broader public (OECD 2013; Clauss, Moussa, and Kesting 2018).

Independently of how entrepreneurial they are, universities function as complex systems due to their divergent strategic goals, as well as the internal and external stakeholders they deal with (Bartell 2003; O'kane et al. 2015; Cunningham, Menter, and O'Kane 2018). The purpose of universities is to produce reliable knowledge which can be used to re-solve technical, societal and environmental challenges (Beck et al. 2020).

In this conceptual piece, we focus on the economic and social roles of entrepreneurial universities. We define an entrepreneurial university as a platform for scientific research that works towards furthering our understanding societal, economic and environmental challenges (Beck et al. 2020) while innovating and creating new market opportunities (Kirby 2006; Kirby, Guerrero, and Urbano 2011). Entrepreneurial universities act as producers and disseminators of scientific knowledge (Etzkowitz 2003), and use a variety of formal and informal mechanisms to increase the economic and societal impact of universities.

Heterogeneity in the university's objectives, mechanisms of knowledge creation and dissemination results indicate that not all university managers perceive their organisations to be entrepreneurial, as the degree of engagement with external stakeholders commercially and non-commercially is likely to differ between different university types, e.g., between teaching-led and research-led universities (Abreu et al. 2016). The role of the university in the entrepreneurial economy is broader than simply investing in knowledge and then transferring it to industry (Audretsch 2014). Universities experience different social and economic challenges which require different approaches (commercial and non-commercial, formal and informal, in-house or external knowledge sourcing) when aligning entrepreneurial activities with the traditional core university mission.

As the university's role in the entrepreneurial economy has changed (Audretsch 2014), investment in human capital is no longer sufficient to ignite an entrepreneurial ecosystem (Isenberg 2010; Belitski, Aginskaja, and Marozau 2019). Universities are expected to engage in interdependent networks with government, spin-offs, students, large and small businesses, entrepreneurs, investors, professional and academic communities, research institutions, science-parks and incubators (Geuna and Nesta 2006; Valdivia 2013; Miller, McAdam, and McAdam 2014; Meoli and Vismara 2016).

There are at least three key challenges that act as barriers for universities wishing to become more entrepreneurial. Firstly, universities may lack an appropriate entrepreneurial culture, which Audretsch, Lehmann, and Warning (2005) and Audretsch (2014) define as key for entrepreneurial university. Secondly, the majority of entrepreneurial universities focus on pecuniary benefits (D'Este and Perkmann 2011), while universities with different degrees or entrepreneurial profiles should focus on both pecuniary and non-pecuniary goals (Slaughter and Leslie 1997; Franke, Poetz and Schreier 2014). Thirdly, knowledge creation should be followed by knowledge dissemination, as universities seek market opportunities using various formal and informal mechanisms to connect with external stakeholders (Beck et al. 2019).

However, to the best of our knowledge, little research exists into the role of individual skills and competences, organisational infrastructure and processes and the role of the

local context in value creation and capture (Kirby 2006; Miller, McAdam, and McAdam 2014; Autio et al. 2014).

The purpose of this paper is to understand how entrepreneurial and knowledge capital can be strategically aligned at all three levels of an entrepreneurial university. It will accomplish this by applying the strategic alignment framework to Open Innovation in Science literature (Chau, Gilman, and Serbanica 2017; Sauermann, Franzoni, and Shafi 2019; Beck et al. 2020).

In doing so we make two theoretical contributions to the Open Innovation in Science literature. Firstly, we propose a framework – a multi-level strategic alignment model (SAM) of the entrepreneurial university derived from the literature on strategic alignment in private firms (Henderson and Venkatraman 1993). The SAM can help universities to develop a 'strategic congruence' between three levels of entrepreneurial university (the individual, organisational, and system/the entrepreneurial ecosystem levels) and 'functional congruence' between knowledge capital and entrepreneurial capital. Firstly, the SAM framework for the university context can be described in using complex, plural objectives (versus firms which have a more straightforward focus on profit maximisation).

Secondly, building on the Open Innovation in Science literature (Chesbrough and Bogers 2014; Franzoni and Sauermann 2014; Sauermann, Franzoni, and Shafi 2019), this conceptual piece explains how functional and strategic congruence could be achieved.

We argue that the strategic alignment of knowledge and entrepreneurial capital between the individual, organisational and system levels of an entrepreneurial university becomes an important boundary condition if entrepreneurial universities are to achieve their objectives. These objectives include: i) knowledge commercialisation, generating and sustaining the economic rents as an indicator of the financial success of a university (Powell 1992); ii) regional economic development and the development of regional entrepreneurial ecosystems; attracting research funding, national and foreign students and global research talent (Franke, Poetz and Schreier 2014).

In addition, we expand the view that capturing value from scientific knowledge occurs in the context of formal transfer mechanisms such as university-industry collaborations (Guerrero, Cunningham, and Urbano 2015) and through academic entrepreneurship (Wright et al. 2008; Grimaldi et al. 2011; Perkmann et al. 2013; Dedrick and Kraemer 2015). As most knowledge dissemination occurs through informal mechanisms, such as journal or book publications, conferences, or education (Abreu and Grinevich 2013; Link and Scott 2019; Beck et al. 2019), an increasing number of research projects involves researchers directly collaborating with industry and the public (Franzoni and Sauermann 2014).

The remainder of this paper is structured as follows. The next section introduces the Open Innovation in Science perspective of the entrepreneurial university and discusses the role of strategic alignment. Section 3 outlines the three levels of the entrepreneurial university, while Section 4 debates the role of the strategic alignment framework in achieving strategic and functional congruence. Mapping stakeholders across three levels of the entrepreneurial university is done in section 5. Section 6 discusses major results and foundations, while section 7 concludes.

2. Open innovation and the entrepreneurial university

2.1. Knowledge creation and dissemination in entrepreneurial universities

The Open Innovation in Science literature suggests that stimulating knowledge dissemination between researchers, universities, and system stakeholders is important as it increases the use of knowledge (Beck et al. 2019, 2020). This can be achieved by focusing on the university's 'Third Mission' and the 'Quadruple Helix' (Miller, McAdam, and McAdam 2014, 2018). For this reason, policymakers provide financial incentives to scientists and universities in order to promote the facilitation of knowledge creation and knowledge dissemination via knowledge spillovers, as well as via direct knowledge transfers between industry and university (Link and Siegel 2005; Braunerhjelm et al. 2010; Acs et al. 2013).

Dahlander and Gann (2010) developed an analytical framework which categorises open innovation as either inbound and outbound, with outbound innovation referring to formal (licencing-selling) and informal (disseminating-revealing) mechanisms of knowledge transfer. From the Open Innovation in Science perspective, an entrepreneurial university encompasses both formal (patent-protected inventions) and informal (legally unprotected) commercial activities as well as non-commercial activities. Abreu and Grinevich (2013) demonstrated that a university's formal commercial activities are supported by its entrepreneurial activity, and traditionally include consultancy, licencing, and the creation of spinouts, which are often seen as an ultimate objective of an entrepreneurial university (Fini et al. 2017; Audretsch and Belitski 2019). Entrepreneurial capital is important in this regard, as it is used to identify profitable market opportunities. Informal commercial activities occur via commercialisation based on more tacit knowledge that cannot be easily protected.

Non-commercial activities based on tacit knowledge are unlikely to be protected by intellectual property or in areas where scientists and universities are unwilling to protect the knowledge. Non-commercial activities are more likely to be carried out bypassing the technology-transfer offices (Huyghe et al. 2016; Belitski, Caiazza, and Lehmann 2021) as they do not lead to direct financial rewards. Instead, their main impact is on open access to knowledge, reputation, societal benefits, or other non-monetary rewards which represent non-commercial value (Beck et al. 2019).

Scientists and universities perform non-commercial activities which do not carry monetary value. Firstly, scientists, as firms may selectively reveal tacit knowledge to the public and competitors as they attach different values to it (Henkel 2006). Secondly, platform firms support open-source technologies as part of their platform strategies by balancing the tension between value creation and value capture (West 2003, 2014). Thirdly, the entrepreneurial university aims to facilitate the transfer and commercialisation of researcher knowledge; however, it may not always pursue pecuniary benefits (Franke, Poetz and Schreier, 2014). Fourthly, organisations such as universities may suffer from a 'myopia of protectiveness' (Laursen and Salter 2014), while knowledge dissemination to external partners becomes necessary to find additional commercial applications for inventions.

Prior research on knowledge transfer between university and industry highlighted that little income can be derived from increasing the number of technology transfer activities, although some spinouts may generate a substantial income for the university and/or

researchers involved (Mowery et al. 2001; Mowery and Sampat 2004; Geuna and Nesta 2006; Valdivia 2013). Research on spinouts has also demonstrated that academic spin-offs and other new technology-based firms are very heterogeneous (Colombo and Piva 2008). The existing literature explains the difference between university spin-offs and independent start-ups: spin-offs, on average, are more likely to attract venture capital (Colombo et al. 2010). Early studies criticised the outbound formal (licencing-selling) mechanisms of knowledge transfer and emphasised the destructive effects of the 'entrepreneurial university mindset' on the long-term production of scientific knowledge (Slaughter and Leslie 1997).

2.2. Strategic and functional congruence in entrepreneurial universities

The existence of commercial (formal and informal) and non-commercial mechanisms of knowledge transfer suggests that for value creation and capture, investment in knowledge alone will not suffice to facilitate knowledge dissemination beyond the university. That said, an entrepreneurial university requires an efficient mechanism of engagement with internal and external stakeholders (O'kane et al. 2015) at the individual, organisational, and system levels if they are to ensure that the value created on an individual level by one or more scientists is disseminated within an organisation and to system stakeholders. This can be defined as a strategic congruence between individual, organisational and system levels of the entrepreneurial university for knowledge creation and dissemination.

To achieve strategic congruence between all three levels of the entrepreneurial university, universities engage in collaboration with internal and external stakeholders at different levels (West 2014; Miller, McAdam, and McAdam 2018). This leads to greater productivity in transferring knowledge to industry and the public (Rasmussen, Moen, and Gulbrandsen 2006; Kirby, Guerrero, and Urbano 2011). Numerous examples can be found in the literature that illustrate how the strategic congruence can be enhanced between individual researchers who create value, a university, that enables knowledge dissemination, and external stakeholders, who are engaged in the process of value creation and co-creation with scientists (Klofsten and Jones-Evans 2000; Huggins and Kitagawa 2012; Bradley, Hayter, and Link 2013; Abreu et al. 2016).

Knowledge creation and co-creation require investment of resources with a high level of risk and uncertainty on the part of investors with regards to the expected returns (Audretsch, Lehmann, and Warning 2005; Aldridge and Audretsch 2011; Caiazza et al. 2014). This is because investors do not know for sure what the demand for the research outcome will be (Bradley, Hayter, and Link 2013). The value created should be considered valuable on the one hand by individual researchers (Levin et al. 2016), and by the industry and the general public on the other. Knowledge capital is required to produce knowledge in the first place (Beck et al. 2019), but entrepreneurship capital is needed for researchers and university managers to recognise profitable opportunities.

Investment in entrepreneurial capital can help scientists and universities to choose the most efficient knowledge transfer mechanisms and align them with the knowledge outcomes and university objectives (e.g., pecuniary and non-pecuniary). Entrepreneurial capital is therefore positioned in this paper as essential to complementing knowledge capital at each of the three levels of the entrepreneurial university. This is defined as a functional congruence between knowledge and entrepreneurial capital, giving an

entrepreneurial university greater adaptability to university-industry collaborations and pursuing the university's 'third mission' (Cunningham, Menter, and O'Kane 2018; Miller, McAdam, and McAdam 2018).

The resultant evolving entrepreneurial university model is dependent upon multiple levels of value creation and capture (Etzkowitz et al. 2000; Lambert 2003): individual, organisational and systemic (strategic congruence). The model is also dependent on the university's ability to invest in knowledge and entrepreneurial capital to create and capture value via pecuniary and non-pecuniary knowledge dissemination (Bradley, Hayter, and Link 2013) (functional congruence).

3. Three levels of entrepreneurial university

The entrepreneurial university has three levels, known as the individual, organisational and system levels.

At the system level, knowledge transfer opportunities are shaped by the framework and systemic conditions of the regional economic development, market demands, and entrepreneurial ecosystem (Audretsch and Belitski 2017). The system level includes conditions such as the demand for university knowledge, legal and institutional conditions (Autio et al. 2014), and social and cultural factors (Fayolle 2007).

Institutions and culture may either hinder or facilitate outbound university innovation because a university's role will change from investing in knowledge and technology transfer (Audretsch 2014) to engage with multiple stakeholders outside the university. This provides a catalyst for regional entrepreneurial activity (Guerrero and Urbano 2014) and entrepreneurial thinking (Gibb and Hannon 2006). At a system level, the university's objective could be to improve the societal status quo, as 'the exchange value also consists of a non-monetary component' (Beck et al. 2019: 6).

However, individual researchers are more likely to create and capture value if the ecosystem where the university operates is growth-oriented and supportive (Link and Sarala 2019). This includes closer integration of the Quadruple Helix model (Miller, McAdam, and McAdam 2018), which will increase the institutional support to innovation in universities by the general public, scientific communities, industry, and the local government. Degroof and Roberts (2004) have suggested that strong communities in entrepreneurially-developed contexts will be able to select the best projects and allocate resources to them (Wright et al. 2008), clearing market failures. These market failures can also be cleared by congruence between system-university and individual levels at university and in collaboration with Quadruple Helix model stakeholders. Stakeholder demands for knowledge are addressed by the university's entrepreneurial actions as they invest in knowledge and transfer it back to the market and society using commercial and nonpecuniary practices. Universities make a vital contribution to innovation and value creation by investing in knowledge, and later by commercialising knowledge through university-industry collaborations and science-based entrepreneurship activities (e.g., entrepreneurship education, business incubation, entrepreneurship competitions, engagement with external risk capital, business networks, etc.) (Kirby 2006; Kirby, Guerrero, and Urbano 2011; Etzkowitz 2016).

In particular, universities and individual researchers in less research-intensive universities (Abreu et al. 2016) who focus on education and industry connections may play

an important role in promoting industrial clusters which leads to regional capacity-building.

At an organisational level, entrepreneurial universities aim to develop stronger mechanisms of inbound and outbound innovation, such as investment in entrepreneurial education and the creation of entrepreneurial a mindset. They can also connect research to industry and disseminate research outputs via publications, conferences, and scientific reports. University should track their scientific publications on their webpages, as well as the numbers of citations as in the Adams and Griliches (1996) study of the scientific publications resulting from university research. This could be the first step towards understanding a dimension of the social benefits associated with scientific publications as a mechanism for outbound innovation. Another dimension may require supporting students, initiatives, and entrepreneurial ideas from all backgrounds, with universities offering a wide range of modules that build core entrepreneurial skills and competencies, including social enterprise and social entrepreneurship. Additional specialist taught programmes are required for those students who want to go further and pursue entrepreneurial careers.

Inbound open innovation spans practical business-related activities and panel sessions for students, local entrepreneurship community, scientists, and other stakeholders within the Quadruple Helix setting. These activities may include demonstrations of successful knowledge transfer and projects, case studies, role models of business and social engagement, pitches aimed at tech hubs and incubators, interventions with start-ups, and a range of international study visits organised by programme directors and module leaders to work with early-stage tech entrepreneurs or to mentor social enterprises under educational initiative (Belitski and Heron 2017).

As for the organisational level, the process through which knowledge dissemination occurs is influenced by the legal frameworks and institutional characteristics of the region and country where the university is located (Grimaldi et al. 2011; Guerrero, Cunningham, and Urbano 2015). Researchers, departments, research support groups and central university management will differ on how the university can best align its efforts at both the individual and systemic levels to become a truly entrepreneurial university, producing and disseminating scientific knowledge to increase its economic and societal impact. Crafting a strategy to achieve stronger integration between organisational incentives and individual capabilities thus requires more effort at the individual (micro) level of an entrepreneurial university.

The demand for university knowledge at a system level creates commercial and non-commercial incentives at the organisational and individual levels. The demand affects the individual level via activities organised by the entrepreneurial university, such as entrepreneurial efforts by faculty and students to launch new ventures (Kenney and Goe 2004).

System-level incentives change the determinants of knowledge creation by individual researchers in activities ranging from participation in externally-funded government grants or voluntary research to licencing new technology and spinouts (Louis et al. 1989; Markman et al. 2005; Civera, Meoli, and Vismara 2020). There has been a significant push for knowledge commercialisation with industry, exemplified by the adoption of the Bayh-Dole Act of 1980 which brought about the establishment of technology transfer offices at universities in the United States and then globally

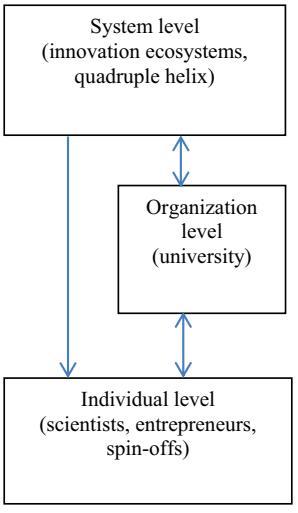

Figure 1. Three-dimension model of entrepreneurial university. Source: Authors

(Aldridge and Audretsch, 2010). Despite this, scientists most commonly disseminate their scientific knowledge through publications (Link and Scott 2019), conferences, or teaching (Beck et al. 2020) via formal and informal knowledge transfer mechanisms (D'Este and Perkmann 2011).

Bercovitz and Feldman (2008) analyse faculty members who disclose their inventions to facilitate commercialisation in response to an increased demand for commercialisation by department chairs and research support departments. Greater involvement in knowledge creation and commercialisation among researchers, sessional lecturers and students at university is possible when investment in knowledge is followed by the creation of a variety of entrepreneurial opportunities for scientists (e.g., conferences, research grants, publications, industry contracts) and students (e.g., starting their first business, consultancy, internships, and work placements) (Belitski and Heron 2017). The interplay between the individual, organisational, and institutional levels of an entrepreneurial university (Perkmann et al. 2013) is important, as it allows all elements of inbound and outbound innovation at university to work together. The three levels of the entrepreneurial university are illustrated in Figure 1.

4. Theoretical foundations of the strategic alignment model

4.1. Introducing the strategic alignment concept

Extending the strategic alignment framework used in private firms to the Open Innovation in Science literature (Franke et al. 2014; Franzoni and Sauermann 2014; Beck et al. 2020), this section will explain why and how the strategic alignment concept can be implemented for entrepreneurial universities.

The traditional model of the university includes 'loosely coupled' domains (Audretsch 2014) and organisational structures in which stakeholders at the individual level (scientists, students, lecturers, TTOs) strive to avoid dependence on other stakeholders at the

organisational and system levels (e.g., TTO managers, knowledge commercialisation centres, lawyers, local government, patent offices, business and industry associations, industry). Quite a different model of the entrepreneurial university has emerged since Etzkowitz et al. (2000) and Etzkowitz (2003) described the role of the Triple Helix model and argued that University-Industry-Government relations are interdependent, operating as a complex system of workflow linkages created by collaborations and knowledge co-creation (Mowery and Nelson 2004; Bradley, Hayter, and Link 2013). Dependencies between stakeholders across all three levels of the entrepreneurial university (Figure 1) allow entrepreneurial and knowledge capitals at university to work as one mechanism, enabling the rapid exchange of knowledge and the coordination of activities related to knowledge investment and transfer.

The model based on interdependencies between various stakeholders and departments within an organisation was developed from systematic field research on organisational alignment and information systems. This research was conducted in the late 80s by organisational study and information science authors who drew on their professional experience and multiple case studies in both the United States and Europe (Henderson and Venkatraman 1993; Mahoney and Pandian 1992; Powell 1992). A modification of the SAM framework for entrepreneurial university can be applied across a large array of educational organisations and industrial research institutions.

Firstly, we must turn to the concept of strategic alignment per se and ask how universities may align knowledge and entrepreneurial capitals. How can these two capitals be aligned, and how should this best be researched? The literature regularly laments the paucity of studies that assess how universities align entrepreneurial with human capital in practice (Audretsch 2014; Guerrero, Urbano, and Fayolle 2016).

The concept of strategic alignment has been used in prior research on clusters and complementarities (Porter, Goold, and Luchs 1996), integration of business and information systems in an organisation (Weill and Broadbent 1998), and linkages between an organisation's strategic and operational functions (Henderson and Venkatraman 1993). When applied to the entrepreneurial university, the concept of alignment relates to integrating human capital investment, knowledge creation, and outbound innovation.

Scholars may argue that strategic alignment enables higher performance and productivity. Powell (1992) demonstrated how organisational alignment affects performance and the potential consequences of misalignment. In an empirical study of two manufacturing industries, the author demonstrated that organisational alignment significantly increased profits. It is reasonable to regard the alignment between human and entrepreneurial skills in organisations as a strategic resource available to a university, acting as a fertile source of commercial and non-commercial research outcomes. From this perspective, universities are organisations that are embedded in the local context (Kirby 2006), which not only produce codified knowledge and human capital but also participate actively in public/private partnerships, the commercialisation of knowledge (Guerrero, Cunningham, and Urbano 2015; Audretsch, Link, and Scott 2019), and other forms of public engagement activities (Franzoni and Sauermann 2014).

The strategic alignment between knowledge and entrepreneurial capital assists the university in meeting its objectives in two important ways. Firstly, it increases a university's competitive advantage by improving its ability to compete successfully with other universities and educational institutions in attracting government and

industry funding, students, and research talent (Allee 2000; Etzkowitz 2016; Beck et al. 2019). Secondly, by providing direction and flexibility, universities are better able to react to new market opportunities as they become available.

To achieve a competitive advantage, value creation at the university needs to be coordinated with system-level stakeholders (strategic congruence). Strategic congruence is influenced by the degree of alignment of entrepreneurial and knowledge capital (functional congruence), as knowledge creation is likely to be given a better validation test when university managers can act entrepreneurially and engage with external stakeholders on attracting research grants, motivating research talent, and proactively attracting students using university resources and knowledge. Neither entrepreneurial nor knowledge capital should be prioritised due to the risk of reducing the quality of academic research and deterring non-commercial forms of academic entrepreneurship (Abreu and Grinevich 2013).

The other critique of the entrepreneurial university and capital relates to the works of Bousquet (2008) and Mirowski (2011), who compare entrepreneurial universities to academic enterprises with the objective of profit-making and reducing costs while impeding tenure-track positions and offering low-quality teaching. Many universities appear to have become 'knowledge businesses, ' which are focused on knowledge dissemination to specific stakeholders (McKelvey and Holmen 2009) and reducing academic productivity and neglecting the public good (Agrawal and Henderson 2002). In the neoliberal university model, Slaughter and Rhoades (2000) critique public colleges and universities that act like capitalist enterprises by investing in business ventures and spin-offs. Universities that adopt a commercial enterprise strategy in their attempt to raise profits cannot be cushioned by extensive public support. In a similar vein, D'Este and Perkmann (2011) argue that universities and industry are converging towards a hybrid order where the differences between scholarly and commercial logics are unclear and policymakers will further encourage university-industry collaboration (Mowery and Nelson 2004; Miller, McAdam, and McAdam 2014).

The Open Innovation in Science perspective challenges the implicit logic that entrepreneurial universities engage with external stakeholders to commercialise knowledge (Wright et al. 2008), which allows open knowledge diffusion (Rosell and Agrawal 2009; Murray and Stern 2007).

To address the university's narrow focus on knowledge creation and commercialisation, the strategic alignment framework emphasises the role of congruence between knowledge and entrepreneurial capital across all three levels of the entrepreneurial university. This may help universities to facilitate outbound innovation and cope with 'corporate strategy' thinking (Bramwell and Wolfe 2008). We argue that the SAM may enhance private/public initiatives at universities (Audretsch, Link, and Scott 2019), such as Citizen Science, Public Engagement, Inter- and Trans-disciplinary Research, Responsible Research, and Innovation (Martinuzzi et al. 2018), as both capitals will be prioritised. The dissemination of scientific knowledge enables this through establishing stronger collaborative networks between private and public institutions (OECD 2013; Vicente-Sáez and Martínez-Fuentes 2018; Audretsch, Link, and Scott 2019). We argue that achieving a strategic alignment between entrepreneurial and knowledge capital is an appropriate mechanism at all three levels of the entrepreneurial university.

While university management priorities change over time, the strategic alignment of the two capitals presumes that university management at both the micro and organisational levels is in full control and that infrastructure aligns with emerging management insights (Galliers and Newell 2003). The application of concepts such as a strategic fit between the university's resources and entrepreneurial opportunities to commercialise knowledge, and their strategic goals, strategies, and tactics, may make the strategic process rigid. This will have a negative rather than a positive impact on a university when followed specifically and pedantically. Strategic planning can distort creative thinking and mislead universities into confronting their research and teaching plans.

4.2. The cross-domain perspective of the strategic alignment model

The Open Innovation in Science literature requires that investment in knowledge and entrepreneurial capitals are internally consistent with the mission and objective of the entrepreneurial university (Kirby 2006; Etzkowitz 2016). In general, the literature has positively assessed the congruence between knowledge and entrepreneurial capital; for example, a number of scholars supported the Bayh-Dole Act (Mowery et al. 2001; Link and Siegel 2005; Kenney and Patton 2009; Aldridge and Audretsch 2011). Further investigations into the importance of alignment relate to exploiting research without tedious negotiations with system stakeholders (e.g., federal agencies, government, risk capital, non-for-profits, communities) when both functions are aligned within a single organisation, which minimises transaction costs.

Problematic alignment trajectories could be explained by the knowledge inertia associated with decision-making at universities. This is particularly the case with public universities, where a greater consensus is needed and entrepreneurial ideas often cannot be commercialised (Audretsch, Lehmann, and Warning 2005; Audretsch, Keilbach, and Lehmann 2006; Acs et al. 2013). We suggest that knowledge and process integration and planning processes involving multiple perspectives or powerful entrepreneurship ecosystem forces may be employed to aid strategic alignment efforts.

Understanding processes leads to a consideration of the factors which may enable or inhibit alignment. The enablers include executive support for entrepreneurship programmes and spin-offs, leadership from the centres for entrepreneurship and prioritising academic workloads and building close relationships between researchers and stakeholders at the organisational level (knowledge transfer offices, risk capital platforms, incubators).

Although alignment tends to be more organisational than individual and systemic, no comprehensive model has been systematically developed for university-industry relationships (Bradley, Hayter, and Link 2013) or is commonly used to demonstrate how the various domains within the three entrepreneurial university levels are interdependent.

We contend that the SAM is essential for universities with different degrees of entrepreneurial capital and orientation (Abreu et al. 2016) and may be approached from the organisational, researcher and system perspectives.

We distinguish between the system perspective of entrepreneurial capital and the internal focus of entrepreneurial capital. This recognises the potential of entrepreneurial capital to support and shape university objectives within the organisation and with external stakeholders (Miller, McAdam, and McAdam 2014; Beck et al. 2019). This

distinction implies a multilevel congruence: strategic congruence between entrepreneurial capital and knowledge capital at the ecosystem level, and functional congruence between all three levels of the entrepreneurial university.

The SAM can be applied to much of the entrepreneurship university's strategic research, as well as the discussion of strategy and structure at university and the factors which need to be considered when assessing alignment (Avison et al. 2004).

The strategic alignment model (Figure 2) is illustrated as six interdependent domains of strategic choice based on the principle of inter-relatedness and interdependency. For example, a university strategy focusing on knowledge investment may also require the creation of physical and knowledge infrastructures, as well as teaching scientists that all domains and processes are interdependent. Each choice has its constituent components: scope, competencies, and governance at the system level; and infrastructure at the organisational level, and skills and capabilities at the individual level. The domain of 'System level knowledge-knowledge creation' includes the scope, size of collaboration, and engagement with external stakeholders within the Quadruple Helix model, and can include other universities, industry-university partnerships, industrial and trade associations, and local and national governments. The domain of 'System level knowledge-knowledge commercialisation' to market and the public includes the scope of

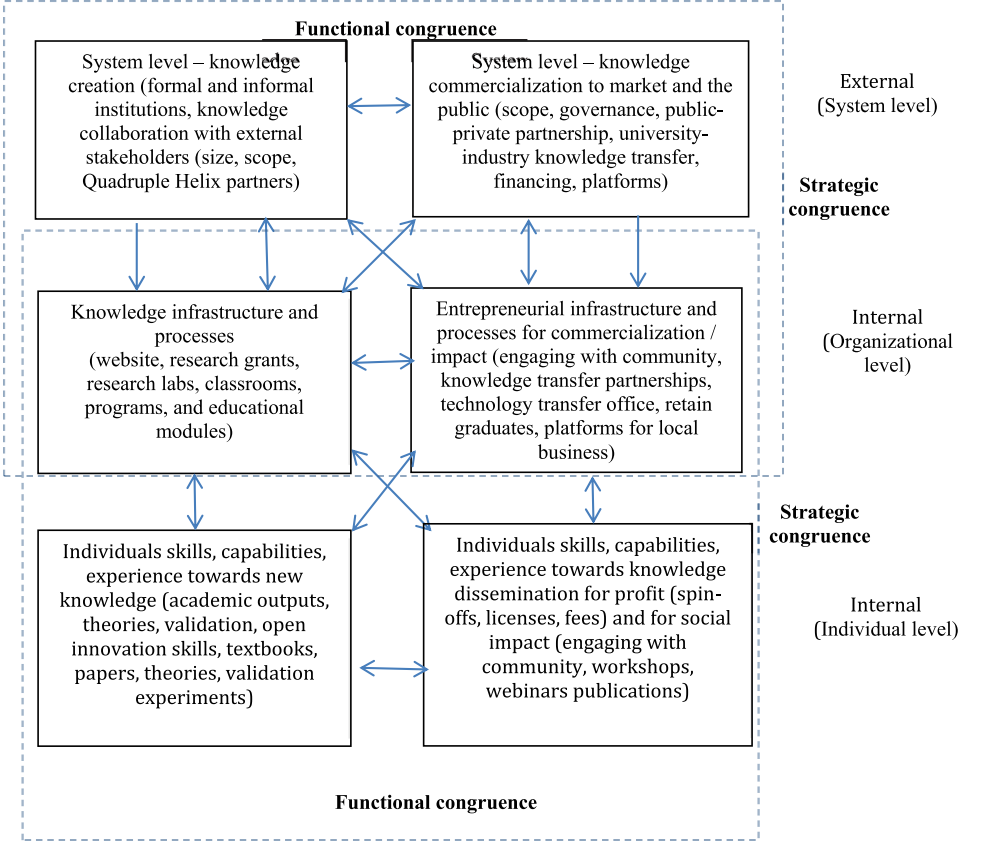

Figure 2. Strategic alignment model of entrepreneurial university. Source: Authors

commercialisation, public-private partnership, university-industry knowledge transfer, and financing. It also includes governance-related mechanisms to monitor the demand for knowledge and the availability of equity and debt financing, such as alternative finance online platforms, local government schemes, and corporations. The knowledge infrastructure and processes domain includes university infrastructure, which is served to create new knowledge (e.g., research labs, classrooms, programmes and educational modules, online open courses, pedagogical and cognitive process, university departments, and research grants). The entrepreneurship infrastructure and processes domain includes the risk capital platforms associated with the university, knowledge transfer partnerships, centres for entrepreneurship, TED talks, entrepreneurship forums, events designed to engage with local communities, retain graduates, and universities operating as labour market platforms for local business. The domain representing individuals' skills, capabilities, and experience related to knowledge creation includes academic outputs (textbooks, papers, theories, validation experiments, and open innovation skills). The domain representing individual skills, capabilities, and experience related to entrepreneurial capital includes various forms of activity related to knowledge commercialisation (e.g., spin-offs, licences, fees) and social impact (engaging with community, workshops, webinars, scientific publications).

The strategic alignment can be achieved via stronger congruence between two fundamental characteristics of the entrepreneurial university: strategic fit (congruence in knowledge and entrepreneurial capitals) and functional integration (congruence between knowledge production and knowledge dissemination at each of three levels of entrepreneurial university). It is important to incorporate cross-domain perspectives, as we argue that neither strategic nor functional congruence alone is sufficient to align knowledge and entrepreneurial capitals effectively at each level of the entrepreneurial university. The multi-variate co-alignment (alignment perspective) addresses functional and strategic congruence. The congruence between the system and the organisational and individual levels is examined in terms of process, structure, and skills, rather than at an abstract level of attempting to relate internal and external characteristics.

Multi-variate cross-domain perspectives work on the premise that congruence in knowledge creation and diffusion may only occur when a university becomes a conduit for outbound and inbound innovation for commercial and non-commercial ends. We argue below that this type of interdependency between individual, organisational, and ecosystem levels at a university is systemic rather than resource-based, and produces tightly coupled, rather than loosely coupled, domains at all three entrepreneurial university levels.

The underlying premise of interdependencies between multiple domains is twofold. Firstly, the change either cannot happen in one domain without impacting on at least two of the cross-connected domains in some way. Secondly, the change in one domain complements efficiency in the cross-connected domains, so that the joint effect is greater than the changes in each individual domain. A strategic alignment perspective in the centre of a model can be derived by drawing a line through the three border domain types, which we may call a trigger domain, leverage domain, and affected domain. Let us now explain all domains in detail.

Trigger domain: this is the strongest domain. It may have the strongest representation at the executive level or be the core business area. It will generally be the initiator of change and provide the majority of requests for entrepreneurship resources.

Leverage domain: this domain indicates which functional or strategic domain will ultimately be affected by the change initiated within the trigger domain. The functionality of this domain is limited, and could therefore be identified as a weak domain.

Affected domain: this domain is the most impacted by the change initiated in the trigger domain. It is important that the affected domain will result in implications for other domain, independent of which comes first, second, or third.

The strongest and weakest domains may or may not always be adjacent to each other, but this cannot hold if the two domains are in opposite quadrants.

The direction of the impact runs from the trigger domain to the affected domain via the leverage domain. The effect is either 'top-down' system driven, or 'bottom-up' individual (process) driven.

Unlike the organisational level, which can be affected by the individual and system levels, individual-level domains cannot affect system-level domains. System-level factors are exogenous and may trigger changes in the entrepreneurial ecosystem at the organisational and individual levels. For example, a call announced by the Research Council may engage individual researchers in projects, design, and validating theories. The model of strategic alignment is illustrated in Figure 2.

The extant literature laments the paucity of studies assessing how universities carry out the alignment of entrepreneurial and human capitals (Audretsch 2014; Guerrero, Urbano, and Fayolle 2016), what strategic alignment looks like, and how the efficiency of different knowledge transfer mechanisms should be determined.

Our first efficiency measurement involves the elasticity of non-pecuniary outcomes (scientific publications, retainment of graduates in a region, growth in scientific and entrepreneurial communities networked with the university, etc.) with respect to R&D expenditures on research and investment in teaching and learning.

Our second efficiency measurement is the elasticity of knowledge commercialisation (e.g., total income from research activities, consultancy fees, amount of contract research by Technology transfer offices – TTOs, licencing of intellectual property, etc.) with respect to R&D expenditures on research and investment in teaching and learning.

These elasticities could be named an annual rate of return (in terms of publications, conferences, industry contracts, government grants, consultancy agreements) on the university's stock of knowledge.

Let us consider two applications. A hypothetical university that had 200 publications a year before the increase in R&D spending has a knowledge stock with some unobserved value, and say that at the margin, whatever that value is, the increase per year in scientific publications for an additional 10 USD million invested in R&D in that unobserved value would be 15 publications. From this example, we observed that an additional 50 USD million in R&D spending each year generated 75 more publications each year. It appears that the knowledge component of the alignment is the investment in R&D, which increases the knowledge stock of the university. The entrepreneurial component here is the capacity and experience of researchers, which guides them when choosing topics to research and whom to engage with within the university. It also guides external

stakeholders to unlock the knowledge transfer opportunities which result in the outcome of 15 additional scientific publications.

Similarly, we could argue in the second example that investment in R&D increases the knowledge stock related to the knowledge capital at university, which is required to produce and appropriate knowledge via patenting and other legal forms of intellectual property rights (IPR) protection. However, entrepreneurial capital, which can recognise entrepreneurial opportunities and address market demands for university innovation, is needed to generate licence income from patents and other IPRs. In these terms, the efficiency of the alignment is determined by an annual royalty payment.

5. Mapping stakeholders across the strategic alignment model

Each level of the model has different stakeholders (Yusef 2008; Miller, McAdam, and McAdam 2018). While the complexity of these relationships increased in the 1960s, university-industry-government collaborations began to develop and grow in the late 1990s and early 2000s (Miller, McAdam, and McAdam 2014). Following Yusef's (2008) categorisation, we distinguish between general, specialised, and systemic stakeholders and map them across individual, organisational, and systemic levels in the SAM of the entrepreneurial university. The first level is general stakeholders, including organisations and individuals that produce and translate knowledge within an entrepreneurial university into tangible products and marketable outcomes: cooperative research centres, university-corporate research, education centres, cooperative research centres, consultancies with industry, academic registries, admissions, research offices, departments for specific faculties, and incubators. They operate at the organisational level of the model.

General stakeholders embed knowledge and human capital into the university's mission and strategy, and develop collaborative relations with other ecosystem stakeholders. They collaborate with departments, administrators, and individual entrepreneurs (academic entrepreneurs, academics/principal investigators, graduates, alumni and scientists) to facilitate more basic than applied research. General stakeholders may be involved in teaching entrepreneurship and preparing the research projects (Hayter 2016). General stakeholders include individual academics/principal investigators who work on licencing, spinouts, and new venture creation building on their applied research results.

The second level includes specialised stakeholders, consisting of organisations and individuals that become conduits of knowledge creation and dissemination. They work at the organisational and individual levels, preferably within the knowledge commercialisation domain. Specialised stakeholders operate within the 'Entrepreneurial ecosystem – knowledge commercialisation' domain and take an active role in financing entrepreneurial activity through alternative debt and equity financing schemes, risk capital, and venture capital (Colombo et al. 2010). These are angel and venture capital investment platforms (university-based and external). Specialised stakeholders within the entrepreneurship infrastructure domain include centres for specific roles, including interdisciplinary research centres, who embed entrepreneurship into regional and international entrepreneurial ecosystems. Some of these specialised stakeholders, such as industry liaison committees and TTOs, develop intense collaborative relations with industry through knowledge transfer partnerships, the location of industry divisions in the city, joint research and executive education training, and other knowledge spillover

mechanisms outside the university (O'kane et al. 2015). Specialised stakeholders facilitate more applied rather than basic research, and hence operate mostly in the knowledge commercialisation domain.

Centres for entrepreneurship and institutes of innovation located onsite have remained one of the most important specialised stakeholders. By building networks with system and other specialised stakeholders (Hayter 2016), centres for entrepreneurship develop a range of knowledge transfer mechanisms: courses and events to target local and international entrepreneurship communities, knowledge exchange, and research translation initiatives to start-ups and incumbents, research commercialisation and to improve students-scientists-business community interactions.

An entrepreneurial university requires ongoing engagement between various external and internal stakeholders. Investment in knowledge capital by general and specialised stakeholders involves creating tangible infrastructure (Hayter 2016), as well as virtual infrastructure for e-learning and knowledge transfer using platforms such as Microsoft Teams and Zoom. Finally, system stakeholders are firms that facilitate entrepreneurial incentives to create and develop the Quadruple Helix model of university-industry-government and community partnerships (Etzkowitz and Leydesdorff 2000; Miller, McAdam, and McAdam 2014). Systemic stakeholders encourage tacit knowledge transfers via private/public engagements. The most distinctive examples include Research and Science parks, Accelerator Programmes and Business Growth Programmes, and Research Councils. Further examples include regional development agencies and national governments, which operate at an entrepreneurship ecosystem level in both domains.

An example of a stakeholder operating in the entrepreneurship ecosystem knowledge creation and knowledge commercialisation domains is a Research Council. These councils facilitate entrepreneurial incentives, ambitions and aspirations of specialised and general stakeholders (Etzkowitz and Leydesdorff 2000) and the entrepreneurial ecosystem (Autio et al. 2014; Hayter 2016; Audretsch and Belitski 2020). Collaboration with Research Councils may also provide initial funding, ensure entrepreneurial education and research are kept to a high quality, and serve as a conduit of spillovers to test new ideas together with universities and the entrepreneurial community (Gianiodis, Markman, and Panagopoulos 2016). Engagement with system stakeholders is likely to take place jointly with specialised stakeholders.

6. Discussion

The SAM framework enables university managers and external stakeholders to reliably assess the level of strategic alignment. This is done by understanding the elasticities of strategic alignment outcomes and investment in knowledge stock and entrepreneurial capital across all three levels of the entrepreneurial university. The reliability of the assessment will depend on the access to information by university managers and external stakeholders, the involvement of technology transfer offices. While the assessment will differ between universities of different types (e.g., teaching vs. research-led universities), the degree of alignment is domain-dependent and is associated with the extent to which the university's private and public objectives are aligned. This means that investment in a researcher's skills, capabilities, and experience enabling knowledge production and

commercialisation via spin-offs, licences, fees and consultancy should directly support outbound innovation, such as an increase in academic outputs (conferences, networks, publications, know-how), theory development, attracting students and new research talent (Allee 2000).

In this regard, the university's entrepreneurial capital should enhance and celebrate the freedom of inquiry and creativity. It should also raise awareness of potential economic and societal benefits of knowledge commercialisation by scientists beyond the walls of the university (Audretsch 2014).

What distinguishes the entrepreneurial university from the traditional university is that they bring a stronger alignment between knowledge and entrepreneurial capital, which enables knowledge to be transformed into outbound innovation with pecuniary and non-pecuniary benefits. This does not imply that this stronger alignment is imperative for a university, but means that entrepreneurial universities prioritise both capital needs. The SAM framework's emphasis is therefore on the 'alignment' between two capitals and not the 'stock' of each capital at university. The opportunities include greater coordination between scientists, university and external stakeholders. This is required to create and capture knowledge and ensure that knowledge that originated with a university is transferred to its external stakeholders, and that knowledge spillover occurs (Audretsch 2007; Acs et al. 2013). Differences will remain in the degree of alignment for every specific university to pursue its objectives, such as contributing to the region's entrepreneurial ecosystem and economic development (Clauss, Moussa, and Kesting 2018).

This conceptual piece uses the SAM framework to demonstrate that greater alignment between the two congruences (strategic and functional) are feasible and desirable at all three levels of the entrepreneurial university. The interconnected domains of the framework align individual skills with university capabilities and infrastructure and with external stakeholders.

The SAM framework relates to the processes or structures at each of the three levels of the entrepreneurial university that are integrated to the point where additional resources do not need to be invested. Their alignment enables universities to effectively create and capture value from knowledge and identify market opportunities and channels for knowledge dissemination (OECD 2013).

Certainly, many universities could use the SAM model to label themselves as an 'entrepreneurial university' to external stakeholders. However, the degree of engagement with external stakeholders for economic and societal benefits (Meoli and Vismara 2016; Beck et al. 2019) is different for universities of different types which possess different levels of human and entrepreneurial capital and different levels of focus on the 'Third Mission' (Miller, McAdam, and McAdam 2018). As with the differences between entrepreneurial universities and traditional Humboldt universities in the entrepreneurial economy are blurred (Audretsch 2014; Etzkowitz 2016), one could argue that the entrepreneurial mission of universities can be seen as a reflection of how universities work to fulfil the increasingly complex role they play in the development of science, industry, society and the environment (Beck et al. 2020).

The SAM can become an actionable strategy that is applied in universities with different degrees of entrepreneurialism and societal impact. There are three reasons for this: (i) the SAM fills the gap in research between entrepreneurial capital and incentives

for scientists in traditional research-based universities focused on new knowledge creation; (ii) it fills the gap in knowledge capital for scientists and universities which traditionally focus on industry-led research and teaching activities (Abreu et al. 2016); (iii) it enhances the alignment of multiple university objectives (e.g., pecuniary and non-pecuniary).

7. Conclusion

In this conceptual piece, we introduce the SAM framework with cross-domain perspectives, arguing that neither strategic nor functional congruence alone is sufficient to effectively align both knowledge and entrepreneurial capitals at each entrepreneurial university level. This paper contributes to the related literature on Open Innovation in Science by demonstrating that the strategic alignment can be achieved by the greater congruence of knowledge and entrepreneurial capitals at all three levels of entrepreneurial university. We also emphasise that both the '"top-down"' system-driven and '"bottom-up"' individual-driven approaches can be relevant to entrepreneurial universities if knowledge creation is followed by knowledge transfer. The SAM framework demonstrates how university performance can be enhanced and discusses the channels which can be used to accomplish this.

Firstly, universities have a mandate to invest in knowledge and human capital, and to invest in entrepreneurial capital in order to facilitate the entrepreneurial ecosystem and contribute to regional economic development and the public good.

Secondly, knowledge capital as the dominant production factor in the entrepreneurial economy requires congruence with the entrepreneurial capital to achieve pecuniary and non-pecuniary outbound innovation in universities.

Thirdly, an entrepreneurial university can implement the SAM model as a core business and development strategy with all six domains, indicating the importance of interdependencies between the two capitals and the three levels of the entrepreneurial university. Finally, the SAM should be applied at all three levels by university managers, entrepreneurs, and policymakers aiming to promote knowledge diffusion and commercialisation as a tool to allow a graphical interpretation of the university's position from a strategic (system level) and structural (university level) and knowledge operationalisation perspective (individual level).

The strategic alignment concept is rooted in the strategic alignment of private business (Henderson and Venkatraman 1993). However, the authors do not use the language of multiple capitals in their work on strategic alignment; instead, they focus on the role of business strategy, knowledge, and operations, as well as their alignment with the other domains, such as information system components of strategy and infrastructure. Our conceptual piece applies the concept of strategic alignment to the entrepreneurial university. Universities and private firms differ significantly in their knowledge creation and strategy objectives – firms have more clear-cut objectives (generating rents and developing and sustaining profits). The application of this concept to a university acknowledges the complexity of university objectives related to their contribution to regional economic development (O'Shea et al. 2014) and creation of public goods (Beck et al. 2019), as well as knowledge transfer to public and private organisations (Link and Sarala 2019; Link and Scott 2019). The university require knowledge inputs to create and absorb external

knowledge (Cohen and Levinthal 1990) as well as the entrepreneurial capital to recognise collaboration opportunities and take risks in knowledge development and transfer (Link and Sarala 2019). The SAM therefore presents the alignment of two capitals as a necessary condition for i) knowledge creation; ii) identifying the profitable and non-profitable opportunities for knowledge transfer.

To overcome the limitations of the SAM, it could be useful to benchmark this framework against other promising models in the extent literature. It would be particularly useful to compare it with: (i) the promising entrepreneurial university model with core research and education. This includes a number of stakeholders at the individual level (researchers, students, graduate entrepreneurs) and system level (venture ecosystem, industrial collaboration, angels, experienced mentors) with the goal of achieving high-tech venture creation (Wong, Ho, and Singh 2007); (ii) the university spin-off framework that represents the conceptual integration of the elements found in academic entrepreneurship literature. This includes engaging in scientific entrepreneurship (individual level), the attributes of universities such as human capital, resources and institutional activities (organisational level), and the broader social context of the university, including the barriers to entrepreneurial activity and regional infrastructure (institutional/system level) (O'Shea et al. 2014).

For this alignment perspective to succeed in an entrepreneurial university and contribute to its objectives, the university's management should provide an entrepreneurial vision which articulates the logic and choices pertaining to knowledge creation and dissemination for pecuniary and non-pecuniary benefits (Franke et al. 2014). This would best support the strategic alignment framework as a strategy to engage individual researchers and external stakeholders in the process of value creation and capture within and beyond the university's boundaries.

Universities should become the conduits for industry and the public in designing and transforming new knowledge into market products and public good, connecting all three levels of the entrepreneurial university from individual researchers to system stakeholders. The performance criterion in this framework is based on the degree of alignment between functional and strategic congruence, with qualitative but insightful benchmarking of the value creation for the marketplace and the general public and the inputs committed by actors at all three levels of the framework.

Subsequent studies should focus on building upon this framework by analysing how it could be used to monitor and track entrepreneurial and knowledge capital alignment as well as investigating any possible dysfunctionalities between its domains. The model could be extended to pre-empt a change in strategy and implement a new alignment perspective by re-allocating the university and ecosystem resources. Combined strategic planning through all levels of the entrepreneurial university, along with some form of knowledge flow prioritisation, is vital to ensuring the alignment process is efficient.

Future research should aim to provide greater empirical insight into how the successes and dysfunctionalities of universities would be tracked, monitored, measured, addressed, and ultimately corrected using the SAM. Using a case study of the entrepreneurial university in the context of a specific country or institution could provide empirical evidence of how the SAM can be applied to achieve congruence in knowledge and entrepreneurial capital. This could further guide university policies designed to optimise the use of knowledge resources.

Disclosure of potential conflicts of interest

No potential conflict of interest was reported by the author(s).

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