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Paola Giuri[1], Federico Munari[1], Alessandra Scandura[2], Laura Toschi[1]*

[1] *Department of Management, University of Bologna*

[2] *Department of Economics and Statistics, University of Torino*

** Corresponding author: laura.toschi@unibo.it*

Paola Giuri is Professor of Management at Bologna University. Her research focuses on economics and management of innovation, economic and strategic uses of patents, technology transfer, entrepreneurship. He has published his work in leading international journals such as Review of Economics and Statistics, International Journal of Industrial Organization, Research Policy, Industrial and Corporate Change.

Federico Munari is Full Professor of Technology and Innovation Management at the University of Bologna. He holds a Ph.D. in Management from the University of Bologna, and has been visiting scholar at the MIT Sloan School of Management and visiting researcher at the Ecole des Mines and at Cass Business School. His research interests are in the fields of technology transfer, valuation of IPRs, venture capital and entrepreneurial finance.

Alessandra Scandura is Marie Curie Post Doctoral Fellow at the Department of Economics and Statistics of the University of Torino within a project entitled "University-Industry Linkages, Green Technologies and Regional innovative Performance". She has been Post Doctoral Fellow at the University of Bologna. She holds a Ph.D. from the Dep. of Geography of the London School of Economics and Political Science. Her research interests are in the fields of economics and management of innovation, university technology transfer, innovation policy.

Laura Toschi is Assistant Professor in Entrepreneurship and Innovation at the University of Bologna. She received her Ph.D. in Management in from the University of Bologna. She has been visiting scholar at the Boston University and Research Fellow at the SPRU, University of Sussex. Her main research interests are on (i) entrepreneurial finance, (ii) technology transfer activities and (iii) innovation management.

Abstract

Previous research has claimed that universities can enhance the effectiveness of knowledge transfer activities by establishing a clear strategic goal and aligning all their activities towards that direction. To shed new light on this issue, in this paper we explore the determinants of universities' strategic choices in the field of knowledge transfer (KT). We identify theoretically and empirically three university KT strategies: income-generation strategy, service-to-faculty strategy, and local development strategy. We then investigate the role of university-level factors that determine the strategic choice of universities, particularly focussing on university horizontal (generalist vs. specialist) and vertical (high vs. low prestige) diversity. The empirical analysis relies on a unique survey of 178 university TTO managers across European universities, combined with additional data sources. Our results show that generalist and low prestige universities mainly pursue the local development strategy, while specialist and high prestige ones are more oriented towards the income generation strategy. These findings are highly relevant for theory and practice of KT in academic insitutions, given the relevance that the university third mission has for economic and societal development.

Key words: knowledge transfer; university strategy; university specialization; university prestige

JEL codes: I23 - Higher Education Research Institutions; O32 - Management of Technological Innovation and R&D

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1. Introduction

Universities are key agents of economic and social progress. Their current role has increasingly added interactions with industry, and with the society more generally, to the traditional missions of teaching and research (Kapetaniou and Lee, 2017). The role of universities so conceived has attracted considerable attention from scholars and policy-makers (Hsu et al., 2015; Trune and Goslin, 1998). Accordingly, several studies have focused not only on the traditional university's goals of teaching and research but also on the third mission of knowledge transfer (KT). KT is a complex and rapidly evolving phenomenon based on the interactions of several stakeholders. Universities may address various objectives through KT activities, such as providing services to faculty, enhancing innovation and the practical use of research results, generating additional income streams, fostering local economic development, complying with national and institutional policies, and promoting public value (Bozeman et al., 2015). Several researchers have claimed that a scattered approach in serving these objectives is less effective than adopting a strategic approach by more clearly identifying a narrow set of institutional goals and priorities and then working to implement coherent actions to reach those goals (Axanova, 2008; Feldman et al., 2002; Siegel and Phan, 2005; Siegel et al., 2007).

However, despite the general claims of the importance of university administrators' adopting a strategic perspective in the field of KT, we still know very little about strategic-goal setting in this area and, in particular, how it should match an institution's unique characteristics. Since universities differ along various dimensions, including the pool of available resources, the scale and focus of their research efforts, and the level of experience in technology licensing, patenting and spin-offs, it is likely that they would not adopt a single style for KT (NRC Report, 2010). This is confirmed by the evidence that TTOs may adopt different organisational structures depending on the intended goal to be pursued (Bercovitz et al. 2001; Huyghe et al., 2014; Markman et al. 2005). When analyzing KT processes, it is possible to identify at least four interconnected domains, namely (i) the decision of the strategic orientation of universities toward KT activities; (ii) the definition of specific goals that TTOs intends to pursue to serve the university strategy; (iii) the identification of the TTOs' optimal structure to manage such goals; and (iv) the performance assessment of TTO operations. Surprisingly, researchers have mainly considered the last three domains, disregarding the role of the university in orchestrating the entire process. Yet, it is well accepted that the commercialization of the knowledge created within universities represents "a conscious and strategic effort" (Brescia et al., 2016: 133). This will be the focus of our work.

Starting with these premises, in this paper, we are interested in addressing the following research questions: *What are the main orientations that universities strategically adopt in performing their KT activities? How are university characteristics associated with the choice of one strategic model with respect to another?* Building on the literature on technology transfer (Axanova, 2012; Bozeman et al., 2015; Feldman et al., 2002; Siegel et al., 2007; Sharer and Faley, 2008), we first identify three strategic configurations for

universities in the field of KT, which depend on the major emphasis that they devote to a specific set of priorities: Income-generation strategy; Service-to-faculty strategy; Local Development strategy. We then discuss and empirically identify the underlying factors that should drive the KT strategic choices of universities, focusing on two dimensions: university horizontal diversity (i.e., generalist versus specialist universities) and university vertical diversity (i.e., university institutional prestige). Our empirical analysis relies on a unique survey of 178 university Technology Transfer Office (TTO) managers across European universities, undertaken in the course of the Horizon 2020 project Progress TT[1], combined with additional data sources.

This paper intends to extend the literature in two main directions. Firstly, we contribute to the literature on higher education institutions that has developed the notion of university strategy (see e.g. Bonaccorsi and Daraio, 2007; Daraio et al., 2011; Deiaco et al., 2012; Warning, 2004; Whitley, 2008). In particular, we aim at conceptualizing different configurations of KT strategies pursued by universities in the European context. Secondly, we investigate the factors that influence the relevance and choice of a given KT strategy. Specifically, with the aim to fill the gap in the literature on KT strategies, strongly focused on TTOs, we focus on university characteristics: we investigate whether and to what extent horizontal and vertical differentiation matter in the strategy pursued for KT activities. Horizontal diversity refers to the disciplinary subject mix in education and the scope of research activity, while vertical diversity refers to the position of the university in a hierarchy of prestige.

The remainder of the paper is organized as follows. Section 2 presents the literature related to university strategies in the field of KT. Section 3 discusses the effect of university-level factors on the choice of a given KT strategy and presents the empirical hypotheses. Section 4 illustrates the construction of the dataset and presents the descriptive statistics. Section 5 describes the methodology employed in the empirical analysis and shows the results, including a set of robustness checks. Section 6 concludes by summing up and discussing the contribution of this work and its implications.

[1] Progress TT ("University Growing Europe Through best practice SolutionS for Technology Transfer") is a European Union H2020 funded project. The overall goal of the project is to contribute to Europe's economic growth by ensuring that Public Research Organisations (PROs) are better equipped to transfer valuable knowledge to industry, which leads to increased innovation and, in turn, economic growth. To this end, best practices in TT have been gathered and formulated into TT tools, methods and training materials that, together with coaching and mentoring programs, will support European Technology Transfer Offices (TTOs) in improving their performance and access to finance. For more information on the project: http://www.progresstt.eu.

2. Literature review

2.1 The strategic diversity of higher education institutions

The literature on higher education institutions has increasingly discussed the notion of university strategy, starting with the seminal contribution by Keller (1983). The idea of strategy in universities emerged in the United States in the late 1970s and 1980s. It then spread rapidly in other contexts, such as Continental Europe, often as a response to external pressures, such as institutional reforms of higher education systems, cuts in public funding, increasing diffusion and interest in international university league tables or rankings (Harvey, 2008; Kogan, 1997; Whitley, 2008). In this context, developing clear strategic thinking has thus become increasingly important for universities to facilitate the attraction of human talent and financial resources and reaffirm their centrality in the economic and social system.

As a response to the increasing relevance of the concept, several attempts to apply the notion of strategy to universities have emerged in the literature (Bonaccorsi and Daraio, 2007; Daraio et al., 2011; Deiaco et al., 2012; Warning, 2004). A fundamental condition for the implementation of strategic behavior is an internal decision-making process that is empowered by some level of autonomy and discretionary power in collecting the resources to be allocated to strategic objectives (Whitley, 2008). Under this logic, Bonaccorsi and Daraio (2007: 11) define university strategy as "an emergent pattern of configuration of university outputs that depend on (relatively) autonomous decision making by universities, supported by appropriate combinations of resources (inputs)." However, the previous literature has emphasized the risks of simplistically extending the concepts and terms that are related to strategic decision-making from the realm of business to the higher-education system, due to conceptual and methodological limitations (Gumport, 2001; Amaral et al, 2002; Whitley, 2008). First, because of their historical origins, most universities carry the "weight of tradition" and "follow largely institutionalized and general rules that limit the scope for discretionary behavior" (Bonaccorsi and Daraio, 2007: 9). Second, as most universities are public institutions, they largely depend on public money (allocated outside of the reach of their power) thus limiting their strategic actorhood. Third, universities often act as "loosely coupled systems," where subunits (e.g., schools, departments) are relatively autonomous and independent from one another, and resources are distributed according to predefined rules (Cohen et al., 1972; Cohen and March, 1974).

On the one hand, there are reasonable conceptual objections to a simplistic application of the notion of strategy to higher education institutions. On the other hand, an ad-hoc and more narrowly defined notion of strategy would allow the explanation of major differences in the approaches followed by higher education institutions as far as the authority exercised over resource acquisition, use and disposal is concerned (Deiaco et al., 2013; Whitley, 2008). For instance, several studies have recently characterized the differentiation patterns of universities in a wide variety of countries (Daraio et al., 2011; Kempkes and Pohl, 2010; Warning,

2004). Daraio et al. (2011) classify the position and evolution of specific universities in the European higher-education landscape with respect to several structural elements, such as research orientation, research intensity, degree of autonomy, horizontal diversity (i.e., mix of subjects taught), and vertical diversity (i.e., position of a university in a hierarchy of prestige). With the aim of understanding the differences among German universities with regard to their levels of efficiency, Kempkes and Pohl (2010) find that faculty composition and structure are highly relevant in explaining efficiency results. In the same context, Warning (2004) asserts that "initial investments and different strategic actions of universities lead to their different positions in the higher education sector. Pursuing similar strategies leads to similar positions that influence structure and performance within the system" (Kempkes and Pohl, 2010: 393). From this research, the importance of applying a strategic lens to universities is clear as they may pursue different missions and, therefore, be focused in different ways.

However, existing studies mainly focus on the characterization of universities along the two traditional missions of education and research, whereas less attention has been devoted to the identification and analysis of universities' strategies in the so-called "Third Mission" area, which is centered on research valorization and KT. This is surprising for two main reasons. Firstly, a large and growing literature has documented various forms of involvement of universities in KT activities. Secondly, universities are addressing the growing need to develop tighter linkages between science, technology and innovation and contribute to local economic and societal development (Etzkowitz, 2002; O'Shea et al., 2005). Thus, in line with the idea that "entrepreneurial universities" have the ability to develop a focused strategic orientation - not only in terms of academic goals but also in translating the knowledge produced into economic and social value (Clark 1998) - we propose a theoretical and empirical assessment of universities' strategic choices in the KT area and their characterization in distinct configurations, which is largely missing in the literature, as we discuss in the following section.

2.2 The strategic orientation of universities in knowledge transfer

Knowledge transfer (KT) refers to the multiple ways in which knowledge from universities and public research institutions can be exploited by firms and other organizations to generate economic and social value and industry development (OECD, 2013). It encompasses a broad range of activities to support the collaborations between universities, industry and the public sector, and it involves a variety of goals, modes and channels. While early research has mainly focused on the objectives related to the commercialization of intellectual property rights generated from universities (with a major emphasis on patents and licensing activity), subsequent studies have emphasized additional missions, such as providing service to faculty, enhancing innovation and the practical use of research results, fostering local economic development, complying with national and institutional policies, and promoting public value (Bozeman et al., 2015). This orientation is in line with the definition of KT activities, which, by their nature, address multiple stakeholders with multiple

goals and expectations (scientists, TTO managers, PRO administrators, industry, investors, and policy-makers at the regional, national and international levels).

Universities have a pivotal role as independent knowledge institutions. Their overarching aims are to ensure that their graduates develop the skills needed to successfully thrive in future job, and to open up to collaboration with external stakeholders when it comes to KT (Meissner and Shmatko, 2017). Therefore, it is reasonable for universities to refine and adjust their managerial models to the changing landscape of the job market and of the knowledge generation and diffusion processes. This is particularly true with respect to KT activities. In fact, although universities typically serve all KT missions, management practices should be carefully considered because they seem to serve different purposes (Benassi et al, 2017). In particular, several researchers and practitioners have highlighted that universities should adopt a specific strategic approach to more clearly identify a set of institutional goals and priorities and then try to implement coherent actions to reach such goals (Feldman et al., 2002; Sharer and Faley, 2008; Siegel et al., 2007). Siegel et al. (2007) argue that universities should make strategic choices regarding institutional goals and priorities in KT to drive resource allocation decisions and choices regarding the mode of commercialization that they wish to emphasize. Bozeman et al. (2015), while reviewing the literature on KT effectiveness, suggest that studies of KT programs should adapt and customize their assessment to reflect the differences in the strategic orientation of the involved organizations. Similarly, moving from the perspective of TTO practitioners, Axanova (2012) and Sharer and Faley (2008), claim that for a university TTO, as for any organization, having unfocused goals can lead to conflicting operational objectives and ultimately to ineffectiveness.

However, despite the general claim of the importance of university KT strategic orientation, only limited attempts have been made to conceptualize a taxonomy of KT strategies and to operationalize it. Moreover, a thorough analysis of the underlying factors that should drive the KT strategic choices of universities is still missing in the literature.[2]

2.3 A classification of universities' knowledge transfer strategies

Recent studies in the field of KT underline that universities are characterized by various strategic configurations in KT activities (e.g. Axanova, 2012; Batalia, 2006; Brescia et al., 2016; Feldman et al., 2002; Sharer and Faley, 2008). For instance, Axanova (2012) reviews US technology transfer models, identifying traditional, experimental and hypothetical models. While experimental and hypothetical models are broader approaches that have been proposed at hypothetical level and are now being tried or are yet to be tried, traditional models have been used for several decades. In particular, traditional models are oriented towards

[2] Differently from the case of universities, various studies investigate the strategic organization of TTOs for KT activities. For instance, a recent study by Battaglia et al (2017) analyse how TTOs organize themselves to achieve external growth. They show that TTOs choose to configure the relationship with other TTOs in three different organizational structures, illustrating the characteristics of these, as well as their advantages and disadvantages.

the core missions of universities, thus including services provision, revenue generation and support to economic development. Experimental and hypothetical approaches include KT models that stress the inventor's and researcher's research interests, the importance of developing alliances with large research oriented companies (e.g. pharmaceutical), the possibility to develop KT collaborations among universities, and the radical proposal to let researchers protect their inventions through independent agents so to increase competition (Axanova, 2012).

In a similar vein, Brescia et al. (2016) analyse the organizational structures of TTOs of the world top 200 ranked universities by specifically considering how universities organize their KT activities. From their study, it emerges that universities may adopt three models: "Internal", "External" and "Mix", depending on the organizational positioning of the TTO with respect to the university. The "Internal" model, where all TTO activities are managed by a dedicated office internal to the university, is the prevalent one in their sample. Feldman et al. (2002) focus on revenue strategies pursued by US universities: they investigate universities' use of equity for KT activities as a function of various factors, including the organization of the TTO. With respect to the latter, they show that when TTOs are expected to be financially self-supported, the propensity to adopt equity-based mechanisms is lower, because of higher risks associated with such strategy. Sharer and Faley (2008) investigate four KT organizational goals of TTOs in the attempt to show that the choice of a primary KT goal should impact strategy and align with operations and policy, so to generate an effective organization of KT activities. Specifically, the authors compare the following goals: "providing a service for researchers", "maximizing the societal benefit of new technologies", "acting as an engine for local economic development" and "acting as a revenue generator for the institution".

Building on the insights of this stream of literature, we identify three strategic configurations of universities in the area of KT, depending on the emphasis that they devote to a specific set of KT priorities:

- Income-generation strategy
- Service-to-faculty strategy
- Local development strategy[3]

In the case of the "Income-generation Strategy," the major emphasis of the university and its TTO is on maximizing the stream of revenues that can be generated from the commercialization of ideas and inventions that are disclosed from research to industry (Axanova, 2012; Sharer and Faley, 2008). This model is based on a profit-driven logic, according to which universities' KT experts work with the faculty to generate

[3] Conceptually, we do not claim that KT strategies are mutually exclusive, because the underlying missions at their basis tend to be jointly shared by all universities (and related TTOs). We rather intend that each university (and its related TTO) may place relatively more emphasis, attention and resources on the achievement of a specific set of priorities, rather than on the remaining ones.

revenues that come from research, particularly from licensing agreements and industry-sponsored research contracts. For instance, licensing agreements involve selling to companies the rights to use university's inventions in return for revenue in the form of upfront fees or royalty payments. The distribution of licensing revenues from universities is typically highly skewed, with many inventions that do not generate sizeable net returns, but with a few big commercial successes that generate large returns (Barjak et al., 2014; Feldman et al., 2002). Pursuing this strategy thus shows a strong orientation towards the generation of university-owned patented inventions and their commercial exploitation to reap financial rewards. The success measures of this model are primarily centered on income streams from royalty agreements or patent sales, as well as income that is derived from industry-sponsored research contracts.

The "Service-to-Faculty Strategy" emphasizes the diffusion and practical application of knowledge outside of academia through dedicated support to faculty as a primary mission of KT activities (Sharer and Faley, 2008). This model focuses on developing long-term capacity building at different levels, from the individual scientist to organizational actors. The capacity to create and apply new knowledge and technology depends not only on the maturation among faculty of the skills and know-how that are related to research valorization but also on the creation of social and professional networks or technological communities (Bozeman et al., 2015). These networks generate opportunities for research collaboration and job mobility and reveal possible applications for scientific and technical results that stem from academic laboratories. A TTO that focuses on helping researchers to valorize their discoveries should therefore engage in scouting activities to attract top scientists with commercially focused research projects, respond quickly to faculty inquiries, offer business development assistance to research, and emphasize quick and efficient deal-making in collaboration with industry (Sharer and Faley, 2008). In this model, more emphasis is placed on the number of invention disclosures, the number of inventions that are patented, exposure to research funding, collaboration and network activity, and faculty recruitment and retention, rather than licensing revenue or start-up formation (Axanova, 2012; Batalia, 2006; Rasor and Heller, 2006)

Finally, the "Local Development Strategy" emphasizes the attempt to contribute to the growth of the local economic systems where universities are embedded, by generating opportunities for knowledge exchange and new ventures creation (Axanova, 2012; Sharer and Faley, 2008). The role of universities that pursue this model is to facilitate the development of technologies that form the basis for new ventures that are founded by researchers and/or students, and the development of technologies that match the interests and skills of local firms. Because creating new companies is the most immediate way to generate new jobs, university spin-offs and start-up formation is a central component of the strategy that is oriented towards local and regional economic development (Di Gregorio and Shane, 2003; Sharer and Faley, 2008). For these reasons, under this model universities and TTOs tend to work closely to generate partnerships with local public and private actors, for instance by establishing local incubators, proof-of-concept programs,

accelerator programs, seed funds or industry-sponsored research labs (Munari et al., 2016 and 2018). Measures of the success of this model include start-up formation by university faculty or students (and related turnover or employment growth), the creation of local jobs and the retention of graduate students in those jobs.

3. The antecedents of universities' KT strategies: hypotheses

Previous studies suggest that universities' strategic choices in KT should be aligned with the more general goals and missions of an academic institution and they should reflect its distinctive characteristics (Di Gregorio and Shane, 2003; Feldman et al., 2002; Siegel et al., 2007; Sharer and Faley, 2008). Universities have different positions in the higher education sector, hence resulting in a variety of university potential categories. Such variety is particularly relevant for understanding how university-specific characteristics explain the prevalence of a given KT strategic orientation with respect to another. To explore the set of drivers of universities' strategic orientations towards KT activities that we have identified, we exploit two dimensions that emerged as particularly relevant in the literature on higher education institutions (Brescia et al., 2016; Daraio et al., 2011; Teichler, 2005): the degree of specialization of the university ("horizontal diversity") and the prestige and research quality of the institution ("vertical diversity"). Figure 1 shows a diagram of the conceptual model and hypothesized relationships that we are going to present in the next sub-section.

-- FIGURE 1 ABOUT HERE --

3.1 University horizontal diversity

"Horizontal diversity" (Daraio et al, 2011; Teichler, 1988, 2002) refers to the disciplinary subject mix in education and the scope of research activity. In terms of education, a university may decide to offer a broad range of courses to differentiate student audiences or to adopt different teaching methodologies. Bonaccorsi and Daraio (2007) suggest that universities may specialize in large-scale undergraduate education or Masters or PhD education. As far as the research mission is concerned, universities may decide to be a leader in basic research, an innovative and industry-orientated university in applied fields, or a provider of proximity research in local development. In this paper, we refer to the horizontal distinction between specialist and generalist universities in terms of disciplinary subject mix in education and research. In particular, we identify specialist universities as those that are focused on applied sciences, thus offering a narrow subject mix (such as polytechnic schools or medical schools), whereas generalist universities provide a wide range of courses that span several macro-subjects and disciplines (humanities, social sciences, science, technology, and medical). Therefore, specialized universities show lower levels of horizontal diversity as compared to generalist universities.

With respect to the KT scientific orientation, universities that specialize in applied sciences generally display higher availability of qualified researchers in specific scientific domains, hence presenting a critical mass that is useful to substantially advance a given technological field. In addition, these universities tend to focus more closely on the needs of industry than do other universities, thus being prone to achieving research outputs that are more likely to be commercialized in the market and generate significant streams of revenue. Additionally, moved by a deep understanding of the market needs to which their technological products refer, specialist universities tend to devote higher efforts than generalist universities in the creation of collaborations with industry to increase the chances of reaching the market with their research outputs. These are the pre-conditions for pursuing an income-oriented KT strategy. Therefore, we formulate our first hypothesis, as follows:

- *Hp 1.a Specialist universities are more oriented towards income generation objectives in their KT activities*

Research activities inside generalist universities are not typically limited to technological and scientific domains, since they also include the humanities and social sciences domains (Battaglia et al., 2017). For this reason, the support provided by KT staff to faculty is wider and at the same time, more general than the support provided inside specialist universities. KT staff within such universities tend to be less involved in scouting activities to attract top scientists with commercially focused research projects, and devote relatively less attention to supporting faculty in the patenting and commercialisation process. In addition, generalist universities have lower incentives to activate internal support structures and financial programs to foster the commercial exploitation of their discoveries (Munari et al., 2016). For these reasons, generalist universities are likely to be less prone to pursue a KT strategy primarily oriented at providing services to faculty. Moreover, TTOs that are not specialized in a given field often lack a highly developed network of relationship within the scientific community and with the industry base. This causes lower visibility and lower exposure to research collaboration and funding opportunities. From these considerations, we argue that:

- *Hp 1.b Generalist universities are less oriented towards service-to-faculty objectives in their KT activities*

Universities that offer a broad range of courses in several fields tend to be characterized by wide-reaching goals such as generating opportunities for students and, more generally, contributing to the economic development of local areas (Bonaccorsi and Daraio, 2007). Within generalist universities, knowledge transfer activities from humanities and social sciences domains tend to present distinctive characteristics, being centered on public engagement, consulting and research collaboration activities, rather than patenting and licensing (Olmos-Peñuela et al., 2014). Therefore, they tend to rely more on personal and direct interactions and they tend to be more strictly rooted in the local or regional context. Furthermore,

given the wider spectrum of fields that generalist universities cover, they can develop a heterogeneous set of competencies among faculty and students, which span from technical excellence to business, artistic and cultural expertise. Additionally, they manage to develop contacts outside of academia in all of these areas, thereby increasing the probability of success of new ventures, which require a heterogeneous background within the entrepreneurial team (Clarysse and Moray, 2004; Kochenkova et al., 2016; Lockett and Wright, 2005; Vanaelst et al., 2006). These arguments lead us to our third hypothesis:

- *Hp 1.c Generalist universities are more oriented towards local development objectives in their KT activities*

3.2 University vertical diversity

The second argument for cross-university variation in KT strategic orientation is based on university prestige. Bonaccorsi and Daraio (2007) label this dimension "vertical diversity" in order to identify the position of the university in a hierarchy of prestige. As in the case of horizontal diversity, this notion relies on various metrics that depend on the specific dimension of the analysis (e.g. teaching, academic research, KT activities). To capture European university vertical diversity, we consider the prestige of research measured by international university rankings, following previous practice in extant research (Bonaccorsi et al., 2015; Brescia et al., 2016; Sine et al., 2003).

High performing organizations exploit their credibility by sending signals of quality to external parties, thus attracting their attention. This may have various effects, including (i) increasing the probability of financial endorsements by potential investors (Munari et al, 2015), (ii) facilitating access to people with expert knowledge and talent (O'Shea et al., 2005), and (iii) supporting intensive interactions and opportunities for collaboration with industrial partners (D'Este and Patel, 2007). In other words, high-prestige universities are better positioned to establish networking activities and accomplish commercialisation agreements. Accordingly, several studies have postulated a positive relationship between the quality of university research and the likelihood of interaction with industry to create social and professional networks, hence favoring the exploitation of research results (Mansfield and Lee, 1996; Tornquist and Kallsen, 1994). Furthermore, prestigious research tend to facilitate the creation of a wide and robust pool of technologies available for commercialization, increasing the propensity of researchers to exploit their inventions and capturing the income flows generated through their intellectual capital (Di Gregorio and Shane, 2003; O'Shea et al., 2005; Owen-Smith and Powell, 2001). Following these arguments, we formulate the hypothesis below:

- *Hp 2.a High-prestige universities are more oriented towards income-generation objectives in their KT activities*

On the other hand, low-prestige universities are not able to reach a critical mass of human capital endowed with strong scientific and technical expertise, which is the main requisite for the development of cutting-edge technologies. Relatedly, formula-based funding allocation, implying the allocation of a part of the public research funding on the basis of competitive performance, results in less funds assigned to low tier universities (Daraio et al., 2011). As a consequence, TTOs of low-prestige institutions are likely to be endowed with less resources than top institutions (Rasor and Heller, 2006).[4] Regardless of the budget of the office and the quality of the support staff, without great research TTOs will have not much to protect, market, and license (Rasor and Heller, 2006). Therefore, the support offered to faculty for the realization of KT activities is likely to be weak. In other words, low-quality universities fail to support the faculty and staff so to counterbalance the lack of non-technical experience and of resources. Indeed, the lower visibility and reputation of non-top universities may hamper the achievement of the complementary human and financial resources that are necessary to diffuse their knowledge outputs. Thus, we postulate that:

- *Hp 2.b Low-prestige universities are less oriented towards service-to-faculty objectives in their KT activities*

Universities are increasingly called to adopt a strategic orientation to meet a pool of goals related not only to the scientific field but also to the more general economic development (Gioia and Thomas, 1996). Such strategic orientation is expected to be different, depending on the layer in which universities are positioned in the hierarchy of quality. On the one hand, top universities, characterized by high levels of prestige, funding and professionalized TTOs, are in the position to undertake research commercialisation activities at the global level. Accordingly, external stakeholders (including governments and public opinion) may expect top universities to meet a profile of what a prestigious university looks like (Gioia and Thomas, 1996). More concretely, they should be able to extract a substantial value from their research and KT activities and, therefore, provide a strong contribution in terms economic development at the international level. On the other hand, the limited resources and visibility characterizing low-prestige universities force them to pursue narrower and more local orientations, by implementing patterns of actions mainly directed at the economic development of the local context they are embedded in. In this case, an increased sensitivity to the external environment and a tight fit with the local environmental needs are the main priorities for these universities. Accordingly, we suggest that:

- *Hp 2.c Low prestige universities are more oriented towards local development objectives in their KT activities*

[4] The way TTOs are funded and budgeted should be firmly founded on the mission and overall objective of the university. However, the size of the budget of TTOs generally correlates with the research base or overall faculty size of a university. In other words "The more you have to work with, the larger your office is going to be" (Rasor and Heller, 2006: 1).

4. Data and descriptive statistics

4.1 Sample selection and data sources

The dataset that we use to test empirically our hypotheses is made up of information collected from various sources of data. The primary data source is an original survey of university TTO managers that we carried out in the course of the H2020 Progress-TT project, in collaboration with the other project partners.[5] In order to construct the sample to investigate our research questions, we conducted a survey addressed at university TTO managers from 27 European countries (Austria, Belgium, Croatia, the Czech Republic, Cyprus, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Italy, Lithuania, Luxembourg, Malta, Norway, Poland, Portugal, Serbia, Slovenia, Spain, Sweden, Switzerland, the Netherlands, and the United Kingdom) plus Turkey. The survey aimed at collecting first-hand information on several dimensions of KT activities inside universities, including demographic information of universities and TTOs and TTOs' structure and operations. A sample of 521 TTOs has been contacted between spring and summer 2015. The sample has been extracted from the list of TTOs that are associated with ASTP-Proton, which is a pan-European association for professionals who are involved in knowledge transfer between universities and industry, and complemented with TTOs belonging to other national TTO associations. The survey was administered in two phases: firstly, paper copies of the survey were distributed at the ASTP-Proton 2015 Annual Conference that was held in May; secondly, the remaining TTOs were contacted by email and/or by phone, asking TTO managers to fill out the survey that was sent electronically through the Survey Monkey platform. Three email and/or phone recalls were conducted over the following three months. We obtained 225 completed questionnaires out of the 521 TTOs contacted, which corresponds to a 43% response rate. After excluding observations with missing data on the variables that are used in our empirical analysis, we retained a final sample of 178 questionnaires across 26 countries (response rate of 34.16%).[6]

In addition to the survey data, we used the European Tertiary Education Register (ETER) dataset and the Times Higher Education (THE) Ranking (both available online) to collect data on other university-level characteristics as of 2014. ETER is a database of higher education institutions in Europe (HEIs), currently

[5] The survey of TTO professionals was part of the H2020 funded project PROGRESS-TT. It was designed and implemented by the following partnering organizations: the Department of Management of the University of Bologna, ASTP-PROTON, Fraunhofer MOEZ, Mito Technology and Pera Consulting.

[6] Table 9 in Appendix A shows the detailed response rate per country. Countries are listed according to the % response rate: the survey obtained a 100% response rate in Turkey, France, Czech Republic, Poland, Hungary and Estonia; the lowest rate was reached in Spain and Belgium (13%); there are also few countries where no responses were obtained. The large response rate in Turkey is due to the fact that the first batch of questionnaires was administered in paper copies at the ASTP-Proton 2015 Annual Conference that was held in Istanbul, where arguably almost all TTO representatives from Turkish institutions were there.

including information on 2,673 HEIs from 36 countries.[7] It builds on the EUropean MIcroDAta project (EUMIDA), a large-scale study supported by the European Commission between 2009 and 2011. The THE Ranking is a world university ranking that is conducted every year and provides a list of the 400 world's best universities, which are evaluated across research, teaching, industry funding, international outlook and citations.[8] Finally, we collected NUTS2-level data from Eurostat regional statistics.[9] Since we combine various data sources to construct our variables, potential problems of common method bias are largely controlled for (Podsakoff et al., 2003).

4.2 Variables

In this paper, we investigate the antecedents of university KT strategies via regression analysis. In particular, we study the role of university horizontal and vertical differentiation. To do so, we estimate a model in which university KT strategies depend on the above factors, along with a complete set of control variables at the TTO, university and regional level. The list of our variables, their description and the data sources used for their operationalization are presented in Table 1.

-- TABLE 1 ABOUT HERE –

4.2.1 Dependent variables

Our dependent variables measure the extent to which universities rely upon income-based, service-based or development-based KT strategies. As underlined in the literature section (see section 2.2.), KT include all activities through which knowledge from universities and public research institutions is exploited to generate economic and social value and industry development (OECD, 2013). These activities include IPRs and their exploitation, spin-off creation, generation of opportunities for faculty. KT strategy refers to universities' strategic choices in the KT area, thus to the main activities pursued by universities in terms of knowledge transfer. For this reason, in order to measure them we exploit a question of the Progress-TT survey that specifically addresses the importance of various objectives pursued inside universities. Respondents are asked to indicate which of the following seven objectives best characterize (on a 1-5 Likert scale from unimportant to extremely important) the KT priorities of the university/TTO:

1) *revenue generation from licensing*
2) *revenue generation from research*
3) *facilitate practical application of research discoveries*
4) *economic development through spin-off creation*
5) *contribution to local and regional development*

[7] http://eter.joanneum.at/imdas-eter/
[8] https://www.timeshighereducation.com/
[9] http://ec.europa.eu/eurostat/web/regions/statistics-illustrated

6) provide service to faculty

7) generate opportunities for students

We perform explorative factor analysis (FA) with the principal component method on the seven items with the aim of identifying underlying driving factors that could allow to classify university KT strategic models.[10] The analysis reveals three major factors with eigenvalue above 1, explaining 62.2% of the variation in the original seven items. The results of the factor analysis are fully reported in Appendix B.[11] The first factor drives items (4), (5) and (7); the second factor underpins items (1) and (2); the third factor drives the remaining items (3) and (6). The retained factors resemble the three KT strategies that emerged from the literature (Axanova, 2012; Bozeman et al., 2015; Feldman et al., 2002; Siegel et al., 2007; Sharer and Faley, 2008). Factor 1 is linked to economic development objectives, Factor 2 suggests income related objectives, and Factor 3 corresponds to services-to-research oriented objectives. The derived KT strategies along with survey items and their factor loadings from factor analysis are reported in Table 2.

-- TABLE 2 ABOUT HERE –

We work out three dependent variables as weighted averages of each of the seven items, where weights are the scoring coefficients of the factors extracted through FA. For each Factor, higher weights are associated to the more related items, while lower weights are associated to unrelated (or less related) items. Therefore, items (4), (5) and (7) have the highest weights in Factor 1, items (1) and (2) in Factor 2 and items (3) and (6) in Factor 3.[12] In so doing we obtain three composite indicators of the importance of a given KT strategy for each university. Our dependent variables are called *Local development strategy*, *Income-generation strategy* and *Service-to-faculty strategy*, respectively.

4.2.2 Independent variables

As illustrated in the previous sections of the paper, we are interested in the role of horizontal university diversity (generalist versus specialist university) and vertical university diversity (university institutional prestige) for KT strategies pursued by universities.

Our measure of horizontal differentiation is a dummy that is equal to 1 for generalist universities. The variable, called *Generalist university*, is created from a variable of the ETER dataset called “Institutional

[10] We follow the guidelines provided in the OECD Handbook on Constructing Composite Indicators (OECD, 2008). Before carrying out FA, we implement the Kaiser-Meyker-Olkin (KMO) test to measure sample adequacy and the Bartlett’s test of sphericity to test the hypothesis that the individual elements of the correlation matrix are uncorrelated. The KMO test shows that sampling adequacy is above the acceptable value of 0.6 (KMO=0.604). The Bartlett’s test has a p value well below <0.001 (p=0.0000), thus allowing to reject the hypothesis of uncorrelation.

[11] Table 11 in Appendix B shows the pairwise correlations among non-standardised survey items; FA is carried out on the standardised items and the 3 obtained factors are rotated through varimax rotation (see Tables 12 and 13); we then predict the scoring coefficients that indicated the weight of each item within a given factor (see Table 14).

[12] See table 14 in Appendix B.

Category Standardized" assuming value 1 for generalist universities, 2 for specialist universities and 0 for others. We recode it assigning value 1 only to universities that have been clearly identified as generalist. We assign 0 to all others, which are mostly specialist universities. The latter include Engineering Schools, Polytechnic Schools, Institutes of Technology, universities of Applied Sciences and Medical Schools. This variable intends to capture universities' positioning with respect to course offerings: generalist universities offer a wide variety of degree courses, typically in almost all disciplines, whereas specialist universities focus on a given small set of disciplines, typically applied ones. This is in line with the extant evidence that shows that generalist universities are the predominant model in Europe (Daraio et al, 2011).

Second, we measure university institutional prestige with a dummy that is equal to 1 if the university was part of the list of top schools in the world in 2014, as indicated by the THE Ranking. All of the other universities that did not enter the world ranking have 0 on the dummy. The variable, which is called *High-prestige university*, intends to measure universities' positioning with respect to an international world-level hierarchy of institution quality. We use the information that is provided by the THE Ranking because it provides a ranking based on various dimensions of quality (i.e. research, teaching, industry funding, international outlook and citations), thus providing an overall measure of quality.

4.2.3 Control variables

We introduce control variables at the level of the TTO, at the level of the university, and at the regional level, with the aim of better isolating the effect of the independent variables on university KT strategies.

TTO level control variables

Given that the TTO is the unit that is in charge of managing KT activities, we expect that the KT strategic orientation of a university is also linked to the governance arrangements of its TTO. More precisely, we control for the presence of incentives to TTO managers, the level of autonomy of the TTO, TTO size, TTO age and whether the TTO provides its services to more than one University. All of these variables are obtained through the Progress-TT survey.

TTO incentives is a variable that allows us to investigate whether incentivizing directly those who are primarily involved in the KT process has any impact on the importance of the KT strategy that universities mainly pursue. This variable is a dummy equaling 1 for TTOs having incentive schemes for the staff and/or management of the TTO, 0 otherwise. Since TTOs manage most activities that bring revenues from commercialization, such as licensing agreements, the adoption of an Income-generation strategy may significantly depend on the effort that TT officers enact in eliciting invention disclosure, successfully marketing inventions and closing deals (Belenzon and Schankerman, 2007; Feldman et al., 2002). Thus, we expect that incentives for TTO staff positively influence the importance of income-oriented KT strategies for universities.

We measure TTO autonomy by means of three exclusive dummies. Firstly, *TTO autonomy low* equals 1 for TTOs whose strategic priorities are only set from the top management of the university. Secondly, *TTO autonomy medium* equals 1 for TTOs whose priorities are jointly set by TTO and university management. Thirdly, *TTO autonomy high* equals 1 when only the Director and staff of the TTOs are in charge of defining TTO priorities. The degree of decisional and operational autonomy of the TTO is an important influential factor for the modes of universities' engagement in KT activities (Bercovitz et al., 2002; Siegel et al, 2003; Markmann et al., 2005; Axanova, 2012; Schoen et al., 2014; Derrick 2015). Previous studies share the idea that creating a decentralized TTO within the university may be instrumental to securing a sufficient level of autonomy for developing relationships with industry (Bercovitz and Feldman 2006; Debackere and Veugelers, 2005; Goldfarb and Henrekson 2002; Rasmussen and Borch 2010). In fact, it is important that TTOs are not subject to pressures for revenue generation or for pursuing local development strategies, which are generally related to centrally-defined profit and socio-economic objectives. Therefore, it is arguable that TTOs' autonomy with respect to the university administration is higher among TTOs that pursue service strategies, hence directed at maximizing the valorization of research discoveries.

We measure *TTO size* based on the number of employees who worked at the TTO in 2014, and we include its logarithm in the regressions. We expect that larger TTOs plays a crucial role for KT activities, notably for income-oriented ones (Thursby and Kemp, 2002; Caldera and Debande 2010; Siegel et al. 2003). TTO size is a measure of its experience, therefore we expect that it is positively linked to TTO income-related outputs (Lach and Schankerman, 2004; Siegel et al. 2003; Friedman and Silberman, 2003). Finally, we construct a dummy variable that is called *Multi-university TTO*, assuming a value 1 for TTOs that provide their KT services to more than one university and 0 for those that serve only one university. TTOs that serve more than one institution are expected to be structurally different from TTOs that are embedded in a university. While the former are often separate institutions following a for-profit logic, the latter are fully part of the university structure, sometimes being one of its various administrative departments. Therefore, we expect this characteristic to be differently linked to universities' KT strategies.

University level control variables

We control for university size, for the presence of a university hospital and of a university Incubator. University size is measured through three exclusive dummies that indicate three size bands for small, medium and large institutions. *Small universities* are those employing less than 500 academic researchers in 2014; *Medium universities* employ between 500 and 2000 researchers; *Large universities* employ more than 2000 researchers. Medium-large universities, due to their size and visibility, are expected to be better in the generation of innovative knowledge and, in particular, in the creation of social and professional networks for business development support. Thus, we expect a stronger orientation of these universities toward service-to-faculty KT strategies. The presence of hospitals, which we measure with a dummy variable equaling 1 for

universities hosting a hospital, implies strong attention to medical and related research, which enables the achievement of university-owned patented inventions and their commercial exploitation. Therefore, we expect this variable to be related to universities' KT strategic orientation toward income-generation. Finally, we introduce a dummy variable called *University incubator* that indicates whether there is an incubator inside the university. We expect that the establishment of an incubator, which supports the process of start-up formation by university faculty, may be related to a higher propensity of universities to pursue economic development goals.

Regional level control variables

The last two control variables account for NUTS2 level information on the regions where universities are located. These are *Regional patents,* which measures the number of EPO patent applications submitted in the regions in 2014 and controls for the innovation intensity of the region; and *Regional size,* which measures the population in 2014.[13]

4.3 Descriptive statistics

Tables 3 and 4 present descriptive statistics and correlations of the variables that are employed in the regression analysis. As far as the dependent variables are concerned, it is particularly useful to show their distribution by geography, so to test for variation across European areas.[14] Figure 2 presents the breakdown across four European country groups: north (Denmark, Finland, Ireland, Norway, Sweden, and the United Kingdom), west (Austria, Belgium, France, Germany, Luxembourg, Switzerland, and the Netherlands), east (Croatia, the Czech Republic, Estonia, Hungary, Lithuania, Poland, Serbia, and Slovenia) and south (Italy, Malta, Portugal, Spain, and Turkey). The Service-to-faculty KT strategy is predominant among universities in Northern and Eastern countries, while Income-generation is highly relevant for universities in the West; the Local development KT strategy is predominant in southern universities.

As far as the main regressors of interests are concerned, a total of 87% of the universities of our sample is made up of generalist universities, thus displaying a high level of horizontal differentiation, and 38% were part of the THE Ranking in 2014, thus displaying top positioning in their vertical quality differentiation. Figure 3 shows that Income generation is predominant among specialist universities while local development prevails among generalist ones. Figure 4 shows that high prestige institutions mainly

[13] Both variables are used in logarithm in the regressions.

[14] The dependent variables originate from standardized variables, hence presenting mean equal to 0 and standard deviation equal to 1. The bar charts in Figure 2 indicate the mean value of each KT strategy in each given country group, with respect to the mean in the full sample (0). Therefore, positive values indicate that the mean in a given sub-group is higher than the mean in the full sample, whereas negative values indicate that the sub-group mean is lower than the full sample mean.

pursue service-to-faculty KT strategies, while local development is predominant among universities that were not included in the THE ranking 2014.

As for control variables, 22% of the university's TTOs have incentive schemes for TTO staff and/or management, while the distribution of the three autonomy levels from the lowest to the highest is 21%, 45% and 34%. It is also notable that only 11% of the universities host multi-institution TTOs, while 42% of the universities host a hospital, and 60% host an incubator. Finally, most of the universities in our sample are medium-to-large sized institutions (72%), and they employ more than 500 researchers.

-- TABLES 3 AND 4 ABOUT HERE –

-- FIGURES 2, 3 AND 4 ABOUT HERE –

5. Methodology and results

5.1 Econometric strategy

We estimate three models for each university KT strategy that has been identified. Because the dependent variables are continuous and normal, we employ OLS regressions, supported by robust standard errors to allow heteroskedasticity of the error terms.

We are concerned that the sample of survey respondents is not representative of the overall population of the universities that we contacted, hence raising a potential selection bias problem due to non-responses. To address this issue and to ensure that it does not directly affect our results, we correct our regressions with an inverse probability weighting scheme (Wooldridge, 2002). In the first place, we run a probit regression to estimate the likelihood of survey response. The dependent variable is a 0-1 dummy indicating whether universities responded to the survey, while the regressors include three dummy variables indicating universities geographical area (West, South, and East)[15] and a dummy variable indicating whether universities were included in the THE Ranking.[16] Secondly, we predict probabilities from the probit regressions and we employ them to construct weights to be used in the main regressions. In the OLS estimates, each observation is weighted for the inverse of the predicted probability of survey response.

5.2 Main results

Table 5 shows the results of the probit estimation: all the coefficients are statistically significant at 1-5% level. In particular, our sample seems to over-represent higher quality universities and Eastern universities. These

[15] North is the baseline category.

[16] We also include a dummy variable to control for missing values of the variable Y/N THE Ranking. The % of missing values in the sample of contacted universities is 19%, it is 8% in the sample of respondents.

patterns may well depend on the above-mentioned issue of non-response bias. The employment of weights constructed on the basis on the predicted probability of response, as derived from the probit estimation, will ensure that over- (under-) represented observations are assigned lower- (higher-) importance in the OLS regressions. Table 6 presents the main results of the weighted OLS regressions. For each dependent variable, we estimate a model where we include only the main regressors of interest (columns (1), (3) and (5)) and a model that includes all the control variables (columns (2), (4) and (6)). We test for multicollinearity via the Variance Inflation Factor (VIF) test, reported at the bottom of the table. The mean VIF is always below the threshold of 6, which would indicate problems of collinearity.

In the first place, the coefficients of the independent variable *Generalist university* are negative and significant (at 1% level) in the *Income-generation* KT strategy and positive and significant (at 1% level) in *Local development* KT strategy. The negative coefficient in column (2) indicate that the importance of the income KT strategy for generalist universities is 0.76 lower than that for specialist universities. On the contrary, the positive coefficient in column (6) shows that the importance of the local development strategy is 0.68 higher for generalist universities. In other words, generalist universities attach less importance to the Income generation KT strategy and more importance to the local development KT strategy. This is in line with our discussion of the role of university horizontal diversity (Hp 1). In fact, universities that choose to offer a wide range of courses rather than a few highly specialized scientific subjects, tend to focus on wide-reaching objectives such as generating opportunities for students and, more generally, contributing to the economic development of the local areas. Instead, specialized institutions, due to the availability of highly specialized researchers, have the capabilities and critical mass to exploit income-generation oriented opportunities such as research contracts and IP-related activities and to establish fruitful connections with industry. Therefore, as far as university horizontal diversity is concerned, hypotheses 1.a and 1.c are confirmed, while hypothesis 1.b is not.

Secondly, the coefficient of the independent variable *High prestige university* is positive and significant (at 10% level) in the *Income-generation* KT strategy and negative and significant (at 10% level in the models with no control variables) in the *Local development* KT strategy. The magnitude of the coefficients indicate that the difference in the importance of the income strategy between high and low prestige institutions is 0.34 (column (2)), while it is -0.3 for the local development strategy (column (5)). High quality institutions attach more importance to income related objectives and less importance to local development objectives. Our results are in line with what we hypothesized (Hp 2), especially in the case of the Income-generation strategy, since the coefficient is significant when introducing all control variables. In particular, higher prestigious research facilitates the generation of a robust pool of technologies available for commercialization, thereby increasing the propensity of researchers to exploit their inventions and capturing the rents that generated by their intellectual capital (Di Gregorio and Shane, 2003; O'Shea et al., 2005; Owen-

Smith and Powell, 2001). Therefore, as far as vertical diversity is concerned, we find support for hypothesis 2.a, while hypothesis 2.c is partially confirmed and hypothesis 2.b is not confirmed.

As for control variables, universities that have established incentive schemes for KT practitioners that work inside TTOs attach more importance to income generation (+0.54, $p<0.001$) with respect to universities that do not have such schemes. As expected, incentives that are directly addressed to KT practitioners boost their productivity of KT outputs that bring income streams to universities, such as IPR, licensing and research contracts. In addition, higher autonomy levels are positively and significantly related to the relevance of the service KT strategy for universities. The dummy *TTO autonomy medium* indicates that a coordinated effort between a university's central administration and the TTO staff and/or management in setting KT priorities is better than central coordination only (*TTO autonomy low* is the baseline). These results show that the more autonomous TTOs are, the better they are in supporting university researchers in the exploitation of their research results. In fact, an excessive bureaucracy and inflexibility of university administrators represent relevant barriers to TTO operations (Siegel et al, 2003). Finally, larger TTOs and TTOs that serve multiple universities positively contribute to the reliance on the income KT strategy.

-- TABLES 5 AND 6 ABOUT HERE --

5.3 Robustness checks

We check the robustness of our results through two sets of regressions. In the first place, we replicate the weighted OLS regressions on slightly different dependent variables. While the previously defined dependent variables are weighted averages of each of the seven question items (where weights are the scoring coefficients of the factors extracted through FA), in the new dependent variables we only include the items explained by each given latent factor, thus being those with the highest factor scoring coefficients. To work out the new dependent variables, we compute the average between items.[17] This strategy allows to obtain three dependent variables that only account for the most highly correlated KT objectives within KT strategy on the basis of the explorative factor analysis, but yet independent from it.

The results, reported in Table 7, confirm our previous findings as far as the role of horizontal diversity for income and development strategies is concerned. The *Income-generation* KT strategy is negatively related to the variable *Generalist* (columns (1) and (2)) while the *Local development* strategy is positively related (columns (5) and (6)). In addition, the new results support hypothesis 1.b, according to which specialist universities are more oriented towards the *Service-to-faculty* KT strategy. The coefficient of *Generalist* is negative and significant (at 1-5% level) in columns (3) and (4). As for the role of university vertical diversity, the results in Table 7 qualitatively confirm the positive contribution of academic prestige to the importance

[17] For instance, the new variable Income generation strategy is the mean between item (1) Revenue generation from licensing and (2) Revenue generation from research.

of income-related KT objectives (column (2)), while they confirm the negative relationship with local development strategy in the reduced model (column (5)).

The second robustness check consists of three separate probit regressions that we run to estimate the probability that a given KT strategy is the prevalent one for a given university. This is in line with the argument that universities tend to (and should) adopt a specific strategic approach to KT, so to achieve the best results goals (Feldman et al., 2002; Sharer and Faley, 2008; Siegel et al., 2007). To implement these models, we create three dummy variables – *Income strategy dummy*, *Service strategy dummy* and *Local strategy dummy* – from the total standardized ratings obtained by each strategy. For each variable, we generate a dummy that is equal to 1 when the total rating is in the third or fourth quartile of the distribution, and 0 otherwise. By doing so, we measure the probability that universities attaches high importance to a given strategy, thus accounting for the probability that it mainly pursues that strategy.

The results reported in Table 8 shows that *Generalist* universities mainly pursue the Economic development strategy (columns (5) and (6)), while specialist ones are more oriented towards income and services related KT strategies (columns (1) to (4)). This is in line with the hypotheses of our work. The results particularly confirms our main findings as far as hypotheses 1.a and 1.c are concerned. As for *High prestige universities*, the results in Table 8 qualitatively confirms the positive contribution of academic prestige to the importance of income-related KT objectives (column (2)), while they confirm the negative relationship with local development strategy in column (5).

-- TABLES 7 AND 8 ABOUT HERE –

6. Discussion and conclusions

This paper has investigated the strategies adopted by European universities in performing KT activities and their determinants. Specifically, we studied the role of university horizontal and vertical diversity for three KT strategies: income-generation strategy, service-to-faculty strategy and local development strategy. This study is motivated by the consideration that universities' strategic choices in knowledge transfer should be aligned with more general goals and missions of the academic institution and they should reflect its distinctive characteristics (Di Gregorio and Shane, 2003; Feldman et al., 2002; Siegel et al., 2007). To help universities in their choice, it is fundamental to identify the set of drivers that should guide them. For this reasons, we focus on the scope of university disciplinary subject mix and research activity (horizontal diversity) and on university positioning in the hierarchy of prestige (vertical diversity). Moreover, we aim at shedding lights on this topic by analyzing it at university level, while most of extant research has focused on TTOs.

To conduct our investigation, we exploit a novel data source that is made up of an original survey of European university TTO managers, combined with data from the ETER dataset, the THE Ranking and the Eurostat Regional Statistics. The results of our empirical analysis show that generalist universities attach more importance to the local development KT strategy, whereas specialist universities mainly pursue the income generation strategy. High prestige universities are more oriented towards the income-generation strategy and, on the contrary, low prestige universities seem to be more prone to pursue the local development strategy. Furthermore, we find that TTO incentives positively influence the prevalence of the income-generation strategy, and autonomy of the TTO increases the relevance of the service-to-faculty strategy. Two robustness checks confirm our results, and add that specialist universities attach more importance also to the service-to-faculty strategy.

This study provides interesting as well as relevant insights about the relationship between university characteristics and KT strategy, and it does so at the European level. In addition, it contributes to the theoretical and empirical literature on higher education institutions in several ways. Firstly, we take a step forward in the application of the notion of strategy to universities, in the specific case of the so-called Third Mission activities.. We thus contribute to the growing literature analysing the notion of university strategy (Bonaccorsi and Daraio, 2007; Daraio et al., 2011; Deiaco et al., 2012; Warning, 2004). Studies in this domain have shown the usefulness of adopting a strategic perspective to explain major differences in the extent to which universities exercise authority over resource acquisition and position themselves in their environment. However, existing studies have mainly focused on the characterization of universities along the two traditional missions of education and research, whereas our work contributes to the identification of universitiy strategies in the "Third Mission" area. In this respect, our findings highlight the heterogeneity of approaches and priorities in governing the interactions between universities and their economic and societal environment. This heterogeneity calls for caution in making strong generalizations about the university–industry interface, and should be carefully considered as well in policy recommendations, as we discuss in detail below. Starting from the idea that universities are heterogeneous, given their unique histories, different capabilities, resources and organizational structures (Bercovitz et al., 2001), we show that it is also possible to distinguish various strategic approaches to KT strategies. In particular, we theoretically classify and empirically test for the first time the existence of three different strategic approaches to KT activities. We also document important variations across European countries in the extent of adoption of KT strategies. This is an additional unique empirical contribution of the paper. In fact, while previous evidence has mainly focused on the US or on individual European countries, we leverage on multi-country evidence to show an extremely variegated European landscape in terms of KT priorities of universities.

Secondly, we make a further contribution by suggesting that these KT strategies are more or less likely to be preferred and undertaken depending on important determinants at the university level. In

particular, we first focus on university horizontal diversity, which is the broadness of the subjects covered by the university in their primary activities. On this matter, we contribute to a growing literature on the specialization of universities and its impact on scientific, economic and social outcomes (Bonaccorsi et al., 2013; Pastor and Serrano, 2016). In the context of university-industry collaborations and Third Mission activities, the scientific specialization of universities has been related to direct output measures, such as the creation of spinoff firms (O'Shea et al., 2015) or the generation of new patents (Acosta et al., 2018). It has also been related to knowledge spillover effects, based on the idea that universities with different scientific specializations nurture territories with diverse knowledge inputs (Bonaccorsi et al., 2013). We make an additional contribution to this literature by highlighting the influence exerted by university specialization on the definition of strategic priorities for KT, which can be seen as an important antecedent of such direct and indirect outcomes. In addition to that, we focus on university vertical diversity, which is its positioning in a hierarchy of prestige, in order to assess how it leads universities' decisions on the most suitable KT strategy to pursue. Our findings thus contribute to the stream of the literature analyzing the effects of university prestige on commercialization activities (Di Gregorio and Shane, 2003; Sine et al., 2003; Lee and Stuen, 2016). They show that high-prestige universities are more likely to pursue an income-generation strategy, being better positioned to establish collaboration activities and to accomplish commercialisation agreements.

Finally, we contribute to a growing stream of the literature emphasizing the role of context in stimulating the extent and variety of entrepreneurial activities by universities and other institutions, as well as its impact on outcomes (Autio et al., 2014; Fini et al., 2017; Rasmussen et al., 2014). While several studies in this domain have looked at the link between institutional determinants and single outcome dimensions, we investigate the role of KT strategy as an important component in the process. By doing so, we document a broad set of organizational and institutional influences on the KT strategic choices of universities.

The analysis and results of this paper pave the way for future research in this field. At the empirical level, the cross-section nature of available data cannot rule out reverse causality concerns on the relation between university characteristics and their strategies. Indeed, while we claim that university characteristics affect university KT strategies, the opposite might as well happen, thus suggesting that university characteristics change as a response to a given KT strategy pursued. Future research aiming at uncovering the causal determinants of university KT strategies should make use of administrative data on universities available through a long time span. Unfortunately, such data is rarely available, and if so, hardly at European level. Moreover, a deeper understanding on the interactions between KT strategic choices and organizational arrangements of TTOs is desired. TTOs can adopt various organizational configurations for structuring internal processes related to IP protection, research commercialization, university-firm collaboration and promotion of entrepreneurship. Critical to success is the implementation of organizational structures and processes that are suitable for the strategic orientation and the distinctive characteristics of the university.

Future studies should therefore analyze in more depth, ideally through selected case-studies, the evolutionary process through which such dimensions unfolds. Finally, we were not able to assess the ultimate economic and social impact of KT strategic choices. New studies should investigate the implications of pursuing a given strategy with respect to another in terms of short-term outcomes and long-term impact.

To conclude, since we document and validate the existence of different (although deeply intertwined) strategic options to guide KT activities within universities, our study presents significant managerial implications for university and TTO administrators on how to prioritize objectives and activities in the field of knowledge transfer. Different strategies in KT imply different goals to pursue, processes to implement, relationships to create, stakeholders to engage with, indicators to monitor and, more generally, choices to make. First, our results suggest that universities' strategic choices in knowledge transfer should reflect the more general goals and distinctive characteristics of the academic institution and of its external environment. Too often, in the past, the complex mechanisms through which universities interact with industry and society have been interpreted with a very narrow focus, mostly centred on IP commercialization activities via patenting and spin-offs. In addition to that, the experiences of largely successful, high-prestige academic institutions are often indicated as best practices to imitate, irrespective of the institutional and local context. Differently from that, our results confirm that there is certainly no one-size-fits-all model for defining the KT strategy of an academic institution, and that each university must adapt strategic choices to its own identity, culture and specific ecosystem.

Moreover, our findings suggest that university KT strategic priorities should be made explicit, communicated within the institution, and translated into objectives and indicators, so to enhance awareness and monitoring at all levels. The deliberate communication of KT strategic priorities should reach different groups of stakeholders, internally (including researchers and students) and externally. As for the former, the first obvious target group is represented by the TTO of the institution and by other intermediaries involved in the KT process (such as incubators or accelerators). These actors should receive from the university top management a clear strategic mandate to pursue in the KT domain, and ideally they should be directly involved in the process of generating such goals. For a university TTO, as for any organization, having unfocused goals can lead to conflicting operational objectives and ultimately to ineffectiveness.

Finally, our results have also profound implications for evaluation activities, of both university administrators and national or regional policy-makers. Often the assessment of KT activities of universities is conducted with reference to a narrow set of KT outputs (i.e. number of patents, licensing agreements, spin-offs). This is likely to underestimate the varied channels through which universities transfer knowledge to external stakeholders. In addition to that, it does not consider that there might exist profound differences across universities that are likely to lead to different profiles in terms of KT strategies, outcome levels and ultimate impact. Our results highlight the importance of monitoring the effectiveness of universities'

knowledge transfer activities by taking into account a broad range of indicators, so to allow for a greater variety of forms of KT engagement. They also show the importance of tracing such indicators and comparing them with appropriate external benchmarks, since the extent of KT activities is largely influenced by institutional variables and environmental factors.

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7. Tables

		Variable name	Description	Data source
DEPENDENT VARIABLES	1	Economic development strategy	Weighted average of standardised ratings of items (1) to (7), where weights are factor analysis scoring coefficients for Factor 1	survey of European University/TTOs
	2	Income-generation strategy	Weighted average of standardised ratings of items (1) to (7), where weights are factor analysis scoring coefficients for Factor 2	survey of European University/TTOs
	3	Service-to-faculty strategy	Weighted average of standardised ratings of items (1) to (7), where weights are factor analysis scoring coefficients for Factor 3	survey of European University/TTOs
INDEPENDENT VARIABLES	4	Generalist university	dummy = 1 for generalist (vs specialised) University	ETER dataset
	5	High prestige university	dummy = 1 for University ranked in the Times Higher Education Ranking	Times Higher Education Ranking 2014
CONTROL VARIABLES	6	TTO incentives	dummy = 1 for the presence of incentives for TTOs	survey of European University/TTOs
	7	TTO autonomy low	dummy = 1 for low level of TTO decisional autonomy	survey of European University/TTOs
	8	TTO autonomy medium	dummy = 1 for medium level of TTO decisional autonomy	survey of European University/TTOs
	9	TTO autonomy high	dummy = 1 for high level of TTO decisional autonomy	survey of European University/TTOs
	10	TTO size (log)	log of number of TTO employees	survey of European University/TTOs
	11	TTO age (log)	log of TTO age	survey of European University/TTOs
	12	Multi-university TTO	dummy = 1 for TTOs serving more than one PRO	survey of European University/TTOs
	13	Small university	dummy = 1 for small-size University (<500 researchers)	survey of European University/TTOs
	14	Medium university	dummy = 1 for medium-size University (500-2000 researchers)	survey of European University/TTOs
	15	Large university	dummy = 1 for large-size University (>2000 researchers)	survey of European University/TTOs
	16	University hospital	dummy = 1 for the presence of University hospital	ETER dataset
	17	University incubator	dummy = 1 for the presence of University incubator	survey of European University/TTOs
	18	Regional patents (log)	log of EPO patent application at NUTS 2 level	Eurostat Regional Statistics
	19	Regional size (log)	log of population at NUTS 2 level	Eurostat Regional Statistics

Table 1 List of variables. Description and data source.

Factor/KT strategy	Survey item	Loading
Income generation strategy (Axanova, 2012; Barjak et al., 2014; Feldman et al., 2002).	1) Revenue generation from licensing	0.8644
	2) Revenue generation from research	0.6716
Service-to-faculty strategy (Axanova, 2012; Rasor and Heller, 2006; Sharer and Faley, 2008)	3) Facilitate practical application of research discoveries	0.5006
	6) Provide service to faculty	0.8717
Economic development strategy (Axanova, 2012; Di Gregorio and Shane, 2003; Sharer and Faley, 2008; Munari et al., 2016, 2018)	4) Economic development through spin-off creation	0.7395
	5) Contribution to local and regional development	0.7883
	7) Generate opportunities for students	0.6807

Table 2 Final measures resulting from explorative factor analysis (see Appendix A for full details).

Variable names	Obs	Mean	Std. Dev.	Min	Max
Economic development strategy	178	0	1	-2.63	2.03
Income-generation strategy	178	0	1	-2.91	2
Service-to-faculty strategy	178	0	1	-3.35	1.94
Generalist university	178	0.87	0.33	0.00	1
High prestige university	178	0.38	0.49	0.00	1
TTO incentives	178	0.22	0.42	0.00	1
TTO autonomy low	178	0.21	0.41	0.00	1
TTO autonomy medium	178	0.45	0.50	0.00	1
TTO autonomy high	178	0.34	0.48	0.00	1
TTO size (log)	178	2.11	1.09	0.00	5.52
TTO age (log)	178	2.03	0.84	0.00	4.57
Multi-university TTO	178	0.11	0.31	0.00	1
Small university	178	0.29	0.45	0.00	1
Medium university	178	0.35	0.48	0.00	1
Large university	178	0.37	0.48	0.00	1
University hospital	178	0.42	0.50	0.00	1
University incubator	178	0.60	0.49	0.00	1
Regional patents (log)	178	3.74	1.61	-1.28	6.36
Regional size (log)	178	14.78	0.84	12.66	16.47

Table 3 Descriptive statistics.

	Variable name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Income generation strategy	1																		
2	Service-to-faculty strategy	0	1																	
3	Economic development strategy	0	0	1																
4	Generalist university	-0.14	-0.03	0.15*	1															
5	High prestige university	-0.02	0.06	-0.07	0.23*	1														
6	TTO incentives	0.29*	-0.01	0.13	0.05	-0.03	1													
7	TTO autonomy low	-0.07	-0.15	-0.05	0.03	-0.06	0.06	1												
8	TTO autonomy medium	-0.13	0.15*	0.05	-0.06	0.07	-0.05	-0.46*	1											
9	TTO autonomy high	0.18*	-0.03	-0.01	0.03	-0.02	0.01	-0.37*	-0.65*	1										
10	TTO size (log)	0.28*	0.07	-0.10	0.04	0.12	0.18*	-0.13	0.07	0.04	1									
11	TTO age (log)	-0.05	0.04	-0.20*	0.03	0.30*	-0.08	0.13	-0.06	-0.05	0.10	1								
12	Multi-university TTO	0.30*	-0.03	-0.03	0.08	-0.04	0.12	0.05	-0.13	0.10	0.39*	-0.17*	1							
13	Small university	0.06	-0.00	0.10	-0.16*	-0.16*	0.08	-0.05	0.10	-0.06	-0.17*	-0.27*	-0.18*	1						
14	Medium university	-0.12	0.07	0.00	0.03	-0.15*	-0.14	0.15*	-0.16*	0.04	-0.22*	0.07	-0.18*	-0.46*	1					
15	Large university	0.06	-0.08	-0.10	0.19*	0.30*	0.07	-0.10	0.07	0.02	0.38*	0.18*	0.34*	-0.48*	-0.55*	1				
16	University hospital	0.03	-0.05	-0.10	0.33*	0.35*	-0.02	-0.10	0.01	0.08	0.10	0.11	0.07	-0.24*	0.04	0.18*	1			
17	University incubator	0.17*	-0.05	0.13	-0.04	-0.04	0.06	-0.11	0.10	-0.01	0.22*	0.01	0.10	-0.03	-0.05	0.08	-0.08	1		
18	Regional patents (log)	-0.13	-0.01	-0.19*	-0.05	0.27*	-0.19*	0.13	0.01	-0.12	0.06	0.35*	0.14	-0.22*	-0.13	0.33*	0.08	-0.11	1	
19	Regional size (log)	0.1	-0.07	0.03	-0.16*	0.02	0.15*	-0.11	-0.03	0.13	0.11	-0.21*	0.02	0.23*	-0.16*	-0.06	0.04	0.20*	-0.28*	1

Table 4 Pairwise correlations among all variables (significance level 0.05 or less).

Variables	Survey response
Western Europe	0.541***
	(0.162)
Southern Europe	0.311**
	(0.154)
Eastern Europe	1.329***
	(0.224)
THE Ranking Y/N	0.381***
	(0.130)
Dummy missing THE Ranking	-0.803***
	(0.165)
Constant	-0.725***
	(0.145)
Observations	521

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 Probit regression of the probability of being a respondent of the survey.

VARIABLES	(1) Income-generation strategy	(2) Income-generation strategy	(3) Service-to-faculty strategy	(4) Service-to-faculty strategy	(5) Economic development strategy	(6) Economic development strategy
Generalist university	-0.542***	-0.764***	-0.325	-0.141	0.650***	0.683***
	(0.189)	(0.210)	(0.202)	(0.204)	(0.193)	(0.216)
High prestige univ.	0.188	0.336*	0.00730	0.138	-0.300*	-0.0617
	(0.201)	(0.186)	(0.185)	(0.200)	(0.163)	(0.180)
TTO incentives		0.543***		0.00716		0.214
		(0.133)		(0.173)		(0.184)
TTO auton. medium		0.00264		0.541**		0.221
		(0.197)		(0.209)		(0.219)
TTO auton. high		0.270		0.221		0.188
		(0.187)		(0.226)		(0.215)
TTO size (log)		0.152**		0.0207		-0.0723
		(0.0726)		(0.0864)		(0.0892)
TTO age (log)		0.0710		-0.0351		-0.0640
		(0.0898)		(0.103)		(0.101)
Multi-univ. TTO		0.811***		0.00481		0.149
		(0.185)		(0.255)		(0.217)
Medium university		-0.179		0.181		-0.0756
		(0.219)		(0.184)		(0.207)
Large university		-0.357		-0.250		-0.185
		(0.244)		(0.227)		(0.230)
University hospital		0.119		-0.181		-0.224
		(0.154)		(0.175)		(0.176)
University incubator		0.0696		-0.260		0.182
		(0.150)		(0.164)		(0.167)
Region patents (log)		-0.174***		-0.0547		-0.0650
		(0.0502)		(0.0593)		(0.0644)
Region size (log)		-0.163*		0.0447		-0.0928
		(0.0940)		(0.122)		(0.114)
Western Europe	0.926***	0.784***	-0.501**	-0.242	-0.150	0.0512
	(0.294)	(0.262)	(0.242)	(0.255)	(0.212)	(0.255)
Eastern Europe	0.308	0.255	-0.398	-0.534*	-0.354	-0.323
	(0.342)	(0.325)	(0.255)	(0.285)	(0.262)	(0.306)
Southern Europe	0.535*	0.358	-0.682***	-0.719***	0.276	0.260
	(0.289)	(0.276)	(0.215)	(0.237)	(0.205)	(0.254)
Constant	-0.103	2.546*	0.763***	0.0241	-0.474**	1.104
	(0.297)	(1.466)	(0.243)	(1.838)	(0.235)	(1.761)
Observations	178	178	178	178	178	178
R-squared	0.154	0.403	0.078	0.159	0.121	0.181
Log Likelihood	-245.2	-214.2	-241.5	-233.4	-236.5	-230.2
F	5.240	6.637	3.060	2.368	5.777	2.220
Adj. R-squared	0.130	0.340	0.0512	0.0696	0.0956	0.0937
Mean VIF	1.50	1.75	1.50	1.75	1.50	1.75

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 Main results. Weighted OLS regressions. Dependent variables: Income generation strategy, Service-to-faculty strategy, Economic development strategy.

VARIABLES	(1) Income-generation strategy	(2) Income-generation strategy	(3) Service-to-faculty strategy	(4) Service-to-faculty strategy	(5) Economic development strategy	(6) Economic development strategy
Generalist university	-0.258*	-0.395**	-0.420***	-0.309**	0.494***	0.526***
	(0.139)	(0.168)	(0.161)	(0.153)	(0.143)	(0.159)
High prestige univ.	0.0497	0.229	0.0951	0.183	-0.223*	-0.0360
	(0.156)	(0.144)	(0.127)	(0.134)	(0.120)	(0.131)
Control variables	No	Yes	No	Yes	No	Yes
Country group dum.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.232	1.643	0.742***	0.584	-0.385**	0.716
	(0.211)	(1.290)	(0.184)	(1.438)	(0.175)	(1.313)
Observations	178	178	178	178	178	178
R-squared	0.109	0.343	0.134	0.234	0.126	0.189
Log Likelihood	-209.5	-182.4	-192.3	-181.3	-182.9	-176.2
F	3.625	4.841	5.267	3.836	5.976	2.404
Adj. R-squared	0.0833	0.273	0.109	0.153	0.100	0.103

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7 Robustness checks. Weighted OLS regressions. Differently coded dependent variables.

VARIABLES	(1) Income strategy dummy	(2) Income strategy dummy	(3) Service strategy dummy	(4) Service strategy dummy	(5) Development strategy dummy	(6) Development strategy dummy
Generalist university	-0.429	-0.594*	-0.839**	-0.812**	1.256***	1.441***
	(0.331)	(0.361)	(0.329)	(0.344)	(0.337)	(0.355)
High prestige univ.	-0.00652	0.268	0.0886	0.271	-0.595**	-0.329
	(0.226)	(0.267)	(0.229)	(0.277)	(0.243)	(0.264)
Control variables	No	Yes	No	Yes	No	Yes
Country group dum.	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-0.0796	1.827	1.348***	3.971*	-0.745*	0.218
	(0.396)	(2.409)	(0.457)	(2.364)	(0.442)	(2.512)
Observations	178	178	178	178	178	178
Chi2	9.448	38.71	17.31	42.49	21.92	38.17
Log Likelihood	-301.1	-263.8	-284.6	-252.3	-280.4	-265.4
p-value	0.0925	0.00196	0.00395	0.000570	0.000543	0.00233
Pseudo R-sq	0.0522	0.170	0.104	0.206	0.116	0.163

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8 Robustness check. Weighted Probit regressions. Dummy dependent variables.

8. Figures

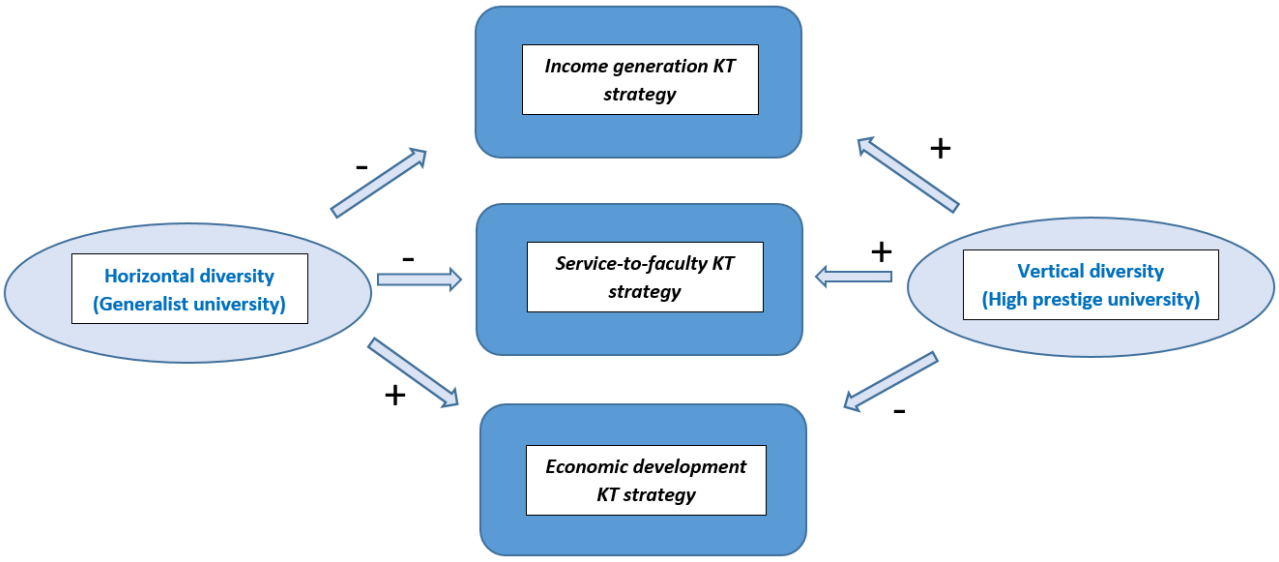

Figure 1 Diagram of conceptual model and hypothesised relationships.

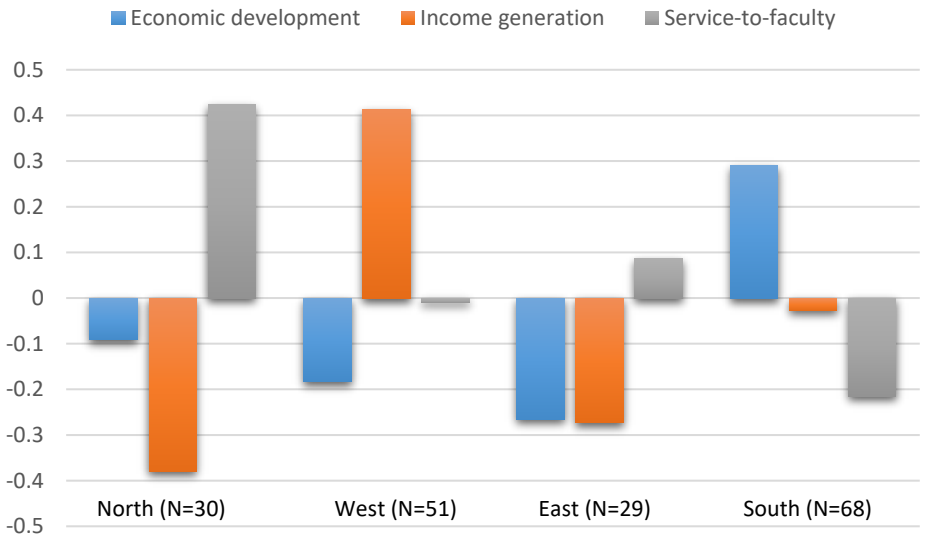

Figure 2 University KT strategies across European country groups

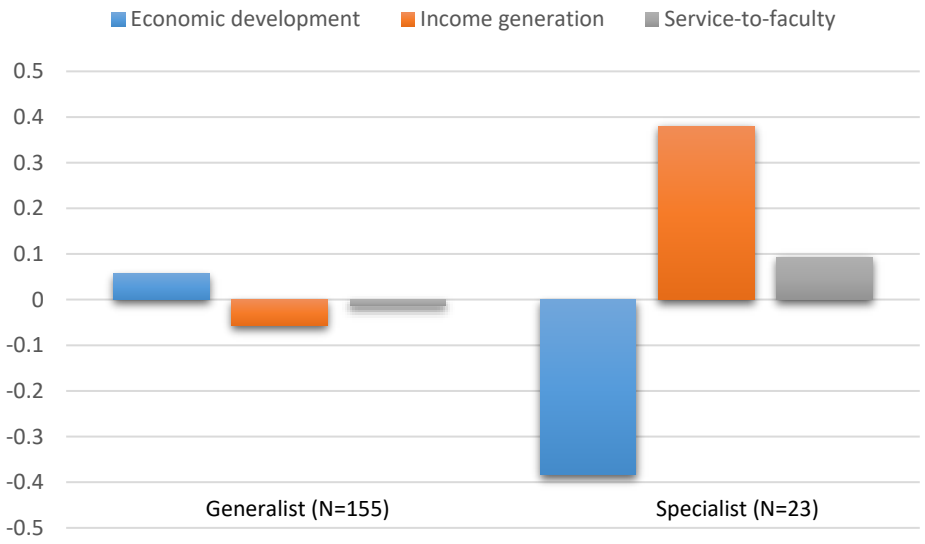

Figure 3 University KT strategies horizontal differentiation (generalist vs specialist universities)

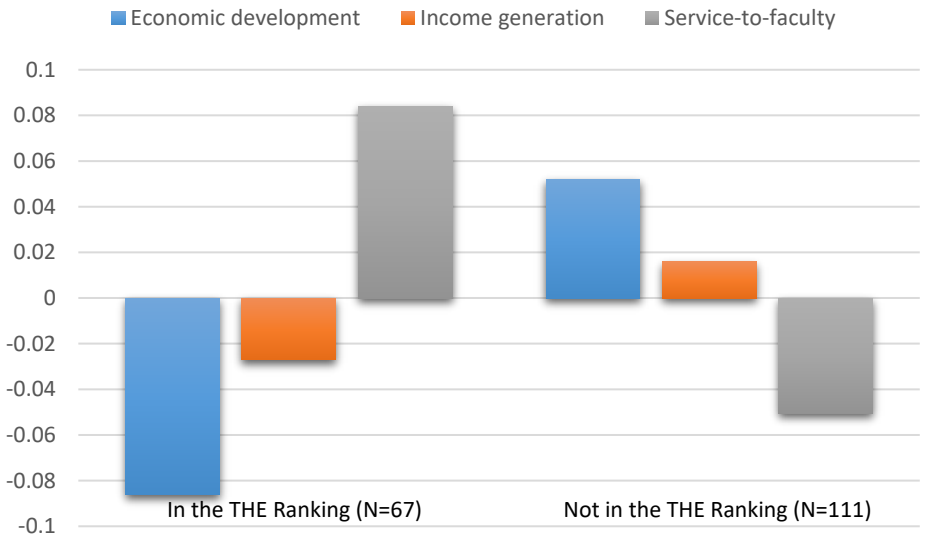

Figure 4 University KT strategies and vertical differentiation (High prestige universities)

Appendices

Appendix A – Response rate by country and by country group

	Respondents		Contacted		Response rate
COUNTRY	N	% out of 178	N	% out of 521	%
Turkey	24	13.48%	24	4.61%	100%
France	15	8.43%	15	2.88%	100%
Czech Republic	8	4.49%	8	1.54%	100%
Poland	8	4.49%	8	1.54%	100%
Hungary	5	2.81%	5	0.96%	100%
Estonia	2	1.12%	2	0.38%	100%
Norway	4	2.25%	5	0.96%	80%
Serbia	3	1.69%	4	0.77%	75%
Denmark	7	3.93%	10	1.92%	70%
Malta	1	0.56%	2	0.38%	50%
Lithuania	1	0.56%	2	0.38%	50%
Austria	9	5.06%	20	3.84%	45%
Germany	14	7.87%	34	6.53%	41%
The netherlands	7	3.93%	18	3.45%	39%
Luxembourg	1	0.56%	3	0.58%	33%
Italy	26	14.61%	85	16.31%	31%
Portugal	3	1.69%	11	2.11%	27%
Slovenia	1	0.56%	4	0.77%	25%
United kingdom	11	6.18%	48	9.21%	23%
Sweden	3	1.69%	18	3.45%	17%
Switzerland	3	1.69%	19	3.65%	16%
Finland	2	1.12%	13	2.50%	15%
Ireland	3	1.69%	22	4.22%	14%
Belgium	2	1.12%	15	2.88%	13%
Spain	14	7.87%	110	21.11%	13%
Croatia	1	0.56%	0	0.00%	0%
Greece	0	0.00%	9	1.73%	0%
Iceland	0	0.00%	1	0.19%	0%
Bulgaria	0	0.00%	2	0.38%	0%
Romania	0	0.00%	1	0.19%	0%
Russia	0	0.00%	1	0.19%	0%
Slowakia	0	0.00%	1	0.19%	0%
Ucraine	0	0.00%	1	0.19%	0%
Total	178	100.00%	521		34%

Table 9 Response rate by country.

	Respondents		Contacted		Response rate
COUNTRY GROUP	N	% out of 178	N	% out of 521	%
Eastern Europe	29	16.29%	39	7.49%	74.36%
Northern Europe	30	16.85%	117	22.46%	25.64%
Southern Europe	68	38.20%	241	46.26%	28.22%
Western Europe	51	28.65%	124	23.80%	41.13%
Total	178		521		34.17%

Table 10 Response rate by country group.

Appendix B - Factor analysis with principal component method

Item	1)	2)	3)	4)	5)	6)	7)
1) Revenue generation from licensing	1						
2) Revenue generation from research	0.3549*	1					
3) Facilitate practical application of research discoveries	0.1482*	0.0759	1				
4) Economic development through spin-off creation	0.2217*	0.0149	0.1147	1			
5) Contribution to local and regional development	-0.0244	0.1476*	0.0819	0.3891*	1		
6) Provide service to faculty	-0.0214	0.2069*	0.2058*	-0.07	0.0745	1	
7) Generate opportunities for students	-0.094	-0.0494	0.0574	0.2233*	0.3463*	0.1076	1

Table 11 Pairwise correlations of survey question items (significance level 0.05 or more).

Factor	Variance	Difference	Proportion	Cumulative
Factor1	1.65866	0.2238	0.237	0.237
Factor2	1.43487	0.1723	0.205	0.4419
Factor3	1.26256	.	0.1804	0.6223
LR test: independent vs. saturated: chi2(21) = 127.50 Prob>chi2= 0.00				

Table 12 Factor analysis. Method: principal-component factors. Rotation: orthogonal varimax. Number of retained factors: 3.

Item	Factor1	Factor2	Factor3	Uniqueness
1) Revenue generation from licensing		0.8644		0.2435
2) Revenue generation from research		0.6716		0.4202
3) Facilitate practical application of research discoveries			0.5006	0.6651
4) Economic development through spin-off creation	0.7395			0.3062
5) Contribution to local and regional development	0.7883			0.3643
6) Provide service to faculty			0.8717	0.2399
7) Generate opportunities for students	0.6807			0.4047

Table 13 Rotated factor loadings (pattern matrix) and unique variances.

	Factor1 Economic development strategy	Factor2 Income generation strategy	Factor3 Service-to-faculty strategy
Item 1	-0.00345	0.61654	-0.13847
Item 2	-0.04368	0.44747	0.23791
Item 3	0.05833	0.12752	0.37599
Item 4	0.45402	0.19835	-0.2637
Item 5	0.47322	-0.0269	0.04777
Item 6	-0.04925	-0.07691	0.70423
Item 7	0.41486	-0.25453	0.14777

Table 14 Factor scoring coefficients. Method: regression; based on varimax rotated factors.