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Crossing (or not?) the ‘valley of death’: university-industry collaborative e-platforms

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Abstract: In the today’s era of the two-sided markets, the online knowledge market places (as yet2.com) are developing rapidly. Given the importance of the academia-business interface, for the economic development these online tools now emerge to assist knowledge transfer also between academia and business. However, despite their potential, the online marketplaces or platforms for university-industry innovation remain unexplored from a research perspective – although at least three streams of literature try to tackle this phenomenon to a certain extent: economics, sociology and computer science. Using nine case studies of such platforms from across the globe, we explore in-depth their role in crossing the ‘valley of death’ between academia and business. Analysing the academia-business online knowledge transfer intermediaries through the lenses of economics, sociology and computer science, we outline the theoretical scope of this emerging phenomenon, its key characteristics and share managerial as well as policy implications on its contribution to ‘crossing the death valley’.

Keywords: academia-business collaboration, university-industry collaboration, knowledge transfer, innovation intermediary, online platform, valley of death

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1. Introduction and the research problem

The importance of universities as suppliers of knowledge and human capital in the knowledge-based economy is continuously growing as the product lifecycle keeps shortening, the demand for research-intensive innovation among business keeps increasing and entrepreneurial orientation among universities has already become a survival condition for most of the higher educational institutions (Yusuf 2008). Given the importance of the

academia-business interface for economic development, the innovation intermediaries of different nature continuously emerge to facilitate the knowledge diffusion, the actual innovation management process and the technology transfer between the two (Howells 2006). In the today's era of the two-sided markets (Evans & Gawer 2016; Gawer & Cusumano 2014), in addition to traditional innovation or knowledge transfer intermediaries (KTIs), as technology transfer offices (TTOs), the online knowledge market places (as yet2.com) develop rapidly. Those KTIs emerge to decrease the costs of the technology search, to assist in codifying the tacit, cross-disciplinary university' knowledge and to increase the degree of its applicability across industries (Dushnitsky & Klueter 2017). Despite the evident ideological relevance and the growing demand of such online marketplaces or platforms for university-industry innovation, such a type of intermediary (as e.g. iBridgenetwork or In-Part that serve particularly university-industry innovation) remain less spread in practice and less studied by the existing literature (Dushnitsky & Klueter 2017). Thus, the novel forms of KTIs emerging to assist in crossing the 'valley of death' (the gap between inventions and innovations (Auerswald & Branscomb 2003)) and meet the growing demand for fast and efficient knowledge transfer remain unexplored (Dushnitsky and Klueter, 2017; Søndergaard et al., 2015). Learning those by both academia and business communities would facilitate utilization of the bridges emerging across the 'death valley'. Therefore, in this paper we aim to explore the role of the online KTIs in crossing the 'death valley' between academia and business.

2. Knowledge transfer intermediaries in university-industry collaboration

The phenomenon of knowledge transfer intermediary (KTI)

Knowledge is a complex phenomenon and takes various forms – from 'explicit' (or codified) to 'tacit' (or implicit) (Polanyi 1966; Nonaka & Takeuchi 1995). Therefore, the knowledge transfer intermediary (KTI), facilitates the functions of the *knowledge market* – information, related goods and services exchange as well as regulates the knowledge transfer 'transactions' (Bakos 1998; Booker et al. 2008). Depending on the contextual settings of the knowledge transfer – where the exchange is happening, what types of knowledge are exchanged, between whom (e.g. whether it is company-university exchange or company-to company, small and medium-sized enterprise (SME) or large player being involved, whether it is one-to-one or one-to-many), etc. – the knowledge transfer intermediary may take different forms. Respectively, the different terms are being used to underline the intermediation function. That may be 'Technology Transfer Office (TTO)', 'innovation intermediary' or simply 'intermediary', 'collaborative platform', 'Research Centre', 'Knowledge brokers' and others (Barlatier et al. 2017; Bercovitz et al. 2001; Howells 2006; Schoen et al. 2014; Wright et al. 2008). To avoid a confusion with a various terms being used, in this study we use the term Knowledge Transfer Intermediary (KTI) – as an umbrella concept. Furthermore, given the growing demand for decreasing the costs of the technology search, codifying the tacit, cross-disciplinary university' knowledge, we particularly focus on the emerging forms of the *online* KTIs functioning in the context of university-industry collaboration as those online tools (often referred to as *platforms* or *marketplaces*) are proven to assist in meeting that demand (Dushnitsky & Klueter 2017).

The phenomenon of particularly, university-industry KTI has been quite accurately defined by Yusuf (2008) as an entity, which “... ‘midwifery’ assists knowledge exchange between universities and the business community through the creation of bridging ties and interfaces, by diagnosing needs and articulating the demand for certain kinds of innovation, by instituting a dynamic framework for change and working to achieve the change through financing and other means.” (Yusuf, 2008, p. 1170). The context of university-industry collaboration appears particularly specific for the knowledge transfer processes and respectively intermediation in these processes due to a number of specific barriers and drivers in these relationships (Galán-Muros & Plewa 2016). Among the barriers are the connection problem (university and business often have a greater cognitive distance between each other when compared with business-to-business relationships (Muscio & Pozzali 2013)); funding issues; differences in organizational culture and internal characteristics (Galán-Muros & Plewa 2016). Availability and complementarity of resources as well as prior history of relationships may serve as drivers in university-industry collaboration and knowledge transfer (D’Este & Perkmann 2011; Galán-Muros & Plewa 2016). Furthermore, the specifics of university-industry collaboration may be described also by particular collaborative links, which are called to assist in crossing the ‘valley of death’ (Auerswald & Branscomb 2003). The high-level categories of those links include: education (curriculum design and delivery; lifelong learning; student mobility) research (professional mobility; R&D) and valorisation (entrepreneurship, commercialization) (Galán-Muros & Plewa 2016).

The key literature insights on the online KTIs and the research gap

A number of studies has tackled the phenomenon of university-industry online KTIs from various theoretical perspectives, and the key streams of those perspectives as highlighted by Holzmann (2014) include economics, sociology and computer science. We follow with an overview of each of those literature streams studying KTIs that bridge academia and industry.

The first, economics stream of the related literature deals with the economic theory of intermediation, from where the two-sided knowledge markets emerge (Arnold et al. 1989). The phenomenon of economic intermediation is studied quite thoroughly so far mainly in the context of financial services – in regards to transaction costs theory and information asymmetry (Allen & Santomero 1998). Furthermore, from the economics perspective, a conjunction of the resourced-based view (Wernerfelt 1984; Barney 1991) and a growing capability of the online knowledge transfer KTIs (or marketplaces) to supply firms with a complementary assets faster and thus support achievement of a competitive advantage becomes particularly relevant for the knowledge-based economy (Dushnitsky & Klueter 2017). The open innovation paradigm (Chesbrough 2003) only supports this view highlighting such practices as technology scouting and crowdsourcing, where digital tools are essential for efficient information processing (Chesbrough & Brunswicker 2013). However, the critical relevance of those practices and respectively the value of the online tools for SMEs remain quite unstudied compared to the large companies despite the proven ‘liability of smallness’ (Brunswicker, S. van de Vrande 2014; Vanhaverbeke 2017). Moreover, Presenza and Meleddu (2017) in their recent study on low-tech SMEs found even a negative impact of online communities on the introduction of innovations, although the authors highlight a moderation effect of firms’ absorptive capacity (Cohen & Levinthal

1990). Finally, even in quite largely explored context of financial intermediation, the classical theories appear insufficiently developed to explain a paradox of transaction costs and information asymmetries decreasing with times (which in the knowledge transfer context assist in crossing the ‘valley of death’) and a number of intermediaries continuously growing (Allen & Santomero 1998).

On the borderline of economics stream and sociology, the institutional theory has been used quite widely studying the various structures of the university-industry KTIs (Howells 2006; Bercovitz & Feldman 2007; Schoen et al. 2014). The institutional theory inherently leads us towards exploring the organizational structure of the KTIs, their ownership – whether we talk about a university’ owned unit responsible for the knowledge or technology transfer, whether it is an independent private or public body (Schoen et al. 2014). Furthermore, the linked streams of literature invite us to analyze more in-depth the functions that the KTIs fulfill. Howells (2006) suggested ten key functions of generally ‘innovation’ intermediaries, including: *foresight and diagnostics; scanning and information processing; knowledge processing and combination/recombination; gatekeeping and brokering; testing and validation; accreditation; regulation and arbitration; protecting the results; commercialisation: evaluation of outcomes*. Later works, which focus more on university-industry collaboration context highlight such functions of the TTOs or Knowledge Transfer Offices (KTOs) as *research funding services, set up and managing research projects, knowledge sharing and support services to enterprises, IP management, boundary spanning through HR, entrepreneurship and spin-out services* (Alexander & Martin 2013; Schoen et al. 2014). Furthermore, the sociological stream in respect to the novel online forms of the knowledge transfer intermediation brings in the issue of high versus low ‘media richness’ (Alexander & Martin 2013; Murray & Peyrefitte 2007) – the importance of face-to-face interaction when it comes to the transfer of the tacit knowledge versus codifying the explicit knowledge and carrying out a transaction (Dushnitsky & Klueter 2017).

The computer science literature on its end pays a greater attention to the characteristics of the software enabling economic exchange in various contexts (Li & Horrocks 2013), the matchmaking, networks effects of collaboration (Hayat & Lyons 2017) and network externality (Katz & Shapiro 1986). Furthermore, these literature develop platforms architecture (Cantú & Ceballos 2010; Dobrodziej 2011; Walasik 2012) as well as studies the mechanics of value capture of the KTIs (Yablonsky 2016). In era of the rapidly growing multi-sided markets and online platforms, the technology that support the knowledge exchange and trading appear available (Evans & Gawer 2016), while the applicability of those to the knowledge markets and particular settings (as university-industry collaboration) has proven to be context specific (Dushnitsky & Klueter 2017).

Despite the broadness of the scope, which frames the phenomenon of university-industry KTIs, there is no yet a published study, which would be dedicated to specifically the digital KTIs in this context and would be able to bridge the three streams of the literature outlined above (Søndergaard et al. 2015). Thus, this submission aims to become one of the pioneering research in the field.

Given the discussion above and following our previous study (Albats et al. 2016), in this submission, we are tackling the following research question:

RQ1: *What is the current and foreseen role of the emerging digital university-industry KTIs in crossing the ‘valley of death’?*

3. Research design

This study is qualitative and explorative by nature, since it aims at answering the qualitative research questions and understanding the nature of the phenomenon. The several qualitative research methods have been used for this research.

We used multiple case study (studying 9 digital KTIs from across the globe), participant observation run for 3 of the studied cases and experimental research carried out for one of the selected cases. The table 1 below outlines the KTIs selected for the study. In our sampling we were following the heterogeneity approach: we target diverse UIC online KTIs – diverse in terms of their country of origin, their functions (following the typology developed in our previous research (Albats et al. 2016)), their ownership, their target groups. The data for the case studies were collected through a series of interviews with the owners of KTIs, a few platform users and supplementary analysis of secondary data (press releases, web-sites, platform users' feedback) and field notes during the participant observations (the meetings between the platform owners and users). The materials and observations gathered during the experimental participation of one of the authors in the trial of one of the studied platforms also enriched the data set. The interview data have been transcribed and analysed through categorization and manual text-mining. The received results were checked against the notes from participant observations and the experiment.

Table 1 The list of studied KTIs

| <i>KTI#</i> | <i>KTI (Main) Office Location</i> | <i>KTI Age: Young (2 years old or less); Established (2-5 years old); Mature (5 years or older)</i> | <i>Organizational form:</i> |
|-------------|---------------------------------------|---|-----------------------------|
| KTI1 | UK | Established | private |
| KTI2 | UK | Young | public |
| KTI3 | USA | Established | private |
| KTI4* | UK | Established | private |
| KTI5 | UK | Mature | private |
| KTI6 | Belgium | Established | private |
| KTI7** | Spain | Young | private |
| KTI8 | Ireland | Established | public |
| KTI9* | USA | Established | private |

*In addition to case study method, these KTIs were also explored through participant observation

**This KTI is a part of the ongoing experimental research, where the contribution of the KTI involvement into the overall knowledge transfer process is tracked

1. Findings

The Table 2 summarises our findings on the role of the online KTIs in crossing the 'valley of death' between universities and industry – according to the key types of links served by these intermediaries (education, research and valorisation (Galán-Muros & Plewa 2016)). We follow with outlining our findings against the three core literature streams: economics, sociology and computer science (Holzmann et al. 2014).

First, from the economics perspective, despite the limited presence in the academic research the emerging phenomena of online university-industry KTIs is continuously growing according to continuously increasing demand on both sides (that was reported in all the nine case studies). Companies are looking for the ways to optimize the costs of their knowledge and technology search and transfer together with a constantly remaining need in a continuous inflow of a skilful workforce. Universities on their end (partly due to shifts in the policy measures as particularly, highlighted in the cases of KTI1 and KTI5) are becoming more and more active in searching for ways to commercialize the scientific developments. Furthermore, given the emerging forms of online education and increasingly demanding education market, the universities are also actively looking for ways to redesign the curricular to meet the current industry needs through such means as project-based learning, students participating in solving current industrial challenges (as in the cases of KTI3, KTI6 and KTI7).

Second, as a contribution to the economic and social science literature streams, we found that the emerging digital KTIs differ a lot in terms of the functions they fulfil although we focused our study specifically on those serving the university-industry interface (see Table 2). We were able to identify the two high-level groups of KTIs by their functions. The first one include those that serve as the competence, knowledge or technology matching tools and support promotion and practical application of the university research results (contribute to Research and Valorisation type of link between universities and companies – KTIs 1, 2, 4, 5, 8, 9). The second group include KTIs, which are dedicated rather to industry-oriented teaching and training (KTIs 1, 6, 7). However, in the case of KTI6, which by nature is oriented rather towards serving the education type of link, valorization is also met through direct support of student entrepreneurship and IPR transfer). Furthermore, we found that KTIs differ in terms of the structure and ownership: from private small-size companies to branches of large business, the government-driven or just state-supported entities. Consequently, the KTIs apply various value capture mechanisms (fees charged from both parties, from companies only or upon the knowledge/technology/IPR transfer deal closed). Most importantly, the various online KTIs imply a transfer of different type of knowledge: from explicit (as IPR and possibilities of licencing – cases of KTI8 and 9) towards much more tacit pieces - when the KTI requires a close continuous (although still mainly virtual) interaction between the both parties (KTI1-KTI7).

Finally, from the computer science perspective, the KTIs fulfil a number of functional and non-functional requirements using various technics and methods. For data integration, analysis, recombination and advanced search mechanics, the platforms commonly use semantic and network analysis. The majority of the analysed KTIs (KTIs 1, 2, 4, 5, 9) integrate the data from various data sources including the data available from the web, restricted data provided by contributing agents and individuals, data from the public and restricted databases (e.g. IPR related information). In several cases, the KTIs use embedded virtual collaboration tools and packages for remote collaboration (KTI3, 6, 7) and instant messaging (KTI9) – although the users mainly rely on traditional or alternative communication modes as e.g. emails and calling. Depending on the core platform functions, the KTIs also differ in terms of the target user groups (on both sides) and degree of their involvement. Overall, the platforms are built to bridge universities (academia) and industry (business). However, in each particular case, depending on what particular ‘link’ (education, research and/or valorisation) the KTI aims to serve, the end-users and respectively, their requirements, needs and expectations vary significantly. It may be university researchers and company R&D managers/CEOs (as it is in cases of KTI1, 2, 4); university technology transfer/commercialization agents and company technology scouts/innovation heads/CTOs (KTI1, KTI5, KTI9) or university lecturers and companies’

strategists or university program managers (more rarely R&D managers) (KTI3, KTI6, KTI7). Respectively, the user interface, platform functionality and language (or specific jargon) used in communicating the knowledge and information as well as the actual communication modes used also differ a lot.

Table 2 Summary of the studied KTIs according to their contribution to collaborative links (as per Galan-Muros & Plewa, 2016)

| <i>KTI#</i> | <i>Education</i> | <i>Research</i> | <i>Valorisation</i> |
|-------------|---|--|--|
| KTI1 | - | Matchmaking, Gatekeeping and brokering: Network building | Indirect contribution to Commercialization of University R&D |
| KTI2 | - | Matchmaking, Gatekeeping and brokering: Network building + mapping | Indirect contribution to Commercialization of University R&D |
| KTI3 | Training the university students, developing the curriculum according to the industry needs | - | - |
| KTI4 | - | Matchmaking, Gatekeeping and brokering: Network building + mapping | - |
| KTI5 | - | Matchmaking, Gatekeeping and brokering: Network building | Direct contribution to commercialization of University and SMEs' R&D through marketing innovations |
| KTI6 | Training the university students, developing the curriculum according to the industry needs | - | Direct contribution to students entrepreneurship |
| KTI7 | Training the university students, developing the curriculum according to the industry needs | - | - |
| KTI8 | - | Matchmaking, Gatekeeping and brokering: Network building + mapping | Direct contribution to commercialization of University R&D through mainly IPR transfer |
| KTI9 | - | Matchmaking, Gatekeeping and brokering: Network building | Indirect contribution to commercialization of University and SMEs' R&D through network building |

Referring back to the economics perspective, we also took a close look to the demographics of the agents served by the studied KTIs. Among the university-type of clients, we found a great degree of diversity in terms of the universities size and its position in the global ranking (all the cases). However, in some of the KTIs there is a rather strong national focus in terms of the agents location – both universities and companies location (KTI1, KTI2, KTI4, KTI8). In terms of the company-type of clients, some KTIs appear to have a certain industry focus (as e.g. KTI4), while others (as e.g. KTI5) target primarily the global top players having over 60% of the Fortune1000 and about 90% of the FTSE100 as the platform users (KTI5). Notably, relatively few of the studied platforms specifically target SMEs – with the KTI2 originally designed for SMEs (but still having rather larger players in the network), KTI8 as a public-based KTI also emphasising the SMEs as one of their key target groups and KTI9, which specifically aims to support growth of the university-based start-ups.

2. Discussion, conclusions and practical implications

This submission studying the novel phenomena of university-industry online KTIs bridges the three fields of literature – economics, sociology and computer science. A need for such a cross-disciplinary approach to focus on this generally complex phenomenon of innovation intermediation was originally conceived by Holzman back in 2008. However, so far only few research works attempted to study it and even less of those focus particularly on academia-business interface, which in turn has been admitted important for economic development (Dushnitsky and Klueter, 2017; Søndergaard et al., 2015).

Our study therefore first, supports the learning about the online KTIs by practitioners, finding solutions for their own needs in knowledge transfer and optimizing the resource efficiency in managing knowledge transfer. Thus, the study itself supports crossing the ‘valley of death’ on practitioners’ side.

Second, many of the governmental agents globally have acknowledged the need in such tools, but none has built yet a fully-scale instrument able to fulfil all the needs of the users on both ends of the ‘valley’ and our study provides a holistic overview of the needs, possibilities and development directions. Despite the various functions being fulfilled by various platforms, we found that there is not yet a single solution, which would be superior in meeting all the needs in one place. The role of the university-industry online KTIs in crossing the ‘valley of death’ is however improved by the online offerings, providing key activities in the valorisation cycle according to the perceived demand of each originator. As the majority of these platforms are also privately owned and thus created by entrepreneurs who have identified a need, there is an argument for a “follower” group of platforms, perhaps created and owned by the Universities that fulfil a more comprehensive role. This is purely speculation as the data set provided thus far only begins to indicate at the potential space to grow service offerings to improve the effectiveness of the valley crossing. However, what we do observe in the data is a limited presence of SMEs as the users of such platforms. The policy makers emphasise the importance of small businesses in the economic growth and innovation development already for decades (Hoffman et al. 1998) and online KTIs are supposed to compensate for SMEs’ lack of resources (Vanhaverbeke 2017). Our study brings in an observation similar to the one captured by

Presenza & Meleddu (2017) – there are certain barriers that may keep SMEs away from the online KTIs. Future research should explore whether the limited absorptive capacity (Presenza & Meleddu 2017) is the only constrain here or there are others and how those may be solved.

Additionally, more in-depth analysis into the current platforms is certainly essential, along with a details and comprehensive evaluation of the focal points, effectiveness, efficiency and general usability of these platforms. This will enable a more objective opinion to be formed as to their likely progression to becoming a dominant force in the quest to cross the valley of death.

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