Open Innovation Capacity of the Polish Universities

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Abstract Following the patterns of open innovation should be one of the key elements of knowledge management systems in universities. Universities sharing or selling their intellectual property become natural partners, allies or suppliers in securing innovation in companies. The paper adds to the state of the art research by presenting data on Polish technical universities and by offering discussion over their open innovation capacity. The study covers two key aspects: (1) universities delivering solutions as partners/suppliers in outside-in innovation processes of companies and (2) universities as facilitators of open innovation ecosystems or key players in the ecosystems. The author seeks to answer the research question whether actions undertaken by universities to boost their presence in open innovation ecosystems affect the dynamics of the commercial use of their intellectual property. A method of structured self-assessment concerning open innovation capacity is proposed and applied. Results are cross-checked by accessing financial data concerning research and development contracts. In terms of the sale of intellectual property, Polish technical universities break down into three groups: three leaders, three followers and the low-end. The self-assessment inevitably raises a question whether open innovation is a real business model for universities or is it just a way to seek out opportunities? Open innovation capacity of the Polish technical universities is only potentially high. Even though they set up relevant supporting instruments, they hardly use them for real open innovation transactions.

Keywords Open innovation · Universities · Intellectual property · Innovation · Poland · Europe

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Introduction

The paper is focused on a particular challenge of university–business relations, i.e. universities’ capacities concerning open innovation. Even though the original concept of open innovation involves mostly business to business interactions (Chesbrough 2003), numerous followers (even Chesbrough and co-authors) expand it to a plethora of links with science, communities and also within triple- and quadruple helices. If so, following the patterns of open innovation should basically be one of the key elements of knowledge management systems in universities. It is due to the fact that universities sharing or selling their intellectual property become natural partners, allies or suppliers in securing in-bound innovation in companies.

This notion of understanding knowledge management in universities is well developed and implemented in the most innovative economies of the European Union. The old member states such as Germany, Belgium, the Netherlands, Luxembourg, the UK, Sweden, Finland, Denmark, France or Italy have benefited from this for a long time (e.g. Kauffeld–Monz and Fritsch 2013 or van Geenhuizen 2013). Others struggle to follow. But in most of the new accession countries (especially former socialist countries), the issue is still problematic (e.g. Draghici et al. 2016, Erdős and Varga 2013 or Žižalová and Čadil 2013). Transition from a centrally planned to market-oriented economy is really tough in the case of research and development. It takes much more time and effort than the transition of an industry or a social sphere. Universities were traditionally perceived as places of teaching and learning rooted in quality research. Obviously this is still a primary role of every university. But in the last decades, much pressure was put on academia to become more entrepreneurial, in simple words, to make earnings out of commercialised knowledge. Open innovation is actually a way of thinking that is or could be natural here. Anyway, this phenomenon—directly linked to the concept of open innovation (being a core of this paper)—has not been really widely covered in research literature. Search in the Web of Science Core Collection, using the template: “open innovation” *univ** [*name of the country/first letters*/adjective*]; *all years* returned following numbers of scientific works per country in April 2017: Austria 1, Belgium 0, Bulgaria 1 (conference proceeding), Croatia 1, Cyprus 0, Czech Republic 1 (conference proceeding), Denmark 1 (conference proceeding), Estonia 0, Finland 7 (6 conference proceedings), France 4 (1 conference proceeding), Germany 4 (1 conference proceeding), Greece 2 (1 conference proceeding), Hungary 1, Ireland 4 (1 conference proceeding), Italy 7 (3 conference proceedings), Latvia 1 (conference proceeding), Lithuania 0, Luxembourg 0, Malta 0, Netherlands 6, Poland 1, Portugal 6 (2 conference proceeding), Romania 4 (conference proceedings), Slovakia 0, Slovenia 0, Spain 15 (3 conference proceeding), Sweden 4 (conference proceedings), UK 4, European Union 3 (conference proceedings). As it is argued in the “[Positioning Universities in the Notion of OI](#)” section, with regard to knowledge management and commercialisation universities first of all follow the outside-in pathway. They should put every possible effort to become partners of primal choice for industry players who open their innovation funnel. It is so because apart from founding spin-off companies (which is anyway usually done in an open innovation domain), universities have no other options to convey their knowledge to industrial applications. Making use of the opportunity of a business partner opening the innovation funnel can be modelled as two types of targeted open innovation processes. One is a focused technology knowledge

transfer process. The other is a targeted open innovation participatory research process (Laine et al. 2015). Thus, in the business world, the universities need to position themselves as reliable players who may increase the chance of R&D project success in the following aspects listed by Vanhaverbeke et al. (2014): higher speed of knowledge transfer using scientific knowledge, higher volume of knowledge transfer through more frequent science-related additions and greater business value of knowledge transfer through higher speed and introduction of cutting-edge science. For this reason, scrutinising the way universities in the new member states perform is interesting both in terms of understanding knowledge management processes as well as in terms of provoking future-oriented thinking in less-developed economies within the European Union.

The paper adds to the state of knowledge by presenting data on Polish technical universities and by offering discussion over their open innovation capacity. The study covers two key aspects: (1) universities delivering solutions as partners/suppliers in outside-in innovation processes of companies and (2) universities as facilitators of open innovation ecosystems or key players in the ecosystems. The aim of the paper is to answer the research question whether there is a link between those two, i.e. whether actions undertaken by Polish technical universities to boost their presence in open innovation ecosystems have an impact on the dynamics of the commercial use of their intellectual property.

The paper proposes and applies a method of structured self-assessment concerning open innovation capacity. It is primarily based on interviewing the university authorities. Results are cross-checked by accessing financial statement data concerning R&D contracts (under the Polish law on public information). This allows a qualitative and quantitative approach to the research question.

Positioning Universities in the Notion of OI

In Europe, neither for so-called Western countries nor for the former socialist countries is placing universities in the value chain of innovation an unknown issue. And it is not only about empowering universities to deliver solutions within the old-fashioned linear model of innovation or within the innovation cycle (Padmore et al. 1998). First of all, it implies transition to a non-Humboldtian university, often called an entrepreneurial university or understood as academia entering the triple- or quadruple- or even quintuple-helix models. This approach received wide coverage in scientific discussions, with Etzkowitz (2003a, 2003b, 2004, 2008), Carayannis and Campbell (2009, 2010) and Audretsch (Audretsch 2014; Audretsch and Phillips 2007) being the leading discussants, as well as in policy—e.g. through the recommendations by OECD (2009, 2013) or within the EU policy initiatives (Carayannis and Rakhmatullin 2014). The initial triple helix model of university–industry–government relationships was conceptualised in greater depth by Farinha and Ferreira (2012, 2013) and Farinha et al. (2014) into the triple helix triangulation (THT) model, structured around the interactive relationships between the institutional spheres of the original approach. The quadruple helix embeds the triple helix by adding the “media-based and culture-based public” and “civil society” as a fourth helix. The quintuple helix innovation model is broader and more comprehensive by contextualising the quadruple helix and by adding

the helix of the “natural environments of society” (Carayannis et al. 2012). The other approach was presented by Leydesdorff (2012) analysing a number of integrating and differentiating forces in innovation patterns to conclude that the triple helix indicator can be extended algorithmically to an N-tuple of helices.

As already mentioned, the discussed notion is also frequently referred to as an entrepreneurial university. The entrepreneurial university must undertake two tasks: it must train future entrepreneurs, persons who will start their own businesses, and foster entrepreneurial spirit in students in all subject areas—for example by fulfilling the management education needs of companies (Dabic et al. 2016a). Second, it must operate in an entrepreneurial manner itself, organising business incubators, technology parks, and the like, involving students in these organisations and, through them, assisting students and graduates in the founding of businesses (Schulte 2004). Operating in an entrepreneurial manner establishes a close link to operating within the knowledge landscape. And targeting the utilitarian aspect of knowledge makes this notion perfect for policy making, which was seen in many countries around the world in Australia, Canada, the UK, the USA (Slaughter and Leslie 1997), Sweden (Jacob et al. 2003), Brazil, Italy, Portugal, Denmark (Etzkowitz 2004), Singapore (Wong et al. 2007), Spain and Croatia (Dabic et al. 2016b).

Delivering university spillovers to the society in general is understood as the third pillar, apart from education and research, constituting the modern academia. This notion was characteristic of conceptualisations and research in the 1990s and 2000s. The society can be perceived with no regard to territory, as part of the wide approach to the knowledge-based economy (OECD 1996), or as territorially anchored, e.g. via the triple helix approach (Leydesdorff 2006). Conceição and Heitor (1998) claim that while the role of the university is of renewed importance, its institutional integrity must be preserved through the strengthening of its ability to create and disseminate knowledge. And this actually builds upon the two basic pillars of universities’ mission—universities are producers of new codified knowledge through research and providers of human capital through high-level education (Conceição, Heitor and Oliveira 1998). This understanding constitutes a link between academia, knowledge-based economy and competitiveness policy (Sum and Jessop 2013). Consequently, the society can be territorialised to a national dimension (Dahlman and Andersson 2000; Salem 2014) or to a regional dimension (Lawton-Smith 2006; Coenen 2007; Uyarra 2008; Fritsch 2009; Clar and Sautter 2014). Universities potentially contribute to regional economic development in a number of ways. Goldstein and Renault (2004) list: research, creation of human capital through teaching, technology development and transfer, and co-production of a favourable milieu, and prove that the research and technology creation functions generate significant knowledge spillovers resulting in enhanced regional economic development that otherwise would not occur. Thus, universities can be perceived as knowledge nodes in innovation systems (Schmidt 2013). Lawton-Smith and Bagchi-Sen (2013) offer four propositions, derived from literature, in order to provide a better understanding of the ways in which research universities intentionally contribute to regional development. The extent of regional impact depends on the internal characteristics of the university, how the university responds to exogenous shocks, the nature of funding for higher education institutions that accompanies agenda-setting by national and regional political bodies in relation to wealth creation, and the attributes of the regional economy. The bridging role of doctoral education in a

knowledge-based economy landscape can also be depicted (Davis et al. 2006). Nevertheless, even though the paper is focused on the R&D aspect of university activities, it must be noted that—especially in the countries which struggle for better socio-economic performance—universities are primarily seen as sources of education, including life-long-learning. Afterwards, the R&D contribution is awaited. It was confirmed empirically for Brazil, China, India (Veloso et al. 2003), Romania (Suciu et al. 2011) and Pakistan (Bano and Taylor 2015).

Do these approaches, however, hold true for open innovation? As mentioned above, the original works concerning open innovation referred to business to business relations and transactions that we could label as corporate. Anyway, over time, not only the numerous followers, but Chesbrough himself started to “re-open” open innovation by adding, e.g. the open business model thinking (Chesbrough 2006) or the ecosystem approach (Vanhaverbeke and Chesbrough 2014). As Vanhaverbeke argued (2013) open innovation has to be disconnected from the innovation funnel. And further: once open innovation is freed from this straightjacket, we might give it the “second wind” for additional growth. If so, Von Hippel’s (1986, 1988) sources of knowledge and innovation can be applied to open innovation notions, allowing universities to hold their remarkable position in the open innovation-based ecosystems. More directly—in the context of open innovation—this link was pinpointed by Fabrizio (2006), Perkmann and Walsh (2007) and Gassmann et al. (2010). The latter present trends concerning the future of open innovation, including the following: “Universities: from ivory towers to knowledge brokers. Currently, universities are still largely financed by public money, but in many regions of the world, this financing will decrease despite soothing public statements. Large companies [...] have already reduced their corporate research activities or have increased third party financing. This will force all players in the innovation game to cooperate even further.” Yet, cooperation is conditioned by several factors. According to Plewa et al. (2005), three central, intertwined categories of variables can be listed: interaction mechanisms, linkage mechanisms and organisational environment differences. A few years later, her research showed that communication, understanding, trust and people are universal drivers (Plewa et al. 2013). Suseno and Ratten (2007) propose the model in which a link of trust—social capital (internal and external)—in knowledge development is stressed. Absorptive capacity (Cohen and Levinthal 1990; Van Den Bosch et al. 2003) is also critical. Belso-Martínez et al. (2016) explore the degree to which absorptive capacity and previous innovative performance affect network dynamics, specifically in the creation or destruction of inter-business relationships, claiming that absorptive capacity and previous innovative performance are predictors of inter-business relationships. Absorptive capacity affects the emergence of linkages in the technological network, due to the tacit nature of technological knowledge. On the other hand, previous innovative performance is an indicator to identify leader companies. According to Nelson and Winter (1982), relationships among businesses emerge, change or disappear due to the profile of the knowledge base, absorptive capacity or prestige of the actors involved. Finally, both geographic and organisational proximity are significantly associated with partner choice, indicating that the formation of university–industry links is the result not only of spatial factors but also of prior experience of collaboration (Johnston and Huggins 2016). As noted by Jonsson et al. (2015a, b), open innovation and the triple- and the quadruple helix model’s interactions do not occur automatically but require considerable efforts by the

university management, including particular interaction-stimulating tools allowing a more targeted open innovation approach. The efforts, to be worth undertaking, need to be structured and replicable. They can typically start with need recognition and wrap up with evaluation or be more foresight-based where the initial phase is focused on researching new technologies and futures or identifying current and future challenges of anchor firms and industries (Laine et al. 2015). Roshani et al. (2015) propose similar procedures, but they identify cultural adaptation as the first step in the process.

Gassmann and Enkel (2004) identified three core open innovation processes: the outside-in process understood as enriching a company's own knowledge base, e.g. by external knowledge sourcing, the inside-out process based upon external exploitation of ideas in different markets, selling intellectual property and multiplying technology by channelling ideas to the external environment, and, finally, the coupled process, linking outside-in and inside-out by working in alliances with complementary companies. Universities and other public research organisations are seen as entities facilitating knowledge flows and delivering solutions (Brunswicker and Vanhaverbeke 2014) and as such their activity should be mainly analysed with reference to outside-in open innovation. They are perceived to be secure collaboration partners by business as with all other partners, in all phases of the innovation process the risk of imitation increases (Veer et al. 2016). But universities need to set up the collaboration arena by themselves due to fact that the use of formal liaison devices by firms positively moderates the relationship between knowledge acquisition from suppliers and competitors but it negatively moderates the effect of knowledge acquisition from universities (Cruz-González et al. 2015). The overall performance of open innovation-based ecosystems with universities involved is highly conditioned by absorptive capacity of companies (Fabrizio 2009). And more innovative firms tend to be more interested in collaborating with universities (Fernandez-Lopez et al. 2015). Acosta et al. (2013) find that fostering university R&D capacity enlarges the attractiveness of the local university knowledge base for firms in the region. However, this makes companies more inward (regionally) oriented and consequently their absorptive capacity should be increased to enable their access to university knowledge outside the region. On the other hand, Comacchio et al. (2012) as well as Padilla-Melendez et al. (2013) claim that human capital at individual level and a qualified social capital at individual and organisational level are the main determinants of boundary spanning between industry and university. The research over local connectedness among young globalised high-tech companies shows that specific local knowledge relationships with a university or company of origin are the key factors counteracting the weakening of local connectedness (van Geenhuizen and Nijkamp 2012). Roper and Hewitt-Dundas (2013) found that university-based research and development centres establish more new connections than company-based centres and are more likely to be interacting with small or micro-firms. They consider this finding important to support the idea of using public investment to leverage open innovation among smaller players. Nevertheless, Freitas et al. (2013) pinpoint that there are in fact two different governance modes of university–industry interactions: the institutional mode (interactions mediated by the university through its administrative structures) and personal contractual mode interactions (formal and binding contractual agreements between firms and individual academics, carried out without the direct involvement of the university). Their econometric estimations suggest that personal contractual interactions are used relatively more by small firms involved in technology

and open innovation strategies, while institutional interactions are mostly used by large firms that vertically integrate R&D activities. Masiello and Izzo (2015) add to the state of knowledge in their analysis of innovation networks between small- and medium-sized enterprises and public research organisations by proving the intuitive perception that there is a co-evolution path between the life-cycle of the relationship, mechanisms of governance and innovation objectives. According to their study, informal governance mechanisms and control are predominant in the explorative phase, while formal mechanisms tend to arise in the exploitation phase of innovation research projects. These notions joined together lead to a specific conclusion that addressing small- and medium-sized enterprises emerges as a real challenge for universities being active in open innovation-based ecosystems. As the big names find their way and balance in-house and externalised innovation processes (see also Guimon and Salazar-Elena 2015 on collaboration in innovation between foreign subsidiaries and local universities), “SMEs must embrace innovation in a wider definitional context, and develop their collaborative innovation capabilities beyond that of technical innovation based solely on R&D” (Wynarczyk et al. 2013). Universities can be perceived as natural brokers here, even though in many cases, they show more interest in establishing relations with top multinational brands. Anyway, it is worth noticing that exploring technology opportunity together with institutions such as universities and private research establishments is important for successful innovation in SMEs. But, in addition, contacts with competitors are also important for successful innovation performance (van Hemert et al. 2013). Toedtling et al. (2011) add the territorial aspect, by claiming that open innovation strategies of companies benefit from certain regional culture characteristics and that there is no uniform “model of open innovation that applies to all types of regions”. As such, both corporate cultures and regional cultures in the regions show many aspects hampering open innovation.

Research Design and Methodology

There are two main assumptions underlying the analytical framework of the study on open innovation capacity of the (Polish) universities:

- If present in open innovation-based ecosystems, universities fit into the outside-in type of open innovation processes. In meso- and macroeconomic terms, universities do not “live their own lives”. They are positioned in value chains of business players and as such, their main focus is not just to deal with intellectual property rights (IPR) and know-how achieved within academia, but to deliver applicable solutions to those who seek and source externally.
- The involvement of universities in open innovation processes and related activities vary due to several factors in the ecosystem, such as trust and general level of openness, absorptive capacity of companies, life-cycle of relationships, dominating stakes and relations (product vs. market development; more competitive vs. more cooperative environment). Again, we should not focus on or embrace everything with the fancy terms like “technology transfer” or “intellectual property rights management”. In reality, they hide a plethora of—very often case-specific—actions.

Consequently, a certain internal structure is needed to delimitate open innovation-related activities in universities out of remaining actions. For example, Albats (2013) applies a very wide approach to her monographic study, but she also points that several notions are (reasonably) included in her analysis—even though their authors originally discuss them apart of open innovation concept. In other words, she uses open innovation as a kind of “container” or “umbrella” term that binds the relevant findings in different fields of innovation management. Such a wide understanding, afterwards narrowed to academic discussion on open innovation-related tools applied by universities and finally to case-based scrutiny of Uppsala University, was proposed by Jonsson et al. (2015a, b). A similar kind of approach is used in this paper. The study on open innovation capacity of the Polish universities covers the aspects of universities delivering solutions as partners/suppliers in outside-in innovation processes of companies; and universities as facilitators of open innovation ecosystems or key players in the ecosystems.

The analytical framework, therefore, combines accessing financial statements data concerning research and development contracts with interviewing the authorities of Polish state technical universities. All Polish state technical universities (universities of technology, technological universities, polytechnics) were requested, under the Polish law on public information, to deliver information concerning their financial performance with regard to the sales of know-how and IPR. The data were analysed in a timeframe of eleven years. This is considered relevant, as the beginning of the twenty-first century marks a gradual change in the mindset of Polish higher education authorities which leads universities towards the non-Humboldtian operations. In three cases (referred to as TU10, TU11, TU12), proxy values were calculated for 2004–2009 as the respondents provided data for the last five years only—according to the Polish rule on five-year bookkeeping availability. The proxies were calculated with reference to average available sales data with a slight growth in time. The quantitative information gathered, presented and analysed reflects the facts, not opinions, and as such is an entry point for further analysis of more qualitative nature. Fourteen out of eighteen Polish state technical universities submitted their financial data. In a standardised questionnaire, they were asked to deliver information concerning the revenues from sales of know-how and IPR and the value of shares obtained via contribution in kind (IPR or know-how).

The qualitative scrutiny concerning universities’ approach and experiences related to facilitating of and participating in open innovation ecosystem approach was structured by adapting the proposition used by Baron (2014), earlier inspired by Belussi et al. (2010) and Laranja (2004), to assess open innovation cooperation strategies in regional innovation systems. Similar functional decompositions have been lately used by Pinto et al. (2015) and Fernández-Esquinas et al. (2016) in their studies into university–industry linkages. Authorities of the seven Polish state technological universities agreed to participate in a query regarding their institutions. The remaining refused. In every case, the vice-rector (vice-president) in charge of R&D cooperation or industry relations or science (depending upon the structure of a certain university) was requested to respond in a computer-assisted telephone interview, lasting approximately 20–30 min. In some cases, the interlocutors asked for a direct internet link to the questionnaire and filled the answers out on their own. The questionnaire called for reflection and self-assessment on the issues presented in Table 1. The self-assessment here refers to

Table 1 Key issues in qualitative assessment of universities as facilitators/participants of open innovation ecosystems

Key issue	Scope of scrutiny
Establishing and facilitating cooperative relations	<p>Experiences in time, level of advancement and territorial range of following activities:</p> <ul style="list-style-type: none"> • Conferences and seminars for tech/knowledge-based companies • Professional training and human resource development/recruitment programmes • Cooperation with tech/knowledge-based companies in education (joint curricula, case-based diplomas, real cases applied in teaching) • Cooperation with tech/knowledge-based companies in research (tailor-made research, expertise, joint research and development projects) • Associations or clustering initiatives • Joint actions or strategies in the industry • Ideas and troubleshooting competitions • Ideas and troubleshooting workshops or meetings focused on technology presentations • On-line: ideas, troubleshooting and technology presentation platforms • Technology brokerage/transfer services
Strategic approach to establishing and facilitating cooperative relations	<ul style="list-style-type: none"> • Balanced approach to education and research • Know-how, norms and procedures towards cooperative relations • Proactive approach to facilitating cooperation • Deep knowledge of partners' needs and expectations
Motivations behind establishing and facilitating cooperative relations	<ul style="list-style-type: none"> • Relying on external funding • Financial profits earned in previous similar activities • Partners' satisfaction • Partners' financial profits
Responsiveness of tech/knowledge-based companies	<ul style="list-style-type: none"> • Involvement • Proactivity • Financial contributions
Asymmetries: University vs. tech/knowledge-based companies	<ul style="list-style-type: none"> • In activity • In technology • In benefits originating from cooperation • In financial yields originating from cooperation
Presence of open innovation processes in business routines	<p>Experiences in time and territorial range with regard to the following:</p> <ul style="list-style-type: none"> • Free of charge idea delivery using on-line ideas exchange/technology presentation tool • Free of charge problem solving using on-line ideas exchange/technology presentation tool • Free of charge idea delivery during ideas exchange/technology presentation meetings • Free of charge problem solving during ideas exchange meetings or troubleshooting workshops • Selling an idea or know-how

Table 1 (continued)

Key issue	Scope of scrutiny
	<ul style="list-style-type: none"> • Purchasing an idea or know-how for further developments • Granting licence concerning own technical solution • Purchasing licence for further developments • In kind investment of intellectual assets in spin-off companies • Buying/taking over the other entity to acquire its technology or know-how

Based upon classifications by Baron (2014), Belussi et al. (2010) and Laranja (2004)

delivering the subjective opinion of a person in charge. On purpose, the respondents were not asked to support their answers with evidence. Collected financial data were used for cross-check. To enable further comparisons and analysis, all questions were formulated in a way to be answered using the following: pre-defined statements, seven-point Likert scale or dichotomous variables. For most sections of the questionnaire, the answers were afterwards given values in points and consequently, overall indices were calculated. In the remaining cases, the provided answers were used in their original form.

Results

The universities delivered information concerning the revenues from sales of know-how and IPR and the value of shares obtained via contribution in kind (IPR or know-how), which altogether reflect the performance in delivering solutions as partners/suppliers in outside-in innovation processes of companies. As for the shares, none of the respondents invested their intellectual assets in spin-off companies. Regarding the sales of know-how and IPR in two cases, the universities (TU13 and TU14; not included in Tables 2, 3) claimed they had no transactions throughout 2004–2014. The study shows that three Polish state technical universities (TU06, TU10 and TU03) can be considered the leaders of the game. Their revenues exceed five million Polish zlotys (1 EUR = 4.3 zloty in October 2015) per entity and per year, which is an unattainable value for the remaining universities. In current prices (Table 2), the revenues of the leaders grow in time, but it must be noted that TU03 shows a significant irregularity and TU10 is the case of proxy values for 2004–2009. TU06 emerge as the strongest player with almost constant and steady growth dynamics. In fixed prices (Table 3; 1998 as the base year according to the conversion tables presented by the Central Statistical Office of Poland), the growth rate of the leaders is (quite obviously) not as high as it seems of the current prices. Nevertheless, TU06 still shows a very dynamic growth. Unlike the three leading universities, the others cannot be easily distinguished. TU12 and TU05 can be considered strong followers, but still far behind the leaders. The others, which is better represented in fixed prices, form a “magma” of poor, non-dynamic performers at the low-end. In overall dynamics, TU02 emerges as very dynamic (partly as an effect of low base value) and due to this should be included in a group of followers. Summing up, in terms of sales of know-how and IPR, Polish

Table 2 Revenues from IPR and know-how in Polish technical universities 2004–2014 (thousands Polish zlotys—current prices, sorted in descending order of values for 2014)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TU06	5342	6182	6716	4999	8165	9837	11,688	15,827	19,711	18,977	21,167
TU10*	8566	9017	9492	9991	10,517	11,071	10,381	11,166	10,768	10,840	12,199
TU03	5758	6514	7570	16,262	12,112	8214	7481	10,850	8408	10,343	8663
TU02	188	16	332	1096	1944	1427	1264	1931	2825	3018	3224
TU12*	2371	2496	2627	2766	2911	3064	3873	2445	3853	2384	2766
TU08	3165	2071	2078	1589	1475	2918	2722	2994	2012	2691	2229
TU05	652	810	669	2499	2678	2264	1991	1676	2212	2502	2150
TU01	2702	2907	3138	760	958	716	758	1061	698	1466	772
TU11*	561	591	622	655	689	726	1116	571	866	477	598
TU07	62	109	118	238	247	167	179	55	136	830	251
TU09	45	13	2	25	34	17	49	170	175	192	211
TU04	0	0	108	45	162	249	276	499	270	106	146

Source: own calculations based upon data submitted by universities

*Proxy values calculated for 2004–2009 due to missing data

state technical universities fall into three groups: three leaders, three followers and the low-end.

These findings were consequently cross-checked with inputs from the qualitative study. In terms of establishing and facilitating cooperative relations (Table 4), the respondents mostly assess their institutions as experienced regional or national players.

Table 3 Revenues from IPR and know-how in Polish technical universities 2004–2014 (thousands Polish zlotys—fixed prices 1998 according to the Central Statistical Office of Poland, sorted in descending order of values for 2014)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
TU06	3966	4566	4892	3506	5536	6429	7402	9580	11,629	11,104	12,488
TU10*	6360	6660	6913	7007	7130	7236	6574	6759	6353	6343	7197
TU03	4275	4811	5514	11,404	8212	5369	4738	6568	4961	6052	5111
TU02	139	12	242	769	1318	932	800	1169	1667	1766	1902
TU12*	1760	1843	1913	1939	1974	2003	2453	1480	2273	1395	1632
TU08	2349	1530	1514	1114	1000	1907	1724	1812	1187	1575	1315
TU05	484	598	487	1753	1816	1480	1261	1015	1305	1464	1268
TU01	2006	2147	2286	533	650	468	480	642	412	858	456
TU11*	417	436	453	459	467	474	707	345	511	279	353
TU07	46	81	86	167	168	109	113	33	80	485	148
TU09	33	10	1	18	23	11	31	103	103	112	124
TU04	0	0	79	32	110	163	175	302	159	62	86

Source: own calculations based upon data submitted by universities

*Proxy values calculated for 2004–2009 due to missing data

Table 4 Establishing and facilitating cooperative relations—self-assessment of selected Polish technical universities

Activity	Self-assessment by:						
	TU01	TU02	TU03	TU04	TU08	TU10	TU15
Reference information concerning revenues from IPR and know-how	Low-end	Follower	National leader	Low-end	Low-end	National leader	No data provided
Overall self-assessment performance index	0.725	0.687	0.762	0.775	0.725	0.587	0.787
Conferences and seminars for tech/knowledge-based companies	Long-lasting experience in Poland	Initial experiences; to be continued	Long-lasting regional experience	Discontinued after initial experiences	Long-lasting regional experience	Becoming the mainstream activity	Long-lasting regional experience
Professional training and human resource development/recruitment programmes	Long-lasting regional experience	Discontinued after initial experiences	Long-lasting regional experience	Discontinued after initial experiences	Long-lasting regional experience	Becoming the mainstream activity	Long-lasting regional experience
Cooperation with tech/knowledge-based companies in education	Long-lasting experience in Poland	Long-lasting experience in Poland	Long-lasting regional experience	Becoming the mainstream activity	Long-lasting experience in Poland	Becoming the mainstream activity	Long-lasting experience in Poland
Cooperation with tech/knowledge-based companies in research	Long-lasting experience in Poland	Well established in international dimension	Long-lasting experience in Poland	Long-lasting experience in Poland	Long-lasting regional experience	Becoming the mainstream activity	Long-lasting experience in Poland
Associations or clustering initiatives	Long-lasting experience in Poland	Long-lasting experience in Poland	Long-lasting experience in Poland	Well established in international dimension	Long-lasting regional experience	Becoming the mainstream activity	Long-lasting experience in Poland
Joint actions or strategies in the industry	Long-lasting regional experience	Well established in international dimension	Becoming the mainstream activity	Well established in international dimension	Long-lasting regional experience	Initial experiences; to be continued	Long-lasting experience in Poland
Ideas and troubleshooting competitions	Initial experiences; to be continued	Initial experiences; to be continued	Becoming the mainstream activity	Long-lasting experience in Poland	Becoming the mainstream activity	Initial experiences; to be continued	Long-lasting regional experience
Ideas and troubleshooting workshops or meetings focused on technology presentations	Long-lasting regional experience	Long-lasting regional experience	Becoming the mainstream activity	Long-lasting experience in Poland	Long-lasting regional experience	Long-lasting regional experience	Long-lasting regional experience

Table 4 (continued)

Activity	Self-assessment by:						
	TU01	TU02	TU03	TU04	TU08	TU10	TU15
On-line: ideas, troubleshooting and technology presentation platforms	Becoming the mainstream activity	Initial experiences; to be continued	Long-lasting experience in Poland	Long-lasting experience in Poland	Initial experiences; to be continued	Initial experiences; to be continued	Long-lasting regional experience
Technology brokerage/transfer services	Discontinued after initial experiences	Initial experiences; to be continued	Long-lasting experience in Poland	Long-lasting experience in Poland	Long-lasting regional experience	Initial experiences; to be continued	Becoming the mainstream activity

Author's field work, Summer–Autumn 2015

In all cases, they have at least tried entering the cooperative relations under scrutiny and tend not to discontinue these approaches. Upon the interviews and classification in Table 4, an overall performance index was calculated (ranging 0 to 1). It revealed that universities earning higher revenues from IPR and know-how may either tend to self-assess in a more modest way or their more limited, maybe focused approach leads to better financial performance. The levels of the overall performance index do not follow the pattern of the levels concerning sales revenues.

Referring to the strategic approach to establishing and facilitating cooperative relations, all participating universities assess themselves fairly accurately as having a balanced approach to education and research, having deep knowledge of partners' needs and expectations as well as being proactive in facilitating cooperation. They all claim that know-how, norms and procedures towards cooperative relations are present at the university. A self-assessment index on the issue was calculated (Table 5; ranging 0 to 1). For every university, its level is high—in six out of seven cases, it exceeds 0.8; the average value is 0.85. But again, there is no clear pattern that could link this self-assessment to revenues from IPR and know-how. Consequently, the question re-emerges whether the national leaders are more modest in their own perception or maybe they are more aware of how their mindset and systems are designed and thanks to experiences in managing larger transactions, they identify bottlenecks more effectively.

Further on, the respondents were asked to provide an insight into motivations behind establishing and facilitating cooperative relations. The first significant observation is that all but one (TU10, national leader) universities strongly rely upon external funding—this raises a question whether open innovation is a real business model for the universities or it is just opportunity seeking. The other observation strengthens doubts concerning the impact of large volume transactions and other experiences on awareness and self-assessment. It is so because the national leaders are quite moderate in their opinions that open innovation-related activities really bring profits to their universities. Whereas all but one low-enders claim they truly do. On the other hand, the respondents positively assess an impact of their open innovation-related activities on participating businesses. They mostly believe the satisfaction levels are very high and the companies enjoy certain financial earnings out of these activities. So, consequently,

Table 5 Strategic approach to establishing and facilitating cooperative relations—self-assessment of selected Polish technical universities

Activity	Self-assessment by:						
	TU01	TU02	TU03	TU04	TU08	TU10	TU15
Reference information concerning revenues from IPR and know-how	Low-end	Follower	National leader	Low-end	Low-end	National leader	No data provided
Self-assessment index on strategic approach to establishing and facilitating cooperative relations	0.857	0.928	0.714	0.821	0.893	0.857	0.893

Author's field work, Summer–Autumn 2015

are the tech/knowledge-based companies responsive to open innovation offers of the universities? The universities claim there is no significant interest in their activities. They are not dissatisfied, but surely not enthusiastic either. The only exception is TU03 (national leader), which is absolutely satisfied with corporate involvement. In a similar way, the universities are moderate or moderately positive in perceiving businesses as solution seekers approaching their institutions to address technological issues or solve problems. Nevertheless, businesses are seen as those who are not very much willing to pay for OI-related activities. It is stressed in both groups of national leaders and low-enders. Only the TU02 (follower) is very positive on companies prepared to pay for this kind of services.

The results of a scrutiny on asymmetries in relation between universities and tech/knowledge-based companies (Table 6) are either a bit contradictory or allow identification of “hot spots”. For example, the self-assessed asymmetry in activity is biased towards companies, while universities claimed there was no significant interest in their activities. One of the possible ways to explain this contradiction may be that both sides mismatch their open innovation needs (even though, as mentioned above, the universities believe they have the in-depth knowledge of the needs and expectations of business). In other words, the universities deliver open innovation-related activities that are not sufficiently attractive to the business world, while in the meantime, those who need the outside-in open innovation solutions must approach universities on their own because universities are not proactive enough to “radar” for them and initiate

Table 6 Asymmetries: university vs. tech/knowledge-based companies—self-assessment of selected Polish technical universities

Activity	Self-assessment by:						
	TU01	TU02	TU03	TU04	TU08	TU10	TU15
Reference information concerning revenues from IPR and know-how	Low-end	Follower	National leader	Low-end	Low-end	National leader	No data provided
Activity: the more active party in initiating cooperation and implementing joint activities	–	–	–	+	Equal	–	Equal
Technology: the more technologically advanced party in cooperation	Equal	Equal	++	Equal	Equal	+	Equal
Benefits: the party getting more non-financial benefits out of cooperation	Equal	Equal	–	–	Equal	++	Equal
Yields: the party getting more financial yields out of cooperation	–	–	–	–	Equal	–	–

Author’s field work, Summer–Autumn 2015. “+” signs indicate advantages/involvement of the university; “–” signs indicate advantages/involvement of the business sector

contact. An interesting observation may be based upon the self-assessment of technological asymmetry. Both the national leaders under scrutiny claim that they have technological advantage over the business partners, while all the other universities consider the technological advancement of both parties as equal. A link can be easily seen here: the better doers are the better sellers. It cannot be statistically proven with such a sample, but a logical link is quite strong—if there is no technological advantage, the university will remain the “open innovation meeting point” rather than become the real open innovation player dealing with large volume transactions on IPR and know-how. All but one university confirmed that in their opinion companies anyway earn on open innovation-related activities and even earn more than universities. As for the non-financial benefits, the picture is not clear. Half of the respondents oscillating around equal may mean that universities, in non-financial terms, perceive open innovation as a win-win game.

The presence of open innovation processes in business routines has been scrutinised by self-assessment referring to universities’ experiences in the last three years. Only factual transactions concerning know-how or IPR were included in the study. In other words, while all previous issues (apart from the financial statements) might be affected by individual perceptions, here, the occurrence of certain knowledge flow (transaction)—whatever paid or free of charge—is a starting point for further analysis. Also the territorial range is key in this assessment, as it marks the position of a certain university on a national and international research and development arena. This approach led to calculating the overall open innovation transactions index (Table 7; ranging 0 to 1).

It is worth emphasising that while previous indices showed relatively high levels, here, the situation is different. Partly it is due to the formula of the index, in which international transactions are valued much higher than national (and there are almost no international transactions recorded). But mostly, it originates from the fact that several transactions never occurred in the analysed period. Here, again, it is difficult to show a clear pattern of interrelations between financial performance and the index. The low-enders mix with national leaders—all with fairly poor results. TU02 (follower)—no surprise—ranks higher, but still not high. In detail, this approach shows partly that the universities, even though they set up instruments supporting open innovation, hardly use them for real open innovation transactions. For example (go back to Table 2), all the universities showed interest and experience in on-line: ideas, troubleshooting and

Table 7 The presence of open innovation processes in business routines—self-assessment of selected Polish technical universities

Activity	Self-assessment by:						
	TU01	TU02	TU03	TU04	TU08	TU10	TU15
Reference information concerning revenues from IPR and know-how	Low-end	Follower	National leader	Low-end	Low-end	National leader	No data provided
Overall self-assessment open innovation transactions index	0.100	0.233	0.200	0.100	0.200	0.133	0.266

Author’s field work, Summer–Autumn 2015

technology presentation platforms, but only TU08 and TU15 confirmed that they free of charge delivered idea using on-line ideas exchange/technology presentation tool; and only TU03, TU08 and TU15 claim to have solved any problem this way. The same refers to troubleshooting workshops or technology presentation meetings. All the respondents present themselves as experienced partners for business, while again only TU03, TU08 and TU15 recorded both: free of charge idea delivery and problem solving during workshops. In terms of the “iconic” open innovation transactions, all the universities claim they sold an idea or know-how as well as granted a licence (which is confirmed in their financial performance; go back to Table 2). But none of them bought an idea or know-how for further developments. Only TU02 purchased licences for further development and TU10 was the only one to try taking over another entity to acquire its technology or know-how. Altogether, these facts show discrepancy between activities supporting open innovation and their impact on open innovation transactions. Even though the universities set up activities in the spirit of open innovation, they either use them to channel relations towards buyer-supplier contracts or use them separately from the “traditional” technology transfer transactions, maybe just to boost publicity or to gradually convert from linear innovation thinking towards the ecosystem approach.

Conclusions and Discussion

The paper reveals that in terms of sales of know-how and IPR, Polish state technical universities fall into three groups: three leaders, three followers and plus ten entities at the low-end. The names of the universities are blinded for the publication, but the general pattern reflects the findings by Bigliardi et al. (2006) showing that poorer economic regional conditions hinder the interaction between technical universities and companies. The most important aggregated findings are focused around the issues of open innovation awareness among universities, not their strategic approach. The general picture emerging from the self-assessments executed by the universities is very positive. Openness towards business and society, promoting the idea of an entrepreneurial university and setting up procedures and projects (activities) establishing universities in the value chains of outside-in open innovation processes are at the very heart of declared strategic values of the universities. The word “declared” associated with the fact that the declarations were provided by the university authorities is very important here. It is because of a possible mismatch between official declarations and the reality in research teams. Dabic et al. (2015) studied other moderately innovative economies and found that a large group of professors felt that their university had a very low degree of entrepreneurial orientation, even though they really supported the idea of an entrepreneurial university. Anyway, coming back to the discussed study, the performance self-assessments present relatively high levels of satisfaction and strong belief in own experience with open innovation-related tools. Nevertheless, the picture becomes blurred when individual opinions are cross-checked with financial data. There is no clear pattern that could link self-assessment results to data on revenues from IPR and know-how, but it can be easily seen that the better (financially) performing universities assess their own open innovation performance lower than the poor performers. It is probably not a matter of the leaders being so modest, but an issue of the

lagging behind being unaware and getting into self-inflation (Kruger and Dunning 1999). The big players have more extensive experience and, as a result, they might be much more critical towards certain tools and might identify numerous bottlenecks, compared to “rookies” who naturally are very enthusiastic with single or initial actions. Also, a hypothesis can be drafted that better performers in financial terms seem to be weaker in general terms because their activities are not so versatile. Instead, they go deeply into profitable options: a bird in the hand is worth two in the bush. This assumption is certainly worth further studies. Especially that the British empirical evidence sheds new light on a multi-output approach to universities’ knowledge transfer activities (Rossi 2014). The author claims that the efficiency issue within the system must be approached beyond filing patents and granting licences to generate profits. By including a broader range of knowledge transfer outputs in the computation of efficiency, she found out that universities offering a wider array of activities can also efficiently engage in knowledge transfer. According to the British study, efficiency is linked to specialisation in a few subject areas, as well as to greater orientation towards the social sciences and business—which is also a serious challenge for the Polish technical universities.

Altogether, the study shows that the open innovation capacity of the Polish technical universities is potentially high. Potentially, because the relevant mindset is there, at least basic experiences and knowledge are available, structures and procedures are set up. Yet, these assets are not being converted into capacity. The universities, even though they set up instruments supporting open innovation, hardly use them for real open innovation transactions. To understand this mismatch, one needs to understand the general financing scheme of Polish higher education institutions. Their largest source of funding is the state subvention to education. The financing of research by the state is much smaller. Of course, granting schemes and research contracts with business fill the financial gap. This situation (low level of own funding) causes a strong urge to finance all but education out of external money. So, consequently, a three-silo structure emerges: own (education) money, direct (very often historically established) university-business contracts and projects of various nature (including research and development projects as well as research and development coordinating actions). And the silos are often far from one another. Consequently, well-established buyer-supplier contracts are separate business models at well-performing universities, almost as in the technology knowledge transfer process proposed by Laine et al. (2015), while the OI-related facilitation (open innovation participatory research process; Laine et al. 2015) is very often a bundle of projects (at all universities). But the projects are not business. Apart from official statements, the main stake of every external money beneficiary is to end up with project deliverables not long-term results. This opens another interesting field of study, addressing the efficiency and impact of open innovation promotion/support actions. Because the “iconic” open innovation transactions (buying or selling IPR and know-how) might not at the moment originate from open innovation facilitation. Empirically, this discrepancy was explained by Weckowska (2015), who identified two approaches to commercialisation, namely transactions-focused practice and relations-focused practice. In Poland’s case, it is highly possible that transactions-focused practices are based upon routines and well-established dyadic relations with big industrial players, while the relations-focused practices are set up with the use of external funding, much more in an open innovation manner, to test some new

approaches and radar for opportunities and potential customers. As such, the latter bring limited incomes in this quasi-incubation phase. These findings can be aligned with more general reflections by Pinto et al. (2015), who claim that in peripheral regions, knowledge transfer from universities needs to be considered in a broader sense and adjusted to the capacities of firms operating in a given region.

The two notions mentioned above correspond to one of the findings of the study. Logically, this observation is obvious, but perceptively, numerous players claim there is no justification for assuming that some universities have tiny or no technological advantage over the business sector. The finding is if there is no technological advantage, the university will rather remain the “open innovation meeting point” than the real open innovation player dealing with large volume transactions on IPR and know-how. The awareness of competitive advantage in terms of knowledge is key to building open innovation capacity. As long as OI-related actions will be set just for publicity, project money or opportunity seeking—apart from existing research specialisations and fields of truly competitive expertise—the two silos will remain separate. The successful merger of the existing university-business bilateral relations with the more open approach and ecosystem thinking will boost the overall performance.

Finally, with regard to the issues discussed in the paragraph above, as the paper focused on inside-out processes, it would be interesting to examine the nature of the outside-in processes in universities. In Poland, a general feeling is shared that in many cases, academia gets more knowledge from cooperative actions than the business partners who might often be—as already mentioned—a step ahead. This must be considered fundamental, because the bargaining power of both parties changes if we radically change the stakes. A study on the influence of relational mechanisms on university researchers’ technological and scientific knowledge acquisition in Korea could be a cornerstone for the new approach (Hemmert 2016). His findings indicate that university researchers can enhance their acquisition not only of technological knowledge, but also of scientific knowledge by developing and maintaining a strong working relationship with industry.

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