Seminar Economics of Innovation

"The "Third Mission" of Universities"

Submitted By:

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1.0 Introduction

Nowadays, knowledge can be considered as the main component in the study of innovation, and universities can be regarded as major factors and main players in production, distribution and production of knowledge (Feldman et al., 2002). Nevertheless, the studies of technology diffusion and transfer are mainly made over traditional universities as (Schlegel et al., 2022) states, and there is information scarcity over the UASs. The precious literature and case studies such as (Liu, 2015) and (Feldman & Audretsch, 1999), propose that universities in general stimulate regional innovation, not only by the means of basic traditional research, but also through spillovers of direct and indirect nature. The effects of established UASs on regional are evidently presented and explained by (Pfister et al., 2021) where it is stated that there was an increase of over 6.8% in the activity of patenting and over 9.7% increase in the quality of regional patents. Other publishments supporting the positive effects of established universities can be recognized in (Andrews, 2017) , stating that the establishment of UASs on average results in an increase in patenting activity by 7% to 32% on average. There has been a surge for research in this field, where these numbers caught the attention of other researchers such as the case of (Pfister et al., 2021) where after implementation of empirical calculations and different measuring mechanism it is shown that the effects on innovation from UASs was almost three times higher than from traditional universities when compared, thus concluding that the increase in the number of UAS students has a higher effect on innovation when compared to traditional universities in Switzerland case.

This effective and efficient performance of UAS on the field of regional development and implementation, can be considered as the starting point for raising questions over this topic. Firstly, focusing on performance of universities of applied sciences and traditional universities, respectively: Are UAS more effective and more successful on knowledge diffusion compared to traditional universities? Secondly, the shifting of preferences between university types, respectively: Are the UAS going to surpass basic research universities in the future? With a sneak peek analysis over the transfer strategy mechanisms to understand where the approaches of these types of universities differ from each other, and thirdly what are/will be the new adapted modern forms of research approach? To form an answer for this question, a brief explanation and “real-life” examples over the transfer mechanisms might come in handy, since amount of information and research over this topic remains relatively limited and unsettled. These information gaps will be addressed by an organized previous literature review and academic engagement.

2. University Technology Transfer and its transfer mechanisms

Universities compared to commercial firms have a more complex structure of objectives, whereas commercial firms have financial profit motives, the objective structure of universities include educational, societal and covers the interests of faculty members (Bercovitz & Feldman, 2006). To better understand the transfer mechanism an potential invention goes through, (Bercovitz & Feldman, 2006) has provided a mixture of formal literature and other concepts from the previous literature to express the relationship and guide the analysis over university & industry connection. The mechanisms of technology transfers according to (Bercovitz & Feldman, 2006) are summarized in a simplified form (table.1) composed of: Sponsored Research, Licenses, Hiring of students, Spin-off firms and Serendipity.

Table.1

The transfer mechanisms of university technology transfer

Table I
Formal and Informal transactional mechanisms of university technology transfer

Mechanism	Definition
Sponsored research	An agreement by which the university receives funding for conducting a research project
Licenses	Legal rights to use a specific piece of university intellectual property
Hiring of students	Recruitment of students from the university, especially those working on sponsored projects
Spin-off firms	A new entity that is formed around the faculty research or a university license
Serendipity	Simple luck or chance

Note. From Bercovitz, J., & Feldman, M. (2006). Entpreprenerial Universities and Technology Transfer: A Conceptual Framework for Understanding Knowledge-Based Economic Development. *The Journal of Technology Transfer, 31*(1), 175–188. https://doi.org/10.1007/s10961-005-5029-z

2.1 Sponsored research

Sponsored research refers to an agreement between third party organizations that provide funding and secure financial resources for the research effort, where these efforts may appear in the form of grants, cooperation, contracts and gifts (Dwayne, 2016). According to (Turk-Bicakci & Brint,

2005) the institutions of higher education, incorporate various research modules and utilize them as a connecting bridge with corporations, government institutions and other organizations to grow their influence in the regional scale and in some cases even in global scale. The perfect example on the positive outcomes of sponsored research, in this case government sponsored research expenditures, can be seen in the China case where according to (Zhang et al., 2011) the government expenditures through the years increased significantly, starting from 0.3% in 1990 to 1.4% in 2005 expenditures of its total gross domestic product, and a target to increase the spendings to 2.5% by 2020 returning over $2.1 billion dollars in revenues.

2.2 Licenses

To understand what licensing provide and how it is defined , the interpretation from (Bercovitz & Feldman, 2006) comes in handy, stating that the licenses allow the right for the enterprises to use the university property, providing return of revenues for universities, whether when the deal is reached or even when the operations are still ongoing. The costs of acquiring a license might vary from $10,000 to $250,000. Even (Bray & Lee, 2000) adding that some licensing managers and universities can take shares, mainly taking a 5% equity position in the total share of the company. In the literature review of (Buenstorf & Geissler, 2012), licensing is defined as a mechanism to transfer the knowledge and the research in a socially relevant way. An empirical data from (A. J. Nelson, 2009) revealed that 5% to 20% of the issued patents make it to the end of process to become economically useful innovations.

2.3 Hiring of Students & Spin-off firms

Hiring of students are an asset where the technology and knowledge transfer is made directly from university to companies with the personal desire of people (Bercovitz & Feldman, 2006). According to (Kim & Yi, 1997) , the student professor rate plays an important role on supplying more prepared potential students, stating that the decrease of student professor ratio through the years, resulted in the decline of advanced students in which they could have been hired and potentially start a company. The example of student hiring can be mentioned from the previous research of (Kim & Yi, 1997) where the founder, a PHD student in engineering and a group of graduate studies, spun off from a company to form another company called Medison, forming more sophisticated ultrasonic scanners, resulting in a share of 25% in total global market for these models.

2.4 Serendipity

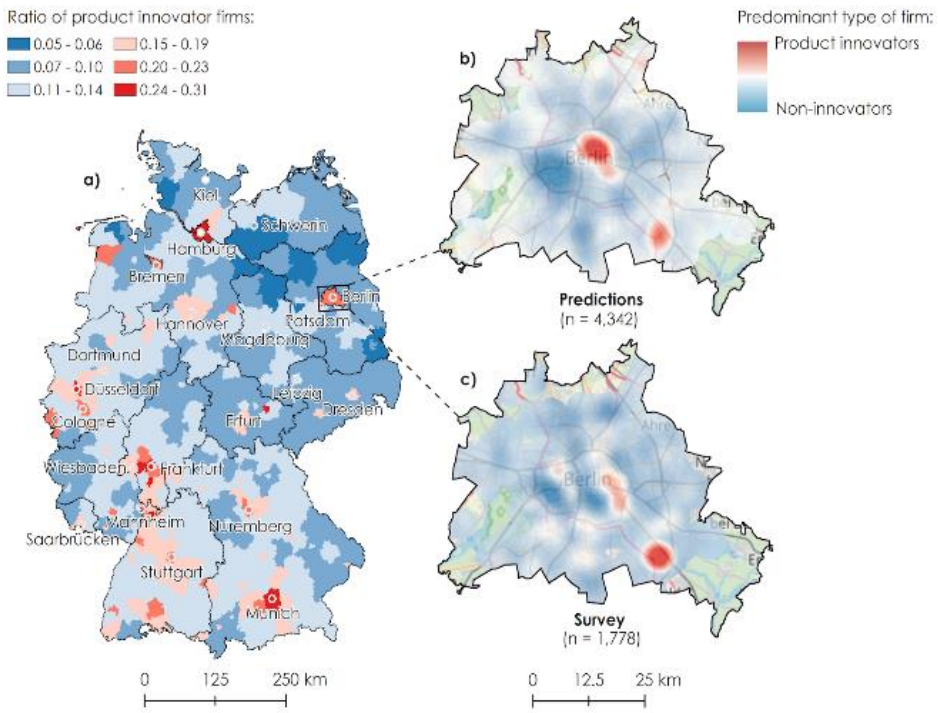
Serendipity, as stated in (Bercovitz & Feldman, 2006) is nothing more than simple luck or chance. These chances, come in different courses of action, for example (Cohen & Levinthal, 1990) bringing up the example of engineering technologies and biomedical companies, where the biomedical companies are more likely to be funded and develop more sponsored research projects, thus, train more qualitative students, rising the potential for future employment, knowledge transfer and start-up investments.

3.0 Universities of applied sciences versus traditional universities (Institutional background)

Some countries, such as Switzerland, decided to establish UASs to provide qualified and highly skilled students with high knowledge and practical experience to supply the academic institutions and private firms, so that they could put their potential in use (Pfister et al., 2021). Even though some study programs might cover the same part as the other university, universities of applied sciences cover dual apprenticeship, which is composed of both classroom education and practical experience (Pfister et al., 2021). The traditional universities mainly focus on the theoretical, conceptual and philosophical aspect, whereas the universities of applied sciences focus in application of the existing knowledge to the local firms, including enterprises of various sizes (Pfister et al., 2021). Nevertheless, the evidence from previous literature and visual data will provide a better background to understand the performance of universities of applied sciences and traditional universities. Rehearsing the literature from (Feldman & Kogler, 2010) about the geography of innovation, the innovation occurs mainly in the areas where research and development occurs. (Feldman & Kogler, 2010) also states that the knowledge spillovers are geographically restricted or limited to a specific part. Supporting these facts, a visual data of Germany and its innovation clusters (firms & innovator firms) it is presented by (Kinne & Lenz, 2021) in figure 2, directly matching visually with figure 3 (source attached below) ,where it supports the idea that innovation rates are higher close to universities, when compared to the areas where the distance from universities in further.

Fig.2

Geographic pattern of product innovator firm predictions



Note. From Kinne, J., & Lenz, D. (2021). Predicting innovative firms using web mining and deep learning. *PLOS ONE*, *16*(4), e0249071. https://doi.org/10.1371/journal.pone.0249071

Fig.3

Location of German Universities and their excellence indicators

Note. From *Karliczek: Deutschland hat Exzellente Universitäten*. BMBF. (n.d.). Retrieved May 2, 2022, from https://www.bmbf.de/bmbf/shareddocs/pressemitteilungen/de/karliczek-deutschland-hat-exzellente-universitaeten.html

3.1 Performance of Universities of applied sciences

Returning to our research question, on whether if the universities of applied sciences are more successful on transferring knowledge and technology, (Lehnert et al., 2020) explains the University of applied sciences has a program that would make its graduates capable of conducting their knowledge into the production of potential new technology, in the same time giving the students the opportunity to co-operate with local firms and practice their applied research over the real-world obstacles, therefore creating teamwork and linking's that increase innovation outputs. Looking back at the Swedish case about the universities (Andersson et al., 2009), the declining interest on attending university by over 4.3%, alarmed the government who reacted by forming new university structure, establishing 11 new institutions. However,(Andersson et al., 2009) stated that the number of students at the newly established universities was performing twice as better as compared to older traditional existing universities. The case of (Lehnert et al., 2020) also states that the employment rates of people in Research and Development are higher within the range of UAS compared to the number of employed outside the UAS. To analyze the effects of UAS on innovation quantity and quality in Switzerland (Pfister et al., 2021) focused mainly on technological spillovers, and to track these spillovers the UASs graduates were the main investigation and experimentation targets since they rarely relocate to further areas. The results of (Pfister et al., 2021) after implementing his research methodology complied of UASs students, graduates and patent data, he concluded that the establishment of UASs resulted in an increase of 6.8% in regional patenting activity. The empirical results of (Pfister et al., 2021) also showed that there was an improvement over the quality of patents which was up by 9.7%. The case study of (Schlegel et al., 2022) had similar outcomes after implying different approach with respect to labor market size, density and high tech density, with a higher patenting activity of 17% after the establishment of UASs. The newly established US colleges also result in 48% of more patents per year in counties around US (Andrews, 2017).

3.2 Performance of Traditional Universities (basic research universities)

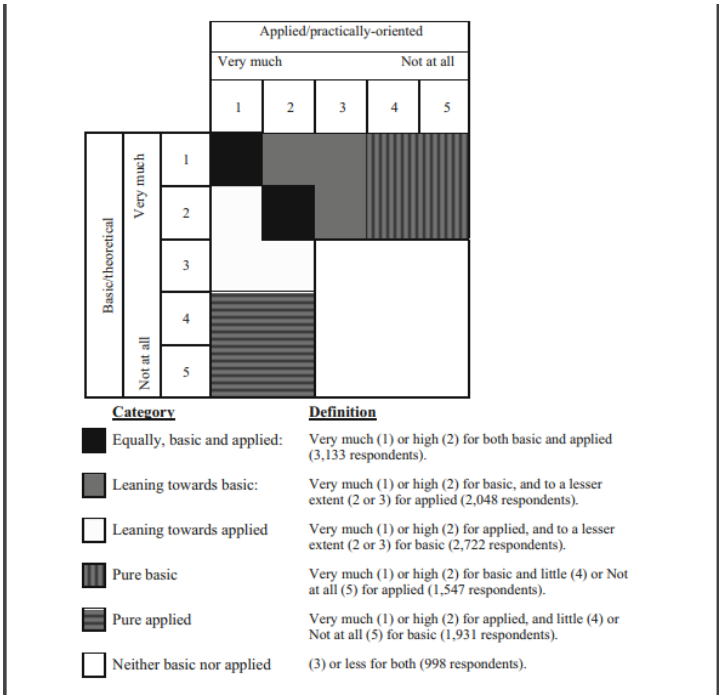
Basic research, nowadays in mainly performed at the traditional universities, which are publicly funded, aiming to reduce the uncertainty over the unanswered dilemmas or creating new fields of study and research potential, so that it might lead to potentially new useful solution. The basic research university students, might not realize the potential for commercialization of their research because of their hesitation to avoid the publication delay process of patent and license, which takes from four months to one year in average (Thursby & Thursby, 2002). In spite of high increase in applied research, according to (Bentley et al., 2015) basic research is still a trademark characteristic for higher institutions, with a significant portion of 61% still being engaged in basic research, 32% engage in somewhat both basic research and applied research, and just few academics of 7% report that they are not engaged in basic research at all. The highest engagement in pure basic research is noticed in Norway, Italy and the Netherlands(Bentley et al., 2015). The type of Research specialization area, possesses a great importance on whether the structure is theoretical or of an applied nature (Becher, 1994). This pure basic research is mostly noticed in humanities with 28%, followed by life sciences with 22%, social sciences 19% and physical sciences 18%, showing the weaker performance in social science disciplines and the applied sciences such as engineering, medicine and agriculture (Bentley et al., 2015), despite the fact that basic research still plays a huge role on drug discovery for medicine, inventing or developing at least 80% of 35 main drugs by the means of basic research funded by government and public institutions (Pohulak-Żołędowska, 2013). Even though the ability of basic research universities to contribute in innovation and R&D remains high, the potential ability of basic research universities to develop more enterprise-friendly research falls short due to three reasons: First, a person who is capable of producing and analyzing basic research, may not reveal the true potential of their idea since they do not prefer to spend time over additional applied research & development which is required to be done to attract the interest of enterprises and potentially license the invention, secondly the researcher might not prefer to wait through the patenting procedures and cope with the risk of publication delays, which these procedures might be required to attract the interest of industrial operators in licensing the technology and thirdly a psychological belief, is that the researchers might deny to take part on commercialization activities at all, claiming that the commercial activity is not suitable for an academic researcher (Thursby & Thursby, 2002).

4.0 Is there a New modern approach over university research on the verge of development?

According to (Nowotny et al., 2003) the three main points that cause a shift from basic research to applied research is the increased steering of research priorities, the commercialization of research (the funding from private companies and ownership income), and the broad coverage and connections of science. The research institutes get their highest portions of funding from the government (Graf & Menter, 2022). The commercialization of research, comes due to the fact that the governments and public organizations have decreased public funding and has shifted the attention to the rights that are gained over the creation of individuals by their own minds and efforts (Nowotny et al., 2003). The new modern approach, according to the case study of (Bentley et al., 2015) over university research is going through different models and transformations, aiming to combine the academic research with various forms of in-society engagement. The extreme leaning towards applied research can be noticed in China and Malaysia, with a percentage of only 2% and 5% specializing in basic research respectively (Nowotny et al., 2003). The reasons behind the hard leaning towards applied search in China, is caused from government policies on China, favoring applied research approach instead that of basic traditional research for a long time, accurately investing 109.04 billion yuan on basic research and over 219.09 billion yuan on applied research (Xia et al., 2020). According to the data surveyed from (Bentley et al., 2015) about how the research is oriented during academic years, originally: " How would you characterize the emphasis of your primary research this (or the previous) academic year?" which combined of 15 countries, including countries such as China, Germany, United Kingdom and USA is presented visually (Table.4).

Table 4:

"Research orientation categorisation and definition, based on: ''How would you characterize the emphasis of your primary research this (or the previous) academic year?''"



Note. From Bentley, P. J., Gulbrandsen, M., & Kyvik, S. (2015). The relationship between basic and applied research in universities. *Higher Education*, *70*(4), 689–709. https://doi.org/10.1007/s10734-015-9861-2

The graphical data of (Bentley et al., 2015) about the distribution of basic and applied research module, is led by the combination of both basic and applied research with 3133 respondents, followed by a leaning towards applied research approach with 2722 respondents, closing with 2048 respondents with a leaning towards basic research approach, adding a number of 1547 respondents in pure basic research and 1931 respondents in pure applied research.

5.0 University-industry collaboration and the performance of innovation

The growth of industrial technology was caused by the effects of changes in knowledge and changes in industry which they have between each other (Schmookler, 1962). Private companies especially start-up companies, seek to co-operate with universities to boost their performance and competitive advantage against its competitors by the help of scientific knowledge and technological opportunities (Tseng et al., 2020). For the creation and formation of scientific research, government

should supply them with funding and facilities in which in some cases such as China (Xia et al., 2020) and (Tseng et al., 2020) the government funding is partially supported by government, and a rising portion of the funding comes from private companies to meet the financial needs of universities. But, since 1980s governments, specifically European governments have guided universities towards other options to fund their projects, specifically towards industries operating in the same field, to boost and contribute to industrial innovation (Gideon, 2017). University-industry rewards (patents, licenses, equities) are important and effective on increasing innovation performance (Tseng et al., 2020). Speaking about the university-industry collaboration, the connection between these categories can be explained rationally by (Schmookler, 1962) stating that if the firm sales are high, the enlarged size of the market in the industry will have the ability to guarantee the expenses for innovation, but if the industry sales are sparse, the returns of investments from innovation expenses will be too low to justify and continue with the project in the future.

5.1 Technological innovation clusters and industrial districts

Returning back to Switzerland case about universities of applied sciences (Pfister et al., 2021), almost 90% of graduates and students live within 25 kilometers (15 miles) in distance from their workplace, this distance of 25 kilometers is considered as a navigational distance to define the area in which an university is established and monitor its effects. The local innovation clusters occur due to the fact that the innovation process is sensitive to geographical distance and knowledge spillovers (Moreno et al., 2006). The organizations operate in a field of information and idea exchange in the form of clusters, with the goal on having access to information between enterprises in a more intensive and fast way, aiming for a better improvement in the flow of information between participating members (Fioravanti et al., 2021). Taking a look in the case of Spanish clusters (Boix & Galletto, 2009), Marshallian industrial districts are the main contributors for producing the 30.6% of total Spanish innovations and patents, with a ratio of 377 innovations per employee, putting them with a percentage of 47% above the national average. Therefore, smaller firms are likely to benefit from these industrial districts and clusters, and the larger firms will display higher innovation levels (Turkina et al., 2019).

5.2 Technology spillovers

Technology spillovers occur when firms benefit unintentionally from the other firms that performed the research and development efforts, without sharing the cost of it (Sun & Fan, 2017).

Technology spillovers, are mainly expected to be transferred from firms of more developed countries to the firms of less developed countries (Sun & Fan, 2017). Investigating into regional technology spillovers, the technology spillovers mainly occur in the areas where the newly universities of applied sciences are established, where such combination results in increase of innovation and R&D intensity in some companies which did not have a background on innovation field (Andersson et al., 2009; Lehnert et al., 2020). The transfer channels of information and knowledge between countries have been responsible for 93% of total factor productivity , and if closed economies would still exist and the free trade policies did not exist the total factor productivity would have been reduced by 35% (Madsen, 2007).

6.0 Discussion

The study investigates the mission of universities as a contributor in knowledge and innovation, in different spheres of operation, such as regional effects and innovation levels as a whole. Before reaching a conclusion, identifying gaps and flaws and sharing personal opinion, a brief look of main points that define the literature review and comparing them with the findings in prior case studies might come in handy. The applied sciences university institutions were formed to perform research and apply their knowledge by the help of enterprises, being as the main terrain to prove their potential (Bercovitz & Feldman, 2006). Overviewing the literature reviews, mainly composed of recent research articles, from authors of different fields with study cases from around the world and specific cases about countries, can be concluded that the establishments of UAS resulted in an increase of 6.8% in regional activity followed by an increase over the quality of patents which was up by 9.7% in Switzerland, (Bercovitz & Feldman, 2006) and an increase of 17% in patenting quality and 40% in quantity of patents in United States of America (Andrews, 2017; Bercovitz & Feldman, 2006) (Andrews, 2017). These increases in quality and quantity of innovation, are transferred through the mechanisms of sponsored research, licensing, hiring of students & spin-offs and serendipity (Bercovitz & Feldman, 2006). The further information and effects of these mechanisms are explained by (Bray & Lee, 2000), stating that the cost of acquiring a license might vary from $10,000 to $250,000, as well as in some cases taking equity positions in the total share of the company and an empirical data from (A. J. Nelson, 2009) revealing that 5% to 20% of the patents make it to the open market for commercial use. The research funding might vary from governments to governments, with China and Malaysia 2% and 5% of their total funding is invested in basic research (A. J. Nelson, 2009). The surveyed data from (Nowotny et al., 2003) reveals that

the highest portions of research module was a combination of both applied and basic research, followed by generally leaning towards applied research and generally leaning towards basic research, whilst the lowest numbers of respondents were composed of those who purely perform applied research or basic research. The noticeable effects of these mechanisms can be recognized in the areas where the universities are located, meaning the closer the university research occur the higher the innovation, technology spillovers and number of patents take place (Feldman & Kogler, 2010). Still, the innovation and industry operate in a linear manner, meaning that if industry if on the brink of enlargement so will the innovation increase, and if the industry is shrinking the innovation rates will be low (Schmookler, 1962).

7.0 Conclusion and personal opinion

To summarize, the universities play an important role in producing knowledge that leads to innovation, but this role of knowledge transfer has gone through some different mechanisms of knowledge transfer due to the local economic developments that pushed the universities to restructure their research capabilities to create easier transfer canals to become more approachable to local industry (Bercovitz & Feldman, 2006). The literature from (Pfister et al., 2021) states that Universities of applied sciences provide a better performance in innovation activities both qualitatively and quantitatively in comparison to those of more basic approach. This new approach on universities caught the attention of different researchers, such as (R. R. Nelson, 2001) claiming that changes in increases the chances of the university to deviate from its traditional functioning, making it vulnerable to damage the norms of open science that the whole society benefits from it, and (Graf & Menter, 2022) stating that traditional universities should be directed and focused more on a central role, making the sectors of applied research to require access to basic theoretical knowledge base so that they can proceed further with their inventions. To understand the performances of students attending universities of applied sciences in comparison of those in basic traditional approach universities, according to (Pfister et al., 2021) he focused on the growing numbers of researchers of universities of applied sciences and results indicated that the innovation effects according to the growth rate of university students, were higher compared to those of traditional universities. Therefore, (Graf & Menter, 2022) claims that these growth rates cannot be implied to the basic traditional universities since the individual scientists are the ones who perform research leading in inventions not universities and most of the times they do not show the desire to process it to further procedures in which it might lead to new inventions. Tackling the question on

whether the UAS are more successful on diffusing technology in comparison to traditional universities, UAS might perform better in this field (Pfister et al., 2021) this phenomena happens due to the fact that the main point of UASs is to produce knowledge with a goal towards commercialization. In the other hand the traditional universities are not mainly focused towards commercialization, but instead they are leaning more toward a nature to create a base that might be economically useful in the future (Thursby & Thursby, 2002). To tackle second question regarding if universities of applied sciences will surpass by performance the traditional basic universities, according to the data of (Nowotny et al., 2003), the surveyed respondents revealed that during their period of conducting research, they implied both basic and applied knowledge to perform their research, meaning that the most suitable approach over research and development is the mixture of both applied and basic knowledge. In addition (Graf & Menter, 2022) suggest that the cooperation between basic research universities and applied research universities is the most suitable way to conduct research and technology transfer. When it comes to tackling the third research question on if there will be new research models inherited to universities, many universities are already setting up more and more approaches such as specialized units, co-operations and projects which are in demands by the industry they are operating in (Bercovitz & Feldman, 2006), resulting in the formation of different clusters which will provide the accessibility to more information and open a route for a better exchange of information and knowledge between participating members (Fioravanti et al., 2021).

Regarding personal opinions about the performances of UAS and traditional universities, the traditional basic research universities should hold onto their academic sovereignty over the shifting of research standards or paradigms. These types of universities should keep feeding each other with information, with traditional universities providing basic research and universities of applied sciences providing more applied research. They should be allowed "each to nurture the other yet allowing each to do what it does best"(Graf & Menter, 2022). There need to be further steps on creating bridges of collaboration between these universities, which will lead in further development of innovation and creations of clusters which will result in the development of industry and a rise in the potential of developing the existing knowledge and information.

Future studies should accurately focus more on the cases and results of co-operation between UAS and traditional universities. The information about the performance of newly established UAS are still scarce in supply and should be analyzed over wider range of countries. Unanswered questions can be formulated over the idea on how these ties between universities of applied sciences and

traditional research universities can be improved and what their effects and performances will be over the open economy. The research over the performance data in a separated methodology for both types of approaches by universities, will provide a better view over the results of performance data when it will be compared.

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