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Introducing the University of Applied Science in the Technology Transfer Process

After WWII, the German Economy increased rapidly, often described as the "Deutsche Wirtschaftswunder". Within a short period, Germany reached the status of unemployment and human capital gets the critical factor and resource in shaping economic growth. While the bottle neck with blue collar workers was solved by an active immigration policy by attracting people from Italy, Turkey or Greece, the lack of white collar workers and engineers still remained. Public universities at this time weren't still unable to provide the quantity of well-educated people in particular in the natural sciences. In particular the high opportunity costs of time made public universities less attractive compared to an early carrier within the industry. In the mid of the 1960s the German government decided to adapt a well-known concept from the theory of the firm – division of labor to provide high skilled employees. A new type of university was created, the so called Universities of Applied Sciences. Public Universities are focused on basic research, while Universities of Applied Sciences (UAS) provide the economy with applied research and education. While the time spend at public universities often exceeded a couple of years before getting graded, the study program at UAS was mainly limited to 3 years (6 semesters). After the Bologna Reform, Bachelor and Master programs of UAS and public universities are treated equally. In the last decade, this division of labor between UAS and public universities was mainly focused on an additional way, the role of each type of university within the technology transfer process. While the role of public universities and their role within the technology transfer processes is intensively studied (Hülsbeck, Lehmann, & Starnecker, 2012), the impact of UAS remains rather under researched. Although they are quite successful in their cooperation with the industry and are nevertheless a bone back in the university-industry relationships, there exists almost anecdotal evidence on this type of universities. This paper tries to shed some lights on this type of universities which could be a role model in particular for countries and regions where small and medium sized firms dominate the industrial landscape.

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Abstract.

After WWII, the German Economy increased rapidly, often described as the "Deutsche Wirtschaftswunder". Within a short period, Germany reached the status of unemployment and human capital gets the critical factor and resource in shaping economic growth. While the bottle neck with blue collar workers was solved by an active immigration policy by attracting people from Italy, Turkey or Greece, the lack of white collar workers and engineers still remained. Public universities at this time weren't still unable to provide the quantity of well-educated people in particular in the natural sciences. In particular the high opportunity costs of time made public universities less attractive compared to an early carrier within the industry. In the mid of the 1960s the German government decided to adapt a well-known concept from the theory of the firm – division of labor to provide high skilled employees. A new type of university was created, the so called Universities of Applied Sciences. Public Universities are focused on basic research, while Universities of Applied Sciences (UAS) provide the economy with applied research and education. While the time spend at public universities often exceeded a couple of years before getting graded, the study program at UAS was mainly limited to 3 years (6 semesters). After the Bologna Reform, Bachelor and Master programs of UAS and public universities are treated equally. In the last decade, this division of labor between UAS and public universities was mainly focused on an additional way, the role of each type of university within the technology transfer process. While the role of public universities and their role within the technology transfer processes is intensively studied (Hülsbeck, Lehmann, & Starnecker, 2012), the impact of UAS remains rather under researched. Although they are quite successful in their cooperation with the industry and are nevertheless a bone back in the university-industry relationships, there exists almost anecdotal evidence on this type of universities. This paper tries to shed some lights on this type of universities which could be a role model in particular for countries and regions where small and medium sized firms dominate the industrial landscape.

1. Introduction

The central role of universities within the technology transfer process is unquestioned. Regions and firms surrounding universities heavily rely on the knowledge created in universities to further develop themselves. Although there exists empirical evidence highlighting the importance of research intense universities and their role in promoting and fostering regional development (Audretsch, Lehmann, & Warning, 2005; Audretsch & Stephan, 1996) these studies cover only a small amount of institutions in the higher educational sector: public universities. In contrast, applied universities (Universities of Applied Sciences) are neglected in their impact and importance as a source of spillover and technology transfer (BMBF, 2004; Krause, 2005). Although public universities (Universitäten) and Universities of Applied Sciences (Fachhochschulen) both belong to the higher educational sector, they differ in several aspects. First, only German Universities have the right to pursue a doctorate degree and to promote for professor. Second, research and teaching in universities is dominated by theoretical approaches, while Universities of Applied Science (UAS) are more practical oriented. Third, in contrast to public Universities, UAS are not solely located in the bigger German cities.

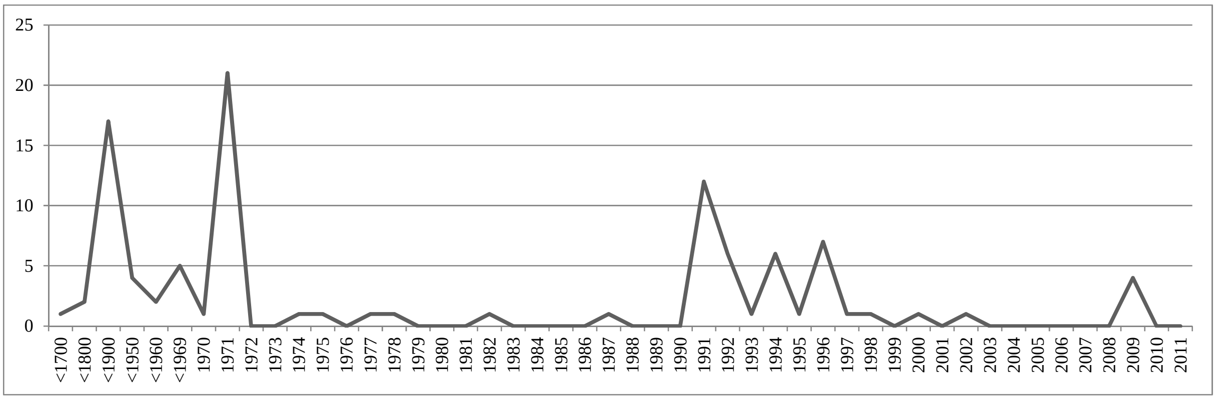
The linkage between regional development and universities has been proven for universities in the US, Germany and other countries (i. e. Audretsch et al., 2005; Audretsch & Stephan, 1996), however little can be found on UAS. Among other reasons, the reason for this linkage is geographical proximity. Although there is no doubt about higher educational institutes influencing regional development (Florax, 1992), not every survey finds statistically significant influences (Anselin, Varga, & Acs, 1997). Besides analyses confirming positive impact (i.e. Harding, 1989; Malecki, 1986; Rees & Stafford, 1986) there are some providing no significance (i.e. Beeson, 1993; Malecki & Bradbury, 1992). Beise and Stahl (1999) is one of the first studies including UAS in their analyses, by asking firms to name useful knowledge resources choosing from universities, UAS, and research institutes. An estimated forty percent of the firms that considered the university ~~as~~ a useful source were located within a range of 75 kilometers of the university named. In contrast, an estimated 80 percent of firms naming UAS as useful knowledge resource were within the same range. Proximity seems to be a crucial factor of success for UAS.

In addition, proximity means to UAS also to adjust their education to the special needs required in the region (Fritsch, Henning, Slavtchev, & Steigenberger, 2007), i.e. the “Hochschule Aalen”. Close to this UAS is the headquarters of Zeiss AG, a company employing almost 25,000 people around the world leading in ophthalmic solutions. To address the needs of this company the UAS in Aalen introduced programs focused on ophthalmic optics. In summary, the founding of the UAS and the resulting separation between UAS and public universities leads to at least three major advantages: (i) higher education is more specialized resulting from the division of labor – universities focused on basic research, UAS on applied sciences; (ii) the competition between higher educational institutions increases; (iii) peripheral location of these institutions improves geographical proximity to firms.

Unfortunately, the potential of UAS is still underestimated (Hamm & Wenke, 2002). To improve this circumstance, this study tries to shift the lenses towards UAS as an important link within the technology transfer process. By analyzing UAS we introduce a unique German institution to the discussion on knowledge transfer. In contrast to universities who are mainly focused on basic research, UAS are specialized more practically, and should therefore be more responsible for enhancing technological development and process innovations than public universities. Although UAS have this assignment, there has hardly been any research analyzing their influence on regional development. To fill this gap, this paper is arranged as follows: first, we briefly introduce UAS. Second, our dataset is described, followed be analyses providing insights to the functionality of UAS and explaining their success in technology transfer processes.

2. The Case of Universities of Applied Science

The Universities of Applied Science (UAS) in their current form of organization were founded in 1969 (BMBF, 2004). The intention of this higher educational institution is to offer more practical oriented studies. In this study we analyze 100 UAS (see also Table 1). Of those 100 UAS around one third (31) existed before 1969. They have their origin in Technical Schools, Academies for Engineers, etc. (BMBF, 2004). The first immense period of UAS founding was in 1972, when more than one fifth (21) of the UAS were established. Between 1991 and 1996, right after the reunion of Germany, another thirty-three UAS were founded, especially in Eastern Germany to help quickly increase the educational level in the former communist country (BMBF, 2004). Besides those major periods only a few UAS have been established (see also Graph 1). Since the reunion of Germany, UAS are established to bring higher education to regions away from the bigger German cities, where they are believed to increase the living standard.



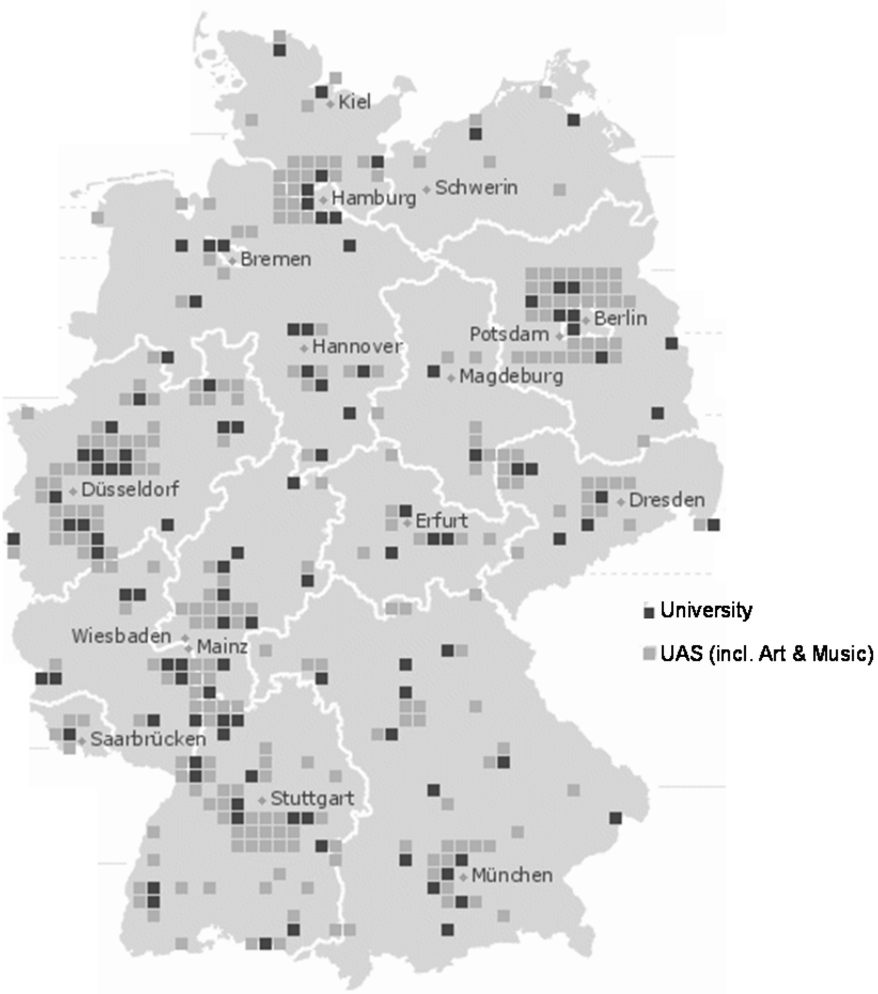
Graph 1 Year of UAS Founding

Among others there are three major structural differences between public university and the UAS. In contrast to the university, the UAS has no means to confer a doctorate and to promote for professor (BMBF, 2004; Lehmann & Starnecker, 2011). Therefore the UAS is less attractive for scientists to be employed as research fellows. In conclusion a UAS consists basically of professor, students and administration, making basic research projects less feasible. In addition, on the one hand professors at UAS are contracted to put twice as much time in teaching per week than professors employed at a German University. On the other hand, sixty percent of the working hours of university professors are intended for research (BMBF, 2004). In summary, the structural differences hint at the fact that a UAS is not designed to contribute to basic research.

Since UAS are not meant to contribute to basic research, like universities or private research institutes (i.e. Fraunhofer Institute) do, UAS have to be successful in practical oriented education. This is supported by Krause (2005), finding that two thirds of all engineers graduate from a UAS. Engineers are most important especially in the sector of Mechanical Engineering. Due to the fact that around the world Germany is known for its skills in mechanical engineering, the education of engineers is crucial for the success of the German economy. In addition to the education of one of the major pillars of the German economy, UAS also show the highest spin-off activity among other research institutes (Krause, 2005). While technology transfer processes are already established in universities (Hülsbeck et al., 2012), technology transfer offices are just starting to be implemented in the UAS structures. Despite the missing structures UAS are succeeding in supporting start-ups based on knowledge generated in the UAS (Krause, 2005). In conclusion, the UAS are fulfilling their task not only by offering a practical oriented education but also by facilitating technology transfer.

Although there are higher numbers of UAS than universities located in Germany, almost 1.4 million students are educated in German Universities, while only 650,000 students in UAS (Fritsch et al., 2007). In conclusion, sixty-six percent of all students made their decision in favor of the university, and thirty percent decided to study at a UAS. There are two major reasons for this observation. First, public universities are located in bigger cities and therefore are addressing more potential students (Fritsch et al., 2007). Second, universities have higher capacities (Fritsch et al., 2007). The higher capacity is resulting from already discussed major structural differences. Universities employ research fellows that are also responsible for the education of the students. Since UAS do not have the rights to confer a doctorate and to promote for professor, research fellows are not attracted to UAS and teaching is done mainly by the professors employed.

While public universities are highly concentrated in large cities like Berlin, Munich, in other areas of high population density (i.e. Ruhrgebiet), UAS are more peripherally located (Graph 2). This means that also cities with only around fifty thousand inhabitants are provided with a UAS and therefore get closer access to the higher education sector. Most of the studies analyzing the role of universities in the regional innovation system come to the conclusion that the proximity to a higher education institution positively influences regional characteristics as well as industrial performance (i.e. Anselin et al., 1997; Audretsch & Lehmann, 2005; Audretsch & Stephan, 1996; Beise & Spielkamp, 1996; Feldman, 1994; Glaeser, Kallal, Scheinkman, & Schleifer, 1992). The positive effects of geographical proximity are often described by personal contacts between scientist and practitioners, leading to an informal technology transfer (Fritsch & Slavtchev, 2007; Grimpe & Fier, 2010; Link, Siegel, & Bozeman, 2007). The local distribution of UAS leads to close geographical proximity also to small and medium sized enterprises and thus should enhance informal technology transfer (Boettcher, 2004; Link et al., 2007).



Graph 2 Distribution of universities and UAS in Germany (BMBF, 2004)

Krause (2005) highlights the importance of the UAS especially for small and medium sized enterprise. The geographical proximity as well as the focus on applied science makes it more feasible for smaller firms to cooperate with the UAS instead of a public university. For example, Dziatzko, Kielkopf, Schittenhelm, and Streinwandt (2011) explain the need for an innovation manager in small and medium sized enterprises, whose responsibility is to put the innovation process into practice. Firms who cannot afford to employ an innovation manager could find a reliable partner in the UAS (Lehmann & Starnecker, 2011). Unfortunately, to our knowledge, the contribution of UAS to the technology transfer process has been barely analyzed. The high spin-off activity of UAS (Krause, 2005) hints at the potential of UAS. To add to the literature we provide another factor accounting for technology transfer – the patenting activity.

3. Dataset

The German Rectors' Conference defines 366 higher educational institutions (German Rectors' Conference, 2011). For our consideration only the state owned institutes are relevant, since education in Germany is a public good and not dominated by private institutions as in other countries (Table 1). Of 104 state owned Universities of Applied Science (UAS) we excluded four[1] , which leads us to 104 UAS and 75 German Universities in our dataset.

Higher education Institutes (366)		
… Universities	109	
… state owned		75
… owned by church		11
… private		7
… educational		6
… others		10
… Art and Music Colleges	55	
… Universities of Applied Science	202	
… state owned		104
… owned by church		21
… private		77

Table 1 Higher Education Institutes (Source: German Rectors' Conference)

In our dataset we analyze the 100 UAS by their technology transfer performance, which is measured in patent applications between 1991 and 2008, filed at the German Patent and Trademark Office. Before 1991 Germany was divided into the Federal Republic of Germany (Western Germany) and the German Democratic Republic (Eastern Germany). Therefore, comparing data before 1990 would lead to a selection bias between Eastern and Western UAS. The innovation performance is controlled by the size, in terms of the number of professors of the UAS, and by the research performance, measured in research funding (Hornbostel, 2001). Additional structural variables are the number of students, the amount of material expenditure, and the basic capital. This data is based on the year 2008 and are drawn from the German Federal Statistical Office (Statistisches-Bundesamt, 2010).

Regional characteristics are classified in labor market regions (LMR) defined in (Eckey, Kosfeld, & Türck, 2006). In contrast to counties (Kreise), LMR include the commuter workforce and therefore better control for spillovers (Eckey et al., 2006). The regional characteristics are measured with the help of four variables indication size (population in

[1] The Alice Salomon Hochschule Berlin since their main focus is pedagogical studies, the Hochschule der Polizei Hamburg, since their objective is to educate police men, the Hochschule fuer Gestaltung Schwaebisch Gmuend, focusing in art and the Verwaltungsfachhochschule Wiesbaden, which is focused on studies in general administration.

2004), overall performance (Gross Domestic Product in 2004) and innovation performance, divided in industry patents (years 2003-2005) and start-up activity (years 2003-2008). The data is extracted from GENESIS dataset of the German Federal Statistical Office. Unfortunately the GDP could only be collected for 143 of the 150 LMR in Eckey et al. (2006)

4. Describing the University of Applied Science

In the history of Universities of Applied Science (UAS) in Germany, research is not the primary objective, although since 1985 applied research and development is defined as one of the tasks of UAS (BMBF, 2004). Recently, the importance is growing. In Germany not the central government, but the local governments of the sixteen states (Bundesländer) are in charge of deciding over-all educational issues. This is why difference in the definition of the importance of research can be observed throughout Germany.

Although, based on the concept of division of labor, public universities and UAS are specialized in different types of research and teaching, comparing reveals further insight on the functionality (Table 2). First, public universities are bigger in all terms that are effected by size, like expenses funding, students, and professors. Second, not surprisingly, universities are older than UAS that had been established in 1969. Third, the funding structure differs a lot. While a very high percentage of almost forty percent of funds for the average UAS are provided by the industry, only two percent come from the most important German research funding institute (Deutsche Forschungsgesellschaft, DFG). There are even UAS that get almost 100 percent of their funding from the industry. Funding from the DFG, which is also used as a proxy for research activity (Hornbostel, 2001), is of great importance to the university, while even less than seventy-five percent of UAS receive less than one percent of their funding from the DFG. This displays and underlines the argument of the division of labor between UAS and universities.

University of Applied Science						
Variable	Obs.	Mean	Std. Dev.	Min	Max	Median
Personal Expenses[1]	95	19291	10859	2438	62792	17579
Impersonal Expenses[1]	95	7914	6066	942	35752	5734
Third Party Funding[1]	95	2571	1918	340	10579	2089
# Students	95	5014	2816	435	15495	4246
# Professors	95	128	71	15	386	115
Age[2]	100	30	13	2	42	40
% DFG Funding	95	2	9	0	78	0
% Industry Funding	95	39	23	0	99	36
DFG Funding[1]	95	35	91	0	633	0
Industry Funding[1]	95	1050	1188	0	7117	703

[1] in 1000 (year 2008)

[2] on the basis of year 2011

University						
Variable	Obs.	Mean	Std. Dev.	Min	Max	Median
Personal Expenses[1]	75	215557	186795	13273	804138	167209
Impersonal Expenses[1]	75	142640	153489	4380	569780	77517
Third Party Funding[1]	75	58267	51705	1696	217794	43486
# Students	75	16916	10328	1075	41782	16455
# Professors	75	257	147	30	655	245
Age[2]	75	175	189	8	625	65
% DFG Funding	75	34	15	0	63	35
% Industry Funding	75	21	12	0	59	21
DFG Funding[1]	75	23510	24257	0	110420	16094
Industry Funding[1]	75	12360	14402	0	74679	8716

[1] in 1000 (year 2008)

[2] on the basis of year 2011

Table 2 Comparing the German University and the University of Applied Science

To verify the impact of these structural differences on technology transfer performances, the number of patent applications between 1991 and 2008 of public universities and UAS is used as a proxy. Compared to the number of patent applications of public universities after the reunion of Germany, the UAS are very much underperforming. Surprisingly, Table 3 reveals further interesting insights. One third of the Top 10 patenting universities are located in Eastern Germany. Regarding the UAS even the half of the institutions can be found in the East. This implies not only the importance of UAS for the development of the former communist part of Germany, but also shows that those UAS have become serious competitors to their Western counterparts. However, size seems to matter. Patent applications per professor point out that for the years 2007 and 2008 the UAS as well as the universities holding the most patent applications seem to be less successful. Therefore, this implies that bigger universities as well as bigger UAS do have a structural advantage, especially when considering a long period of time. At least in both groups almost half of the institutions are also Top 10 when it comes to patent applications per professor. Coming back to the comparison between universities and UAS it is surprising that there are almost no differences regarding patent applications per professor. The institutions placed second even show the same amount of patent applications per professor. Although universities are considered to be better in technology transfer performance, since all public universities in Germany are provided with Technology Transfer Offices (Hülsbeck et al., 2012) and UAS only started to implement comparable structure (BMBF, 2004), the UAS are not behind.

UAS	# PA 91-08	East	PA/ Prof[1]	Rank PA/Prof	University	# PA 91-08	East	PA/ Prof[1]	Rank PA/Prof
Jena	65	1	0.053	7	Dresden	821	1	0.062	5
Hildesheim	63	0	0.031	16	Tuebingen	387	0	0.027	23
Dresden	45	1	0.023	23	Jena	382	1	0.047	10
Kiel	43	0	0.072	3	Freiburg	373	0	0.091	2
Lausitz	38	1	0.091	2	Stuttgart	353	0	0.052	9
Aachen	34	0	0.021	25	Berlin (HU)	221	0	0.018	35
Zittau/Goerlitz	34	1	0.000	83	Munich (TU)	193	0	0.054	8
Anhalt	30	1	0.046	9	Ilmenau	188	1	0.085	3
Niederrhein	30	0	0.036	13	Aix-la-Chapelle	186	0	0.034	17
Dortmund	29	0	0.033	14	Heidelberg	182	0	0.028	22

1 Mean (07-08)

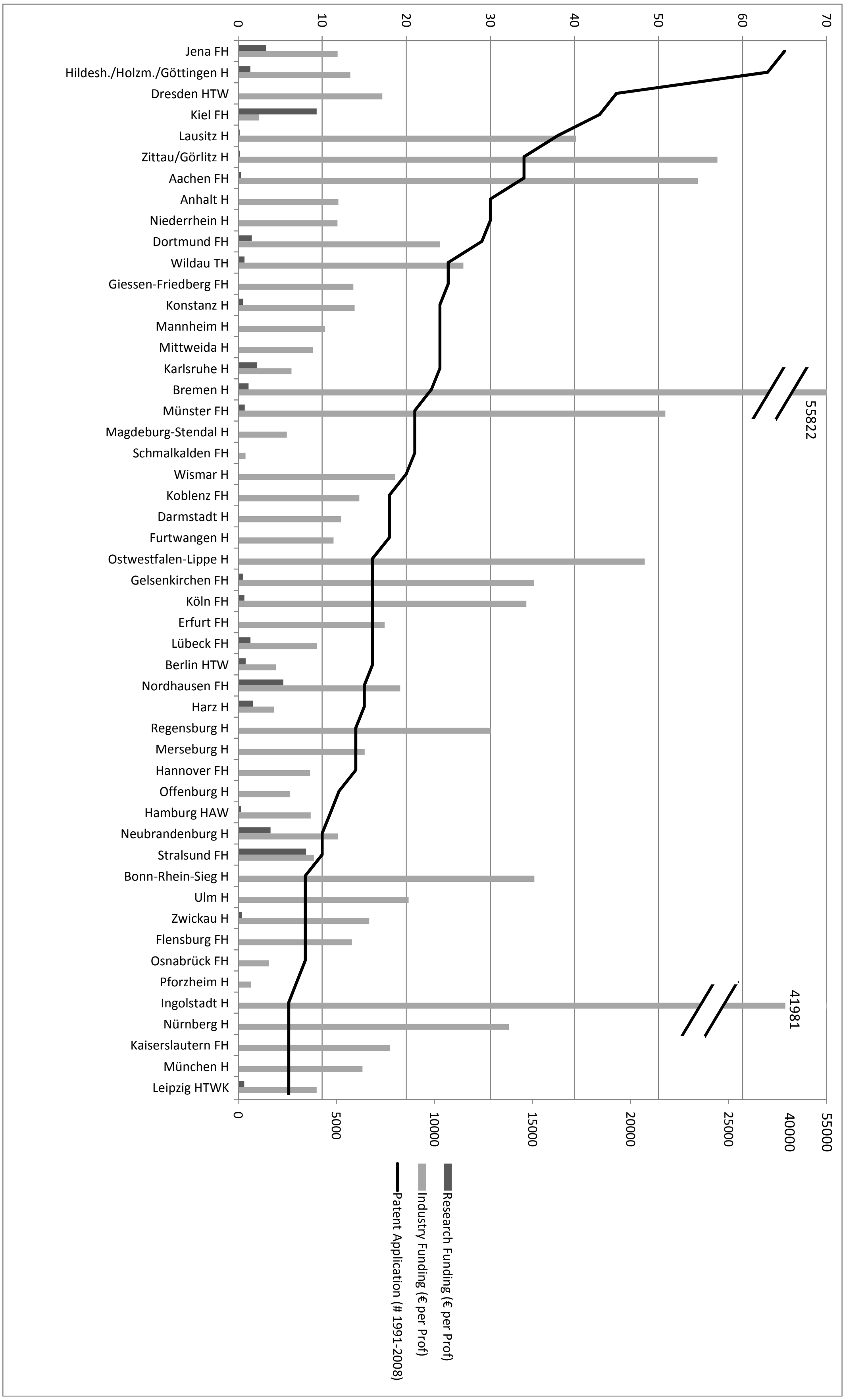
Table 3 Top 10 universities and UAS in terms of patenting applications

An examination on how this patenting activity is concentrated along the UAS reveals that ten UAS account for 37.8% of the patenting activity of all German UAS. Those UAS, providing 411 patent applications from the 1088 that can be associated with the UAS in our dataset, are listed in Table 3. In addition Table 3**Fehler! Verweisquelle konnte nicht gefunden werden.** shows that 15.9 (23.3) percent of patent applications are assigned to the Top 3 (Top 5) UAS, which hints at a high concentration of patenting activities (see also Graph 3).

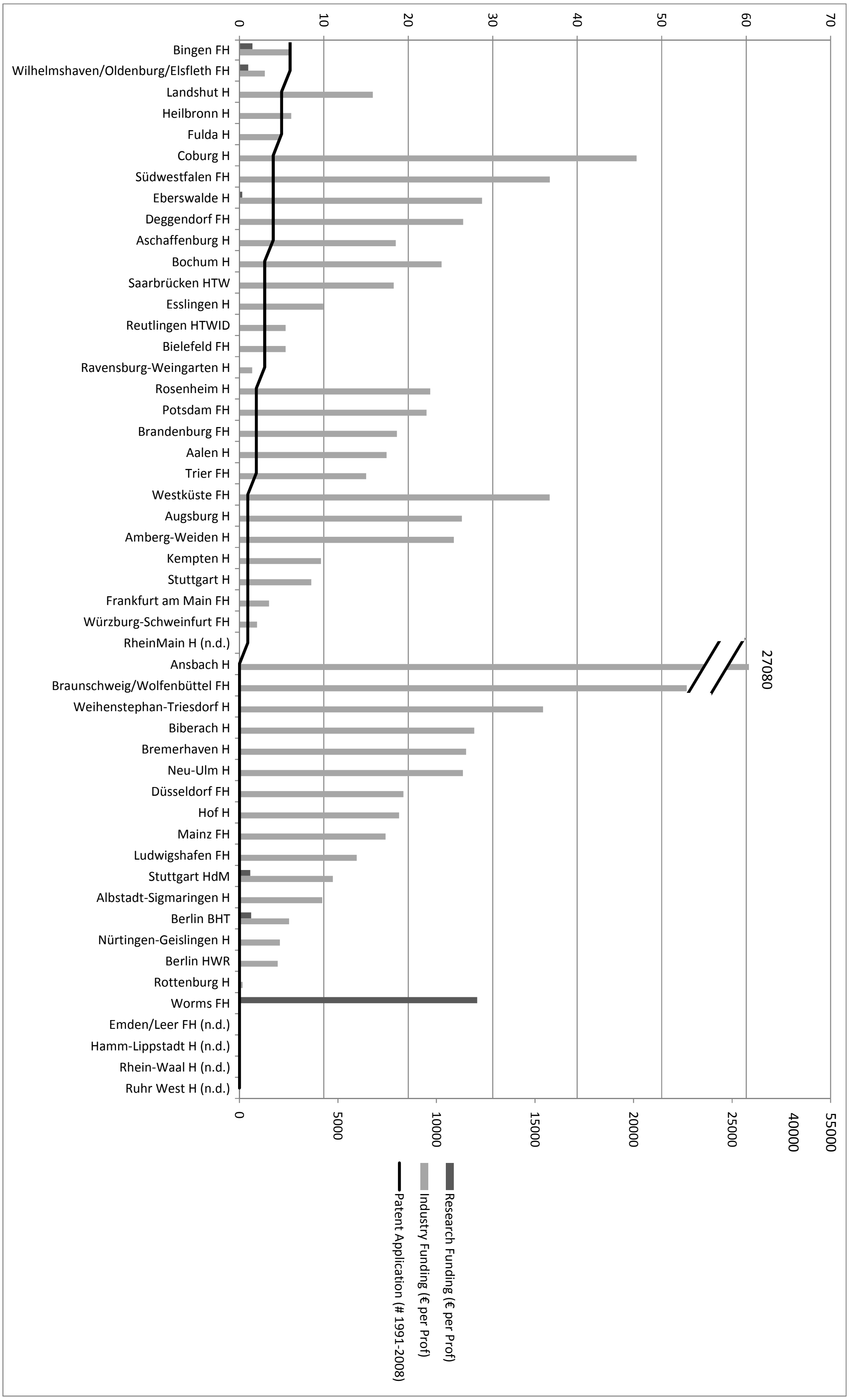
The linkage between public universities in Germany and their technology transfer performance has been examined in several studies (among others, Anselin et al., 1997; Audretsch, Hülsbeck, & Lehmann, 2011; Audretsch & Lehmann, 2005; Audretsch et al., 2005; Grimpe & Fier, 2010; Link et al., 2007). Therefore, we shift the lenses to a further examination of the UAS being a unique institution and responsible for applied research and education. Graph 3 and Graph 4 show all UAS in our dataset sorted by the total number of patent applications from 1991 to 2008. As stated already in Table 3 the distribution is very concentrated. For a further explanation two important factors explaining the orientation of the UAS are added – the amount of funding from the industry and the DFG.

The amount of research funding by the Germany Research Society (DFG) is often used as a proxy for research activity, since one has to signal research activity to get funding (Hornbostel, 2001). In theory more research potential should lead to more research and patenting activity. This could not be approved in Graph 3. While some UAS seem to follow this assumption, most of them do not. Consequently more research potential does not always result in more research activity, which is not new at all. However, it can be observed that research activity is significantly higher in Graph 3, displaying the higher performing UAS. This leads to the assumption that higher research activity could positively influence patenting activity in certain circumstances. Compared to the industry funding, the funding of the DFG does not seem to make any difference. Industry funding is the major financial resource of UAS. However, a high variance can be observed implying that there is no significant connection between the amount of industry funding and the technology transfer performance. This is proven by the fact that the top four UAS show a low amount of industry funding compared to the others. All in all this is surprising, especially since one would expect that the amount of industry founding accounts for the linkage between the UAS and the industry and therefore a better linkage is supposed to lead to a higher technology transfer performance.

There are four UAS that significantly exceed the others in terms of funding. The UAS in Bremen is mainly influenced by big companies like Daimler, Airbus, and EADS, who require for practical orientated experts. The high amount of industry funding of the UAS Ingolstadt is also due to the fact that the headquarters of Audi is located there. In addition the public university of Ingolstadt is focused on social science. Therefore the UAS is the only source for human resources required for their manufacturing processes. The UAS in Ansbach is close to companies like Siemens and MAN employing a high percentage of engineers. In contrast to these UAS and to all others, the UAS in Worms exceed all others by far in terms of getting funding from the DFG, which is also a signal for high research activities. The UAS in Worms is quite specialized by only having economics, tourism, and informatics departments, leading to the possibility of focusing on applied research in these fields.



Graph 3 Patenting Activity of Universities of Applied Science (Top 50)



Graph 4 Patenting Activity of Universities of Applied Science (Bottom 50)

In conclusion, there are structural differences between public universities and UAS in Germany resulting from the division of labor. However, although public universities are bigger in terms of many factors, controlling for size technology transfer performance is not higher than of the UAS. Taking a closer look at the UAS reveals that neither the linkage to the industry nor does the research activity explains the number of patent applications made by a UAS. Therefore, regional difference might be another explanation.

5. Regional Differences

Literature shows that knowledge is not distributed equally throughout regions, even if they are all within the same national innovation system (Cooke, 2001; Fritsch & Slavtchev, 2007). While some regions in Germany seem to be more prosperous, others – mainly found in the former German Democratic Republic – show an increase of unemployment and a decrease of economic activities (i.e. Hunt, 2006; Uhlig, 2008). This is in line with our examination of the 150 labor market regions (Eckey et al., 2006) in Germany. Regions in Germany seem to be very heterogeneous not only in terms of population but also economic indicators. Hence, to control for the size of a region, we use only per capita data (Table 4).

Variable	Obs	Mean	Min	Max	Median
Population	150	549453	63580	4442769	312523
GDP p.c.	143	25.18	15.78	44.48	25.52
Industry Patents p.c.[1,2]	150	0.45	0.02	1.83	0.38
Start-ups p.c.[1,3]	150	9.87	6.80	14.75	9.56

[1] multiplied by 1000
[2] Sum 2003-05
[3] Mean 2003-05

Table 4 Determinants of all labor market regionsin Germany

Although controlled for size, the determinants of LMR seem to be quite heterogeneous. The variables indicating size, overall performance, and innovation performance show huge differences between the lowest and highest value. Surprisingly, the mean and median differ little, which leads to the conclusion that both sides of the mean are equally distributed and that there are not just a few over performing regions that increase the mean of the indicator. Almost 0.5 patents and ten start-ups per 1000 inhabitants seem to be an impressive number. This underlines the impression of Germany as being an innovation, enhancing country.

To verify whether or not the differences could be explained by the presence of a UAS the regions where at least one UAS is located (79) are compared to where it is not (71). This is done via a two-sample t-test (with equal variances). Surprisingly, in Table 5 four variables show highly significant differences between these two groups, whereof the mean of the LMR with UAS is always higher. Once bending the rules a bit, industry patents per capita could also be regarded to show a significant difference between these groups, also with a higher mean for those including a UAS. Therefore LMR with UAS seem to be significantly better endowed and higher performing.

	Two-sample t test with equal variances			
	Population	GDP p.c.	Industry Patents p.c.[1]	Start-ups p.c.[1]
LMR without UAS	258626	24.09	0.40	9.57
LMR with UAS	810829	26.17	0.49	10.15
diff != 0	0.001	0.013	0.109	0.013

[1] multiplied by 1000

Table 5 Testing differences between regions

However, these positive implications could not account for the UAS without any doubt. The problem of endogeneity is quite obvious. UAS are located in regions with a high number of people living there and providing a higher overall performance per capita. Further research needs to be done to verify if those regions really developed better after the UAS was established or if the decision to build a UAS was based on the size and the economic power of the region. Another limitation of the study, is that of those LMR, a high percentage also hosts a public university (Lehmann & Starnecker, 2011). Although differences in population and GDP are hard to refer to the existence of a UAS, the number of patent applications of the industry as well as the number of start-ups in the region could be improved by a UAS. Due to their applied research they could be believed to enhance regional innovation performance. Again, more research is required to verify these assumptions.

Earlier examinations, especially Table 3, showed that a closer look on the differences between UAS in Eastern and Western Germany are necessary. Table 6 reveals that no significant differences concerning the source and the amount of funding as well as the student professor ratio between the UAS in the two parts of Germany can be observed. While Eastern UAS are significantly younger, higher economic performance can be observed in the regions of Western Germany. Those differences and similarities are expected, since Western Germany is still better developed than Eastern Germany, there have been numerous founding of UAS after the reunion of Germany, and there is no reason why there should be a better student-professor ration in either of those parts. Surprising is the higher but not significant mean of research funding per professor in Eastern UAS and of course the immensely higher performance of UAS in Eastern Germany in terms of patent applications. This leads to a simple but impressive conclusion: although having access to almost the same amount of funds and being located in less economically developed regions, UAS in Eastern Germany contra-intuitively over perform their Western counterparts in terms of patent applications as a proxy for technology transfer performance.

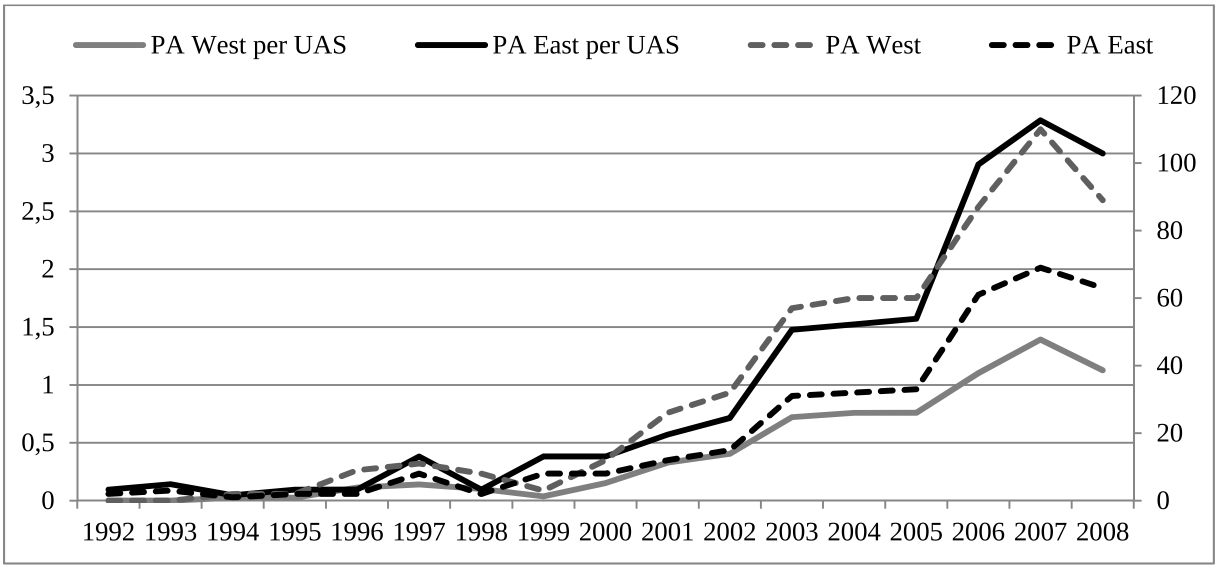
	Students per Professor[1]	Research funding p. P[2]	Industry Funding p. P.[2]	# Patents[3]	Age UAS[4]	Industry Patents p. c.[5]	Start-ups p. c.[6]	GDP p. c[7]
Western Germany	39.8	320	8847	8.4	32.0	0.002	0.011	27.87
Eastern Germany	40.8	512	7561	20.2	23.6	0.001	0.010	20.09
diff !=0	0.645	0.573	0.544	0.001	0.006	0.001	0.004	0.001
	Observation: West 74 / East 21				Observation: West 79 / East 21			Obs. 79 / 17

[1] in 2008
[2] in € in 2008
[3] Sum of Patents 1991-2008
[4] Based on year 2011
[5] Sum 2003-2005
[6] Mean 2003-2008
[7] in € 2004

Table 6 Comparison between UAS in Eastern and Western Germany

The importance of patents as a result of the linkage between the UAS and the industry increases. While being almost unobservable before the year 2000, the number of patent applications by the UAS has grown with high rates (Graph 5). This is in line with the implication of BMBF (2004) suggesting initiatives to increase the focus more on technology. Comparing Western and Eastern UAS again, one not surprisingly finds that UAS in the West have more patent applications. However, controlled for the number of patent application per UAS, the institutions in the East outperform the one in the West already since the mid-nineties. In addition, observing that the line of patent applications per UAS is more flat than the increase of the total number, while the lines of the Eastern universities seem to be parallel, concludes that the increase in patenting performance is more smoothly distributed in the East, which is important for a long-term success.

To sum up, there are regional differences that could to some extent, be referred to the existence of a UAS. Additionally, UAS in the less economically developed Eastern part of Germany leave the impression to make more out of their resources than UAS in the West. After the reunification of German policy makers started to found UAS in the Eastern part to support regional development by providing an applied higher education institution. In conclusion, it could be said, that what has started as a development program has become a high performing and technology transfer enhancing institution.



Graph 5 Comparing TT Performance of Eastern and Western UAS

6. Conclusion

The motivation behind the establishment of Universities of Applied Science (UAS) is simply the division of labor. While public universities in Germany are meant to focus on basic research, the UAS provide applied research and education. There are three major differences between universities and UAS. First, only universities have the right to confer a doctorate and to promote for professor. Second research and teaching in universities is dominated by theoretical approaches, while UAS are more practical oriented. Third, in contrast to public universities, UAS are not only located in the bigger German cities. Although the importance of UAS is well known (BMBF, 2004) and the number of UAS exceeded the number of universities (Lehmann & Starnecker, 2011), their potential is still underestimated (Hamm & Wenke, 2002).

However, right after the reunification of Germany, the government established several UAS in the former communist part to quickly improve the educational level and to develop the economy. In Eastern Germany UAS are still located in areas with lower economic (GDP) and innovation (industry patents, start-ups) performance, than their Western counterparts. However, they show similarities in the student professor ratio as well as in the source and amount of funding. Surprisingly, Eastern UAS outperform in technology transfer. This simply concludes that although having access to almost the same amount of funds and being located in less economically developed regions, UAS in Eastern Germany contra-intuitively outperform their Western counterparts in terms of patent applications as a proxy for technology transfer performance.

This paper adds to the literature by shifting the lenses to a uniquely higher educational institution being unjustifiable underestimated. The results of this paper provide first insights in the important role UAS play in the technology transfer process. First, although universities are considered to be better in technology transfer performance, UAS come up with approximately the same amount of patent applications per professor. Second, regarding the sources of funding, besides the government, firms are the most important partner of UAS. Third, neither industry cooperation’s nor research activity seems to explain the technology transfer performance. Fourth, UAS in Eastern Germany succeed in their objective of improving regional development and by the way out perform their Western counterparts, who are exposed to a way better economic structure.

However, this study only provides a first step into this field to improve the perception of UAS. Further research should address the incoming factors of the technology transfer process in UAS as well as the outcome before explaining the black box itself. Other studies could also look at comparable institutions in other countries to see if results could be generally applied to higher educational institutions like the UAS.

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