German University Patenting and Licensing: Does Policy Matter?

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Abstract

This paper presents work in progress to a broader research programme on German and European universities' technology transfer activities. We investigate the effects of the German Employee Invention Act (2002) by comparing the patenting behaviour of universities over three distinct time periods before and after the law is introduced to find out whether it constitutes a discernible change in university patenting. In a second model we take a closer look on the institutional determinants of university-to-industry technology transfer under the new law. In the two periods prior the new law the age of the first patent significantly influences the total number of patents significantly; this effect vanishes in the third period, where only the number of patents filed in earlier time periods does have a significant effect. These results suggest that the new law was able to disturb existing path dependencies but still patent experience plays a key role in university-to-industry technology transfer.

1. A Model of University-Industry-Technology-Transfer

Our research programme investigates the early stage (2002-2006) of German university technology transfer under the new law to explore a) the effects of the changed law of university patenting and licensing behaviour and b) the effects of regional, institutional, and organisational determinants on the effectiveness of university-to-industry technology transfer (UITT). We aim to contribute to the broader strand of technology transfer literature by firstly augmenting the international empirical evidence on UITT and secondly by integrating existing knowledge about university patenting and licensing on institutional, organisational and individual level (Phan and Siegel 2006).

The measurement of technology transfer and its effectiveness is a complex business. Not only the term 'technology' has to be defined, but also the transfer process delineated and measurement categories have to be chosen (Bozeman 2000). This paper is a first step to a broader research programme on German and European universities' technology transfer activities; therefore our analysis of UITT is restricted to the effects of the new Employee Invention Act on patenting activities of German Universities. This allows a simple definition of technology (everything that is patentable) as well as the deduction of a simplified linear two step model of the technology transfer process (Friedman and Silberman 2003). Following the findings of Siegel et al. (2003) that invention disclosures are the most important input for UITT as they represent the known pool of transferable technology, the first step covers the process from invention disclosure to patent; the second step covers the process from patent to licence and so crosses the university-industry boundary. This approach allows us to use the number of licences as a simple measure of UITT effectiveness[1,2], because the generation of additional income is the strongest incentive for universities to get involved in technology transfer (Thursby, Jensen and Thursby 2001). We acknowledge the fact that this simplified process-model might not be able to capture the whole context and complexity of university-to-industry knowledge transfer.

According to Carlsson and Fridh (2002) the effectiveness of UITT cannot be described by simplistic input (invention disclosure) -output (patents, licences) -models but is influenced by characteristics of regional, institutional, organisational and individual contexts (Phan and Siegel 2006) which are summarised in Figure 1.

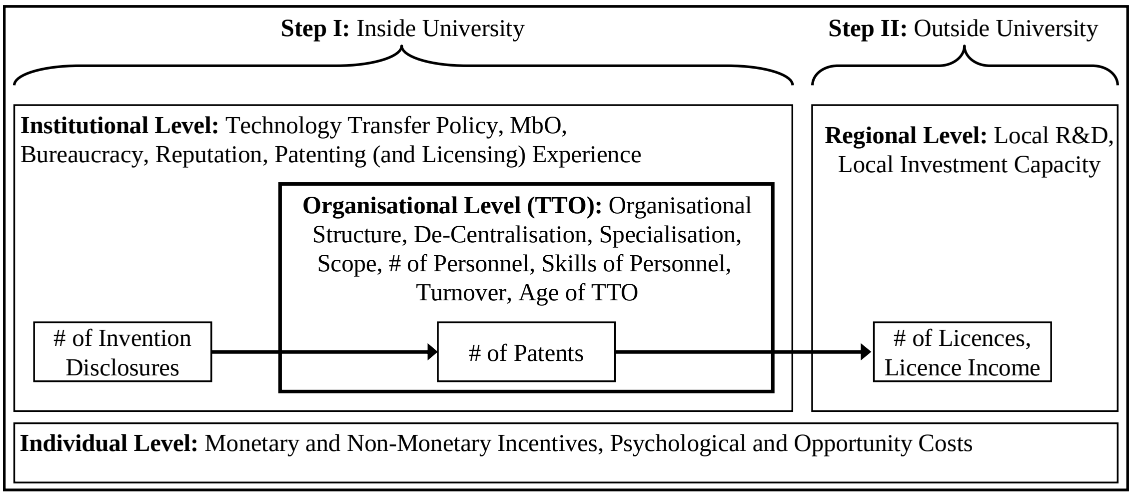

Figure 1: A Model of University-to-Industry Technology Transfer

On a regional level the effectiveness of technology transfer depends on the industry's absorptive capacity for innovation in terms of ability to invest in new technologies and the presence of high-tech firms that create demand for technological spillovers (Carlsson and Fridh 2002; Siegel et al. 2003; Chapple et al. 2005; for Germany see Audretsch et al. 2006, Audretsch and Lehmann 2005a,b).

[1] This is especially true for the case of German universities as related mechanisms of technology transfer e.g. holding equity positions in private start-up companies (or trading patents, licences or consulting for equity) are forbidden under federal law.
[2] While licences are a measure for technology transfer, patents indicate the existence of transferable knowledge.

The institutional layer of the model is described by the policy of a university and its departments. UITT tends to be more effective if universities actively promote a policy of technology transfer that is documented in the universities' mission statement and in MbO-agreements with the TTO, and if the bureaucratic position (e.g. reporting structures, hierarchical level of TTO Director) of the TTOs allows to influence university policy (Carlsson and Fridh 2002; Friedman and Silberman 2003). At the same time the presence of medical, engineering and scientific faculties is a sine qua non for effective UITT because these departments generate almost all university patents (Jensen, Thursby and Jensen 2001). Furthermore Sine et al. (2003) have shown that universities with better overall reputation are likely to licence more technologies to firms than predicted by their past performance.

The organisation and personnel of the TTO as a moderator of technology transfer effectiveness has received most attention in the literature so far. Bercovitz et al. (2001) have shown the implications of different organisational structures of TTOs concerning information-processing capacity, coordination capability, and incentive alignments and its impacts on technology transfer effectiveness. In a similar way Carlsson and Fridh (2002) discuss the effects of scope of activities and structures. Debackere and Veugelers (2005) suggest central services to support patenting and licensing, as well as specialised and decentralised units that actively stimulate patentable research within the academic departments. Furthermore, both they and others (Carlsson and Fridh 2002; Siegel et al 2003; Chapple et al. 2005) postulate a balanced skill-set of managers, scientists, and lawyers within the TTO personnel. Another important element of patenting and licensing success is the experience and learning of the TTO and the employee turnover (Mowery et al 2002; Siegel et al. 2003).

The individual level of technology transfer effectiveness is solely concerned with the incentives for stakeholders (Friedman and Silberman 2003; Markman et al. 2004). The most discussed aspect is the income-split between inventor and university and its effect on invention disclosures. Moreover there are non-monetary incentives influencing the amount of invention disclosures. Like others, we assume that the likeliness of an invention disclosure is closely related to the expected opportunity and psychological costs an inventor has to bear when starting to participate in UITT. These costs are likely to rise with administrative and communicative barriers (physical distance to TTO, poor expertise of TTO-officers) and are likely to diminish with active support and service by the TTO, a university history of effective patenting and licensing ("success stories"), a competitive but supportive peer group, and scientific reputation from disclosing respectively patenting inventions (Owen-Smith and Powell 2001; Siegel et al. 2003).

After this introduction the paper is organized as follows. Chapter 2 focuses on our current interest within our research programme explained above. Chapter 3 explains the research method employed, and the fourth chapter presents the empirical results. The paper concludes with a short summary.

2. The Effect of the Employee Invention Act on the Institutional Level of University-to-Industry Technology Transfer

The enactment of the so called Bayh-Dole-Act (1980) in the United States allowed universities to patent and licence inventions resulting from federally funded research and simultaneously obliged researchers to disclose all inventions made under a federally sponsored program. This policy created strong incentives to generate licensing income through technology transfer along with the need to efficiently protect intellectual property rights and to coordinate patenting and licensing activities: US universities set up Technology Transfer Offices (henceforth TTOs) as organisational entities to achieve these tasks. (e. g. Bozeman 2000; Agrawal 2001; Bercovitz et al. 2001; Goldfarb et al. 2003)

At about the same time German universities began to take share in patents[3] from faculty researchers and to establish their own TTOs[4] to institutionalise their technology transfer efforts. However incentives similar to the Bayh-Dole-Act did not exist in Germany: German faculty members were free to patent privately with neither the need to disclose their inventions nor to share licensing income with their department or university (Schimank 1988).

Without the strong incentive structure of their US counterparts German TTOs were not understood as university-agents with the task to protect and market intellectual property rights (Coupe 2003; Hoppe and Ozdenoren 2001), but as mediators and industry-relations departments of the university administration. This was done mainly for the benefit of the industry that was trying to utilise new basic technologies to escape the economic recession of the eighties. The main activities of these TTOs were to participate in trade fairs, to collaborate with chambers of commerce or to host round tables for companies and researchers. Accordingly, the TTO’s success was measured by ratio of “mediations per employee and year” (Schimank 1988). The history and policy background of German and other Continental-European TTOs (see Goldfarb and Henrekson 2003 for Sweden;

[3] The first patent held by a German university dates back to 1960. In the period from 1960 to 1982 university-held patents accumulate to 18. In 1983 the yearly patenting activity rose to 22 patents and has risen ever since to an average of 591 patents per year in the period of 2002-2006.
[4] The first German TTO was established in 1976. By 1988 25 of the 56 (West-)German universities had established their own TTO.

Saragossi and Pottelsberghe 2003 for Belgium) significantly differs from the ones of the US and UK TTOs that are subject to investigation in the existing literature.

The situation of German University Patenting changes in 2002 with the amendment of the Employee Invention Act. From now on university researchers are obliged to disclose their inventions to their universities and the universities are entitled to patent and licence these inventions (ArbNErfG 2002). This law was meant to create incentives for universities and university-inventors alike to patent new knowledge from research. Inventors are guaranteed a 30% share of the gross income, while universities have to bear the costs of the patenting process, but are entitled to hold and exploit the intellectual property rights by licensing patents to the industry. This policy change aimed to establish incentives and structures comparable to those in the United States.

The patenting of inventions by universities can be viewed as a preliminary stage of university-to-industry technology transfer: By patenting, new knowledge emerging from research is codified and made transferable. Therefore, patents cannot be used to measure technology transfer itself, but as an indicator for the pool of transferable knowledge. The bigger this pool the more likely UITT will occur. The size of this knowledge-pool is determined by a) the resources contributing to and the barriers impeding the production of new knowledge, and by b) the patenting history of the university (e.g. learning effects).

Resources and Barriers

In university-research the most critical resource is human capital. The accumulation of scientists and engineers in a university implies a higher quantity of available human capital, which is linked to the ability of new knowledge creation

(Powers 2003). Zucker, Darby and Armstrong (2002) have argued that "star" scientists are more able to capture rents from their intellectual capital, and Gregorio and Shane (2003) have shown that an increase in university-wide quality rankings leads to disproportional higher technology transfer. Therefore the *faculty quality* should have a positive impact on UITT. These aspects are moderated by the overall orientation of the university. Obviously a university without medical, science or engineering faculties will not be able to generate large amounts of patentable knowledge (cf. Jensen, Thursby and Jensen 2001).

Another critical resource is third party funding of research activities. It is a well known fact that average budgets for research of public universities are small. Hence research funding by third parties like the industry or national research funds is a prerequisite for knowledge creation and at the same time an indicator for faculty quality. Blumenthal et al (1996) have shown for Life Sciences, that industry funding generates more transferable knowledge (patent applications) and technology transfer (new products). Despite the growing industry interest in supporting basic research, national research agencies, scientific foundations, and EU-research framework programmes are the largest sponsors of research. These providers of research funding are more and more concerned about the spending of their money and the expected value of their money in terms of transferable knowledge (O'Shea et al 2005).

The efficient use of these human and financial resources can be hindered by numerous organisational and individual factors (see above). Amongst those the *teaching workload* of researchers could be seen as one very influential aspect. Every German professor and almost every associate professor and research assistant is expected to spend significant time teaching; pure research posts are relatively rare.

Obviously, the more working hours have to be invested in teaching efforts, the less time remains for research activities.

Furthermore the TTO can be more or less efficient in supporting research staff (e.g. discover patentable knowledge, disclose inventions…) and in fulfilling their task as property rights agents (e.g. deciding to patent or not). Thus, the organisation of technology transfer within the university itself influences the creation of transferable knowledge.

Path Dependence and Experience

It is very likely that a "history and tradition" (O'Shea et al 2005) of patenting leads to more patents in the future. Over time a university accumulates relevant knowledge about the patentability of certain types of technologies and innovations, about patenting processes, marketing, and licences. Phan and Siegel (2006) note the importance of this kind of path dependence: As university bureaucracy and policies tend to evolve slowly, early technology transfer experience creates more technology transfer in subsequent periods (O'Shea et al 2005).

In this paper we are going to investigate the effects of the new law by comparing the patenting behaviour of German universities over three distinct time periods before and after the law is introduced to find out whether or not it constitutes a discernible change in the incentive structure: The early stage (T_1) of patent activities of German universities starting with the beginning accumulation of patents in 1981 and ending in 1993 after the reunification of the Federal Republic of Germany (FRG, "West"-Germany) and the German Democratic Republic (GDR, "East"-Germany), the post-reunification-era (T_2) from 1994 to 2001 which is characterised by a significant rise in patenting activity and the years from 2002 to 2006 after the introduction of the new Employee Invention Act. The patenting behaviour of German universities of the three periods is illustrated in Table 1.

Table 1
Descriptive variables on the patenting activity of German universities

	1981 – 1993	1994-2001	2002-2006	1981-2006
Average age of first Patent	-	-	-	12,1 years
Number of *new* patents	908	1844	2953	5705
Number of universities holding patents	25	44	66	66
Number of *new* patents per university	36,32	41,91	44,74	86,44

We will restrict our analysis to the institutional level of our model to explore the factors of new knowledge production mentioned above, and more importantly the effects of institutional learning and exogenous shocks on technology transfer, independently of other possible influences. Therefore we treat the organisational level as a black box, because the universities' TTO cannot influence the resources and barriers and will most likely not be the cause but a symptom of institutional learning. Likewise we expect the regional level to have impact on licences, but not on patents (we still control for regional GDP). The partial model is visualised in Figure 2.

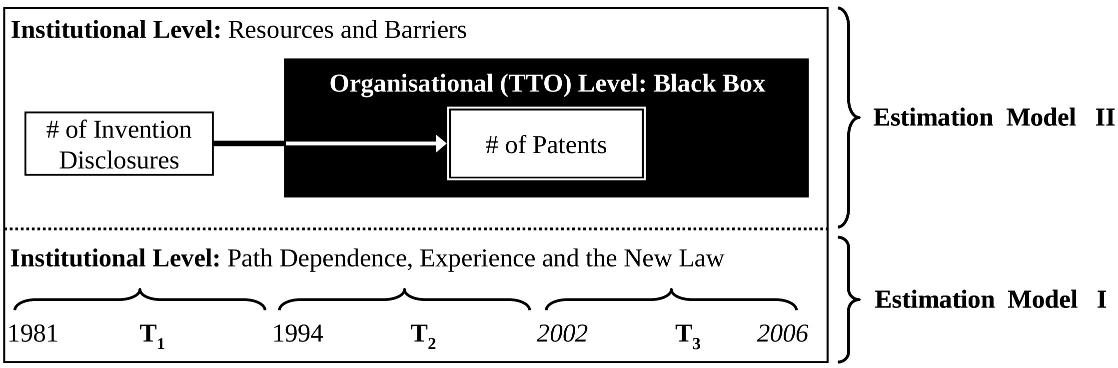

Figure 2: The Institutional Level of University Patents

3. Research Method

To test the impact of the new patent law incorporated in 2002 on patent activities of universities we estimate two different models. The first model describes the link of the number of patents per university to patent experience and changes within this linkage over three distinct time periods. The second model explores further institutional determinants of the number of patents for the third time period.

Sample and data collection

For this study we gathered data from all German universities through database and survey sources. Our input data comes from the internet database of the German Patent Office (www.depatisnet.org), the Federal Office of Statistics (www.destatis.de) and from the research ranking of the Centre for University Development (www.che.de). Additional data was collected from university websites.

The selected sample (66 of 73 universities) consists of all universities that report (on their website) to have institutionalised their technology transfer efforts (via TTO) and have filed at least one patent since 1960. The seven universities that are excluded are mainly universities of fine arts, philosophy, and social sciences, as well as one private[5] medical school (Universitaet Witten-Herdecke) and the University of Bamberg (no patents filed).

Endogenous variable

The number of patents held by each university is used as an endogenous variable in both models. This information is collected from the German Patent Office.

[5] 70 of 73 German universities are publicly funded; in contrast to the US. There are no land grant institutions or privately funded universities.

We use this variable as the endogenous variable to show whether or not, and how the number of patents is influenced by time periods and by individual characteristics of the universities. In the first model we use three different count numbers for three different time periods: First, the period from 1981 to 1993, the period from 1994 to 2001 and the third period covers the time period after the new patent law from 2001 to 2006.

Exogenous variable (model I)

The exogenous variable (also obtained from the German Patent Office) is the age, measured in years, of the first patent registered. As mentioned earlier, this time span may serve as a proxy for both, path dependences and experience. Furthermore, this variable also shows that the respective university invested in patent activities some time ago. Like said, only 44 of the total of 66 public universities have one or more patents before 2001.

Control variables (model I and II)

The next two variables are introduced to measure the main focus of a university. In particular, we control for the existence of a medical school and engineering faculties. These variables were gathered via the universities websites. Finally we control whether the university is located in the former GDR or, nowadays, in East-Germany.

Additional variables (model II)

As discussed above the number of patents filed might be moderated by the TTO-effectiveness and so we use the number of invention disclosures to the TTO as an additional measure of transferable knowledge. We assume that the number of inventions is shaped by the resources and barriers discussed. A three year average (2002-2004) of the amount of research of grants from industry and public research institutions, the number of publications and citations in SSCI-Journals are used as a proxy for faculty quality. These variables are taken from the 2006 research ranking by the Centre for University Development. The teaching workload is measured by the ratio of students per professor. The number of students and professors per university was obtained through the Federal Office of Statistics. Additionally, we control for the relative performance of the regional industry (GDP per capita), as it might influence third party funding and the number of invention disclosures. Regional GDP and the number of inhabitants were obtained from the Federal Office of Statistics.

Model specification for model I

As the number of patents is not normally distributed and is also censored at the left side (22 universities have no registered patents before 2001), we could apply negative binomial regressions method to estimate the coefficients or a left censored Tobit model. To make the results more comparable, we show the results from the negative binomial regressions instead of the Tobit model, since the endogenous variable is only left censored in the first time period from 1981 to 1993. In particular, we estimate the following model:

$$\text{(I)} \qquad \#\text{patents}(\mathrm{T}=1,2,3) = const. + \beta_1(\textit{age of the first patent}) + \beta_2(\textit{medical school}) \\ + \beta_3(\textit{engineering faculties}) + \beta_4(\textit{East} - \textit{Germany}) + \varepsilon$$

with T_1 (1981-1993), T_2 (1994-2001) and T_3 (2002-2006). The results are presented in table 2.

However, to control whether or not the incentives of the patent law are strong enough, we use a second regression model. In this model we also include the number of patents registered in the period before to control for learning and experience instead of new incentives. Thus we use the same regression model as shown above (I), but in addition we include the number of patents from the previous period(s) as new exogenous variables. The results are shown in table 3.

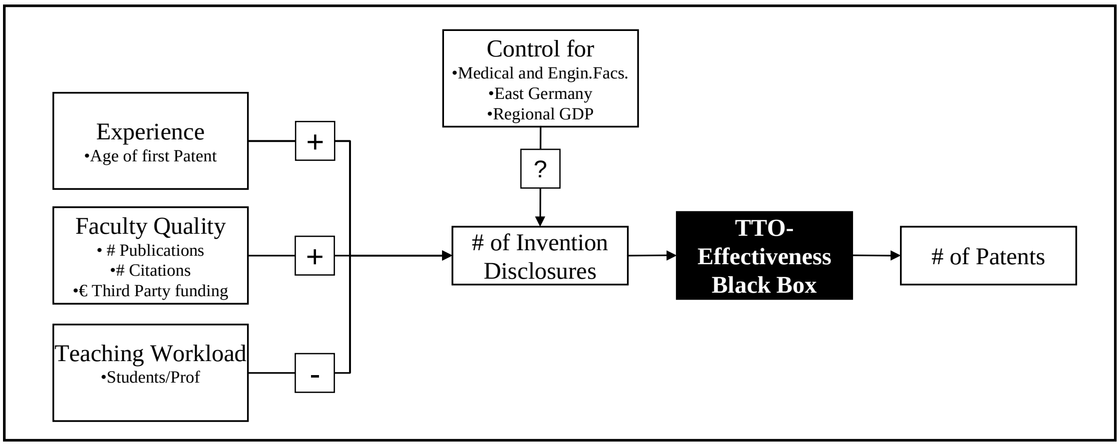

Figure 3: Patents as a Function of Invention Disclosures

Model specification for model II

We use a 2SLS approach to estimate whether or not, and how the number of patents is shaped by determinants others than the type of university. Unfortunately, so far we only have some information about the research and teaching activities for the last time period. We assume that (see Figure 3) the number of patents registered is a function of the number of inventions, and that the number of inventions is positively shaped by the institutional patent *experience* and *faculty quality* and is negatively shaped by the *teaching workload* of the professors. In particular, we estimate the following model:

$$\text{(II)}\quad \#\,patents = const. + \beta_1(\#\,inventions) + \beta_2(medical\ school) + \beta_3(engineering\ \ faculties) + \beta_4(East-Germany) + \varepsilon$$

and

$$\#\,inventions = f(age\ of\ the\ first\ patent;\ \#\,publications\ per\ year;\ \#\,citations\ per\ year;\ \text{€}\,research\,grants;\ students\ per\ professor,\ regional\ GDP) + \gamma$$

The results of the Two-Stage Least Square Estimations are shown in Table 4.

4. Empirical Results

Table two shows the results from the first regression. In the first column, the number of patents from the time period 1981 - 1993 is taken as the endogenous variable. During this period, public universities either show patent activities or not. There was no public pressure or pressure from the government for high research activities like the patents or publications in high quality journals in West Germany. During this period it is the individual incentive of each researcher to publish or to invest time in patent activities.

The results show that the age of the first patent enters the regression significantly. We also tested for non-linear effects, including a square term, but the coefficient of the square term remains insignificant in all regressions, so we dropped it. The positive and highly significant effect of this coefficient could be interpreted in two ways. Firstly, it shows that there are some universities which are engaged in patent activities while others are not. Secondly, the number of patents is increasing with the age of the first patent due to learning effects or self selection effects for researchers which are interested in patent activities. The number of patents is also driven by the type of universities, namely that medical schools are the main drivers of patents of public universities.

Another interesting result is the high and significant effect of the dummy variable indicating that a university is located in East Germany. In the former GDR, the government heavily invested in two prestigious universities: The famous Charité located in Berlin (nowadays part of the Humboldt University) and the Technical University of Dresden. While the Charité is focused on the medical sector, the Technical University of Dresden has its focus on engineering. Both universities have a higher number of patents compared to universities in West Germany during that time.

In the second column, the number of patents from the time period 1994 to 2001 is taken as the endogenous variable. As before, the age of the first patent enters the regression significantly. However the absolute value of the coefficient is lower compared to the first regression and also the z-value is lower.

Table 2

Results of the Negative Binomial Estimation: What explains patent registration of public universities?

The endogenous variable is the number of patents registered for each university. [a] *Estimated regression coefficients,* [b] *Absolute (z)-values in parentheses,* *$^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.*

N=66	1981 – 1993	1994 -2001	2002 - 2006
Age of the First Patent (years)	0.3421 (5.86) ***	0.1508 (4.83) ***	0.0351 (1.61)
Medical School	1.4231 (2.72) ***	0.800 (2.10) **	0.531 (1.89) *
Engineering Faculties	-0.1923 (1.64) *	0.1617 (1.87) *	0.165 (2.10) **
East Germany	1.0952 (1.96) **	0.490 (0.95)	-0.573 (1.80) *
Constant	-5.262 (5,17) ***	-0.057 (0.13)	2.844 (9.16) ***
LogPseudoLL	-107.109	-233.599	-310.607

The third column shows the results for the period from 2002 to 2006. The positive and significant effect of the age of the first patent disappears. As not shown in table 2, all public universities published at least one patent since 2001. Also the number of all patents increased dramatically. However, medical and engineering faculties seem to be the most important source of new patents, although the absolute value of the coefficients decreases over time. The dummy variable indicating the location in the former GDR changed the sign and now enters the regression negatively and significant.

Summing up, the results show that the new patent law changed the innovation behaviour of public universities as measured by the number of patents. Interestingly, the age of the first patent enters the regression positive and significantly in the periods before 2002. Thus, some universities were very active in patenting new innovations while others were not.

Next, we run the same regressions as above but include the number of patents in the previous periods as exogenous variables.

Table 3

Results of the Negative Binomial Estimation (Robust): What explains patent registration of public universities?

The endogenous variable is the number of patents registered for each university. [a] *Estimated regression coefficients,* [b] *Absolute (z)-values in parentheses,* $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

N=66	1981 – 1993	1994-2001	2002-2006
Patents 1981 - 1993	-	-0.0011 (1.36)	0.0067 (6.06) ***
Patents 1994 - 2001	-	-	0.0021 (4.00) ***
Age of the first patent (years)	0.3421 (5.86) ***	0.1543 (4.65) ***	0.0019 (0.09)
Medical School	1.423 (2.72) ***	0.8143 (2.12) **	0.0991 (0.35)
Engineering Faculties	-0.1923 (1.64) *	0.1586 (1.82) *	0.0422 (0.68)
East Germany	1.085 (1.96) **	0.4896 (0.94)	-0.7815 (3.03) ***
Constant	-5.263 (5.17) ***	-0.089 (0.20)	3.404 (10.66) ***
LogPseudoLL	-107.1091	-233.499	-304.241

While the first column of table 3 shows the same results as in table 2, the second regression does not really differ from the one presented before in table 2, although the number of patents is included. The third regression provides new results. Now, the number of patents of the previous periods enters the regressions significantly. Their positive sign clearly indicates that those universities with a higher patent activity in the past show a higher patent activity in the period after the new law came into effect.

Table 4

Results of the 2SLS Regression: Institutional Determinants of patent registrations

The endogenous variables are the number of inventions (instrumented) and the number of patents registered for each university in the period 2002-2006. [a] *Estimated regression coefficients,* [b] *Absolute (z)-values in parentheses,* $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

Method	OLS	OLS	2SLS
Endogenous Variable (N=66)	Inv. Discl. 02 - 04	Patents 02 - 06	Patents. Inv. Discl.
Invention Disclosures 02-04	-	0.3675 (1.93)*	0.7009 (3.65)***
Patents 1981 - 2001	0.1839 (3.07)***	0.2708 (3.11)***	Instrument
Age of the First Patent	-1.5094 (-1.84)*	-1.6322 (-1.45)	Instrument
Publications / Year	-0.1657 (-0.28)	0.0947 (1.21)	Instrument
Citations / Year	0.0068 (1.03)	-0.0126 (-1.42)	Instrument
€ Research Grants / Year	0.0008 (1.55)	-0.0004 (-0.56)	Instrument
Students / Professor	-0.0795 (-0.40)	-0.7772 (-2.96)***	Instrument
Regional GDP/Capita	-0.3547 (-0.87)	0.1799 (0.33)	Instrument
Medical School	19.9655 (1.29)	12.3366 (0.59)	-8.8747 (-0.45)
Engineering Faculties	-6.2128 (-1.59)	12.9765 (2.43)**	13.7475 (3.29)***
East Germany	-5.5384 (-0.40)	0.0605 (0.00)	24.7481 (1.35)
Constant	48.9756 (2.48)**	55.8654 (2.01)**	-21.1385 (-1.32)
R^2	0.7479	0.5778	0.3113

Table 4 present the results from the 2SLS regression. While the variables for institutional experience and teaching workload show the assumed positive and negative correlations to the number of patents, the results for faculty quality variables are mixed. On the one hand the number of publications enters the regression positive; on the other hand the number of citations is significant and negative. One possible explanation of this puzzling finding could be the often discussed trade-off between publishing and patenting of innovations. The number of citations may depend heavily on the significance of the published knowledge, while the number of publications may depend on additional factors (networks, research paradigm…). So one could imagine that researchers who publish more significant knowledge - as measured by citations – invest less effort into patenting. Furthermore the significant value in table 4 indicates that the number of inventions is a function of inventions.

5. Summary

The results clearly show that the amendment of the Employee changed the innovation behaviour of public universities as measured by the number of patents. In earlier periods the number of new patents can be explained by path dependence: the older the patenting experience the more likely new patents will be filed. The 2002 amendment of the Employee Invention Act interrupted this pattern and so the age-effect is replaced by the prior patenting experience of the universities. The most patents still emerge from the most experienced universities. The new law as a "prescribed incentive" seems to work.

Obviously learning and experience can not be the only determinants of university patenting or technology transfer. As shown above there are additional factors like the faculty quality, teaching workload and invention disclosures. The relation between inventions and patents is moderated by the organisation of technology transfer within the university, in our further research we intend to open this black box.

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