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The Effects of University Status on Scientific Output in Sweden

by

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Abstract: The Swedish higher education system experienced a dramatic expansion since the 1960s. In the late 1990s and early 2000s, four higher education institutions obtained university status. As a result, scholars based in these universities enjoyed greater access to research resources. This study aims to utilize the 1999-2005 expansion to estimate the effects of increased access to research funds on scientific output. At the heart of this research is a database documenting the number of publications and citations of researchers employed in Swedish higher education institutions between 1996-2011 (the PARIS database). To estimate the relationship between obtaining university status and research output, a two-way fixed-effects difference-in-difference with multiple treatment timing methodology is applied. A statistically significant increase of 18.8%-66.9% in publication following the change in university status was found. While the effect of the number of publications is found to be robust, the impact on their quality remains unclear. In line with previous studies, the results of this paper shed some light on the impact of increased research funding on scientific publications in Sweden. Alongside potential contribution to policymakers, these results join the academic debates on the relationship between research funding and scientific output, as well as the effects of decentralization of higher education systems.

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Introduction

Across the industrialized world, governments invest substantial resources in their university and academic systems, seeking to promote scientific research. However, little is known about the effects of research funding on scholars' productivity in Sweden. In 1999-2005 four Swedish university colleges obtained a university status: Karlstad, Örebro, Växjö, and Mid-Sweden (Sjölund, 2002; Holmberg and Hallonsten, 2015). The main difference between a university college and a university in Sweden is the ability to access public research funds crucial for their ability to conduct research (Hallonsten and Silander, 2012). Yet, no previous study estimated whether this status change actually affected the scientific output of scholars based in these institutions. Understanding and quantifying the links between these status changes and the production of scientific knowledge is therefore of value to both policymakers and scholars studying and designing the Swedish research infrastructure.

Since the mid-1960s the Swedish higher education system experienced great transformations. The demand for higher education increased rapidly, and the state had to expand its higher education system capacity (Askling, 1989). An important milestone in the development of the Swedish higher education system was the 1977 reform. This reform led to the establishment of new higher education institutions, geographically spread, and with a different institutional setting. One of the major changes this reform introduced is the establishment of many new university colleges (in Swedish: *högskolor*[1]). These institutions were initially formed to meet the de-

[1]The 1977 reform resulted in redefinition of the word högskolor. As Sköldberg (1991) noted: "Before 1977, of högskola meant a non-university institution of higher education ... In the 1977 reform, the term was redefined to mean 'institution for higher education', imposing the concept of högskola on the whole structure. Not only were the non-academic professional schools raised to academic status, but the universities were henceforth to be named högskolor, which they naturally perceived as a degradation ... There is no good translation that catches the Swedish meaning of the word. 'College' is somewhat related to it but does not quite agree with the Swedish semantics." (p. 559). This work will use university college or college to describe a non-university and non-vocational school higher education institution.

mand for higher education and therefore were assigned to only provide education, without having any research activities (Hallonsten and Holmberg, 2013).

However, during the decades following their establishment, an increased tendency to conduct research developed in some of these university colleges. By the early 1990s, some university colleges developed limited research capacity and stressed the need for a government policy allowing them to expand those activities (Hallonsten and Holmberg, 2013). Following some limited in scope changes that took place during the first half of the 1990s, three universities were granted university status in 1999 (Karlstad, Örebro, and Växjö), and one in 2005 (Mid-Sweden). The process of upgrading the status of these institutions included a professional review of their capabilities, in order to assess whether they meet the conditions to become universities (Sjölund, 2002). However, as Sjölund (2002) noted "politics proved to be a much stronger force than the quality review" (p. 173), making the process unpredictable.

Importantly, obtaining university status is not only a ceremonial action. In Sweden, the level of access to public research funds of higher education institutions is determined by the status of the institutions. Therefore, once a university college becomes a university, it increases the ability of its researchers to obtain research funds (Hallonsten and Silander, 2012). This feature of the Swedish higher education system facilitates the link between university status and increased public research funding at the scholars' disposal, central to this work.

Scholars have debated the effects of funding on the scientific output of university researchers. While the existing literature seems to agree on a positive impact of research funding on publications, there is little evidence regarding any causal effect on citations (as a measure of publication's quality) (Payne and Siow, 2000; Arora and Gambardella, 2005; Adams, 2009; Jacob and Lefgren, 2011; Zucker et al., 2007; Whalley and Hicks, 2014; Rosenbloom et al., 2015; Ebadi and Schiffauerova, 2016; Beaudry and Allaoui, 2012; Bolli and Somogyi, 2011). However, this study aims to address several drawbacks and deficiencies in the literature. First, as noted above, this would be the first attempt to study the individual-level effects of university status on scholars in Sweden. Second, by using the change in university status as a proxy for increased funding, this work's identification strategy offers a more robust quasi-natural experiment setting than other studies. Third, unlike a common setting in many previous studies, this work includes scholars from all scientific fields and is not limited to a specific field or a sub-field.

Not much is known about the effects of the 1999-2005 expansion of the Swedish higher education system. Only one study was published, by Bonander et al. (2016), who sought to estimate the effects of university status on regional economic development and innovation. While this work applies a similar rationale, arguing that the university status change could facilitate a quasi-natural experiment, it differs on the overall objectives. This study aims to estimate the effects of university status, as a proxy for increased access to research funds, on the scientific output of scholars. Therefore, this thesis's research question is *how does obtaining university status affects scholars' scientific output?*.

To answer this question, this research will use the Publication of Academic Researchers In Sweden (PARIS) database. This database was developed by a team under the leadership of Prof. Olof Ejermo. They collected research staff lists from most Swedish higher education institutions and merged it with publications and citations data obtained from the Scopus database. Therefore, The PARIS database includes individual-level data on the scientific output of Swedish higher education researchers between 1996-2011. Utilizing the PARIS database, this research will apply a two-way fixed-effects difference-in-difference methodology with different treatment timings to estimate the impact of university status on scholars' scientific output.

This thesis includes four chapters, and each is divided into several sections and subsections. Chapter 2 provides a review of the historical developments in the Swedish higher education system and a literature review. First, Section 2.1 covers the period leading to and following the 1977 expansion of the Swedish higher education system. Section 2.2 provides a detailed review of the process leading to the establishment of four new universities in Sweden between 1999-2005. Section 2.3 reviews the funding structures of Swedish higher education and university research. Following is the literature review (Section 2.4), which is divided into three subsections, the first reviews studies dealing with the relationship between funding and research output. The second mentions studies on other determinants of publications, and the third presents studies conducted on the Swedish experience.

Chapter 3 outline the data and methodology of this paper. It includes two sections, the first (Section 3.1) presents the PARIS database, and it includes a subsection of summary statistics. The second section (Section 3.2) presents the identification strategy used in this work, a two-way fixed-effects difference-in-difference with multiple treatment timing. This section also includes two subsections, one dealing with the central parallel trends assumption and the second with the nature of the main outcome variable of this study. Following, Chapter 4 presents the results of the estimation of the main econometric model (Section 4.1), and of other specifications, served as robustness checks (Section 4.2). This chapter closes with a discussion of the results (Section 4.3). Finally, Chapter 5 concludes and suggests ideas for possible future research.

2

Historical Background and Literature Review

2.1 Swedish Universities: Historical Review

During the 1960s and 1970s, the approach towards higher education's role in western societies changed, Sweden was no exception. Between those years, the Swedish higher education system shifted from elitist to accessible to the masses. The process was named *massification* of higher education (Sköldberg, 1991; Holmberg and Hallonsten, 2015). While the demand for higher education increased, a need for greater supply was pressing policymakers. The demand for higher education came from both employers and individuals, signaling a shift in the society's approach to higher education (Askling, 1989). By 1968, the combination of expanding the schools system, a growing number of the college-age population, and the labor market needs produced immense pressure on the existing higher education system (Askling, 1989). To put these trends in context, in 1954, the net number of first-time enrolled students in Swedish higher education was 2,650, in the peak year of 1968, this number was 11 times higher, at more than 30,000 (Sköldberg, 1991). These developments pushed the Swedish government to address the issue.

Indeed, the Swedish parliament and government monitored the higher education situation closely. Two parliamentary committees were formed, the first in 1955, and the second in 1968, recommended measures of expanding the higher education system. In 1973, and facing political resistance, the 1968 committee submitted a report, proposing a dramatic reform and expansion of the Swedish higher-education system. Making higher education accessible in regions far from an existing university, and to social classes who traditionally did not acquire higher education were the pillars of the 1973 committee's report and the 1977 reform that was based on it (Sköldberg, 1991).

Before 1977, Sweden was home to only six universities and five technical institutions. The 'old institutions' were based in proximity to the country's three most populous metropolitan areas, Stockholm-Uppsala, Gothenburg, and Malmö-Lund (Hallonsten and Holmberg, 2013). Tables 2.1 and 2.2 presents basic information on Swedish higher education institutions. Observable in Tables 2.1 and 2.2, the oldest universities are Uppsala and Lund, established in 1477 and 1666 respectively. Five institutions were founded in the 19th century (Karolinska Institute, Royal Institute of Technology, Chalmers University of Technology, University of Gothenburg, and Stockholm University). The early 20th century saw the establishment of the well-regarded Stockholm School of Economics. Between the end of the second world war, and the big expansion of 1977, three new institutions were founded: Umeå University, Linköping University, and Luleå University of Technology. The 1977 reform led to the establishment of one new university equivalent institution, the Swedish University of Agricultural Sciences, and more than ten higher education institutions, university colleges (Hallonsten and Holmberg, 2013; Holmberg and Hallonsten, 2015).

Opening new higher-education institutions in the form of university colleges served several goals of the 1977 reform. First, it made higher education accessible in distant regions. This tendency to position new higher education organizations in remote locations is also known as regionalization (Engwall and Nybom, 2007). Second, it increased the capacity of the higher education system, in the face of growing demand. Thirdly, and important to the purpose of this work, it transformed the structure of Swedish higher education. The new university colleges were based on numerous established universities' units, located afar from their 'mother university' that received recognition as university colleges (Sköldberg, 1991). Their objective was to focus mainly on providing education and not on research activities. This represented a break from the situation prior to the reform, when all higher education institutions enjoyed the same status (excluding vocational schools). In addition, these institutions were limited in their ability to produce their own curriculum, and to award professorships or doctorates. Besides, university colleges' access to research funds was limited (Holmberg and Hallonsten, 2015).

The decades following the 1977 reform were characterized by a rapid expansion of higher education in Sweden. Two new higher education institutions were established, Halmstad University College and Blekinge Institute of Technology in the 1980s. The number of students grew from 129,120 in 1975 (Sköldberg, 1991) to 203,000 in 1990 (Bauer et al., 1999, p. 48). This trend led Askling (1989) to argue that a clearer result of the rapid expansion following the 1977 reform was the emergence of a new concept of higher education in Sweden. However, though the new university colleges "had a restricted role as suppliers of education on basis of reproduced curricula from the faculties in the universities, who retained exclusive rights to first-stream research funding and to award doctoral degrees." (Holmberg and Hallonsten, 2015, p. 182), a renewed process of expansion began. The following section will present the 1990s higher education reforms alongside their drivers. A special emphasis will be given to the process resulting in the government awarding university rights to three university colleges in 1999 and one in 2005.

Table 2.1: Swedish Higher-Education Institutions: Basic Information (A)

Name	Abbreviation	Year Founded	Year of University Status	Type	Other
Uppsala University	UU	1477	1477	Public University	
Lund University	LU	1666	1666	Public University	
University of Gothenburg	GU	1891	1907	Public University	
Stockholm University	SU	1878	1904	Public University	
Karolinska Institutet	KI	1810	1923	Public University Equivalent[1]	
Stockholm School of Economics	SSE	1909	1909	Private University Equivalent	
Umeå University	UMU	1958	1965	Public University	
Royal Institute of Technology	KTH	1827	1927	Public University Equivalent	
Linköping University	LIU	1965	1975	Public University	
Swedish University of Agricultural Sciences	SLU	1977	1977	Public University Equivalent	
Chalmers University of Technology	CTH	1829	1951	Private University Equivalent	
Luleå University of Technology	LTU	1971	1971	Public University Equivalent	
Karlstad University	KAU	1977	1999	Public University	
Örebro University	ORU	1977	1999	Public University	
Kalmar College		1977		Public University College	Research area in 1999
Växjö University		1977	1999	Public University	
Linnaeus University[2]	LNU	1977	2010	Public University	
Östersund College		1977		Public University College	
Sundsvall/Härnösand College		1977		Public University College	
Mid Sweden University[3]	MIU	1993	2005	Public University	

Table 2.2: Swedish Higher-Education Institutions: Basic Information (B)

Name	Abbreviation	Year Founded	Year of University Status	Type	Other
Malmö University	MAH	1998	2018	Public University	Research area in 1998
Jönköping University	HJ	1977		Private University College	Research area in 1995
Mälardalen University College	MDH	1977		Public University College	Research area in 2000
Blekinge Institute of Technology	BTH	1989		Public University College	Research area in 1999
University of Borås	HB	1977		Public University College	
Dalarna University College	HBA	1977		Public University College	
Gävle University College		1977		Public University College	
University of Skövde	HS	1977		Public University College	
Halmstad University	HH	1983		Public University College	
University West	HV	1990		Public University College	
Södertörn University	SH	1995		Public University College	
Kristianstad University	HKR	1977		Public University College	

[1] A university equivalent is an institution, specialized in specific scientific field, with similar rights as a full university.

[2] Kalmar College and Växjö University were merged in 2010, forming Linnaeus University.

[3] Östersund College and Sundsvall/Härnösand College were merged in 1993, forming Mid Sweden College.

This table is based on Hallonsten and Holmberg (2013) and Holmberg and Hallonsten (2015).

2.2 The 1999 Expansion

As discussed above, the new university colleges experienced growth in terms of the number of students and scholars as well as their research productivity and organizational capacity. While at the onset of the 1977 reform, the main goal of these colleges was to provide education, by the 1990s some of them aimed to obtain recognition as research universities. During the early 1990s, the Swedish government faced pressure to lift some of the barriers university colleges faced when they sought to expand their research activities. The political pressure, from the side of university colleges and their respective regional leadership, led the conservative government to approve a series of resolutions, leading to a growing decentralization of the higher education system. The peak of this process occurred in the spring of 1998 when the government decided to grant three university colleges the desired university status, making it the largest expansion of the higher-education since the 1977 reform. This section will follow the processes occurring during the 1990s with an objective to support the notion that the 1999 expansion was not directly linked to the number of research publications.

In their paper Holmberg and Hallonsten (2015) analyzed what they identified as 'academic drift', a tendency of university colleges to develop university-equivalent research capabilities. The scholars argue some of Sweden's university colleges, reorientated their academic culture and aimed to join the academic research club, which they were locked out of by definition. Holmberg and Hallonsten (2015) found that although some government policies sought to promote research in these institutions, their success was limited. Therefore the scholars acknowledge the role of "normative pressure and mimesis" (Holmberg and Hallonsten, 2015, p. 191), meaning, the colleges were observing the organizational and academic cultures of the established universities and embraced similar cultures. Following, a review of the early 1990s policy measures, supporting the expansion of research activities in university colleges, is provided.

Several policies and governmental bills gradually increased university colleges' ability to develop research activities. First, in a government bill from 1990, specific funds, directed for research conducted in the new higher education institutions were allocated (Holmberg and Hallonsten, 2015). Second, the center-right government introduced a new reform in 1993 (Bauer et al., 1999; Holmberg and Hallonsten, 2015). According to Bauer et al. (1999), two main goals of this policy were (1) to decentralize the higher education system by giving greater autonomy to the institutions, and (2) to use the allocation of research fund to create incentives promoting improved academic performance. More information on the patterns in Swedish research funding will be provided in Section 2.3. One should mention here that the

1993 reform could be seen as a break from the organizational spirit of the 1977 reform, decentralizing the control over the higher education system. In addition, the 1993 reform was in line with the macro trends and reforms of the Swedish welfare state occurring during the 1990s (Bauer et al., 1999).

Further, in 1994, two policies, crucial to the development path of university colleges were introduced. The first policy took the government's monopoly on awarding professorships and put it at the hands of the higher education institutions (Engwall and Nybom, 2007). The second founded a new body in charge of designating research funds, the "Knowledge Foundation (KK-Stiftelsen)" (Holmberg and Hallonsten, 2015, p. 188). The KK-Stiftelsen was directed to university colleges' research endeavors collaborating with local industries. The ability to appoint professorships together with greater access to research funds resulted in a growing number of de facto doctorate programs to be offered by university colleges. Indeed, university colleges were still limited in their ability to award doctoral degrees, yet they overcame this barrier with the help of established universities. The doctorate candidates received their education and training, conducted their research, and were supervised in the university colleges, yet their doctorates were awarded by a recognized university. However, these 'halfway' solutions were not sufficient in the long run and the pressure to award qualifying institutions a university status grew secularly (Bauer et al., 1999; Sjölund, 2002; Holmberg and Hallonsten, 2015).

The pressure to enlarge the universities club led, as early as 1996 to the introduction of the "institutional career path" (Holmberg and Hallonsten, 2015, p. 189) for university colleges seeking to get university status. In the 1994 parliamentary elections, the center-right coalition lost control over government resulting in the formation of a social-democratic, left-leaning government. This political change led to the reversal of some of the previous government's higher education policies, as well as several structural changes. First, merging multiple higher education units, a new central body was formed: the National Higher Education Agency (*Högskoleverket*) (Bauer et al., 1999). Second, the social-democratic led government created a procedure, in which a non-university higher education institution could be granted university privileges, limited to specific research areas. There were four recognized research areas: medical sciences, technical sciences, natural sciences, and humanities and social sciences. The rationale behind this approach was to allow those university colleges that specialized in specific fields to conduct and obtain research funding. Additionally, those obtaining recognition in a research area were allowed to issue doctorate degrees in the designated research areas (Sjölund, 2002; Holmberg and Hallonsten, 2015).

In an enlightening publication, Sjölund (2002) reviewed, step by step, the processes leading to the 1999 expansion. The first major indication for the Swedish government's purpose to grant university status to some of the university colleges was in a 1997 government bill. The bill suggested that following an assessment of the National Higher Education Agency, the government might grant university status to qualified university colleges. Indeed, following this hint of the government's intentions, four university colleges applied for the desired status: Karlstad, Örebro, Växjö, and Mid-Sweden Universities. As a result, the government asked the National Higher Education Agency to assess the applications and return with recommendations, making it clear that the final decision remains in the government's hands (Sjölund, 2002). The process triggered by these applications, detailed next, is presented in Figure 2.1.

The National Higher Education Agency process of evaluating these four institutions was not a linear one, due to multiple within-agency disagreements. At first, the governing body of the agency assigned an experts committee to assess which of these university colleges met the minimum conditions to be called a university. This group of experts included six members, four Swedish professors, and two professors from the neighboring countries of Finland and Norway. According to Sjölund (2002), who at that time served at the National Higher Education Agency, the experts decided to focus on assessing "what environment, quality and capacity PhD-students would be offered at the university colleges applying for university status" (Sjölund, 2002, p. 176). After conducting their assessment, the experts concluded in a report to the agency's board that only Karlstad met the minimum criteria to be granted university status. In addition, the experts signaled out Örebro and Växjö advancements in specific research fields (humanities and social sciences). However, they argued that more time was needed for these institutions to reach the point that they could be recognized as universities.

The agency's board, a politically appointed body, was reluctant to return to the government with the experts' conclusions. Therefore, the board advised Örebro and Växjö to apply for research areas in humanities and social sciences, arguing that the experts' review placed them in a good position to be granted this status. The two university colleges acted upon this advice and applied for research areas. Following, another experts' group was formed to review the new applications. Surprisingly, they as well advised the agency to reject the research area applications. At that point, the agency's board expressed its dissatisfaction with the experts' assessment, arguing it sets a bar too high to reach for university colleges seeking to develop. The National Higher Education Agency's final recommendation to the government was to recognize Karlstad as a university, to grant Örebro and Växjö a research area, and to reject the mid-Sweden application.

In the Spring of 1998, the Swedish government adopted a resolution recognizing Karlstad, Örebro, and Växjö as universities, to get into force as early as January 1^{st}

1999. The decision, while adopting the National Higher Education Agency's stand on Karlstad's application, rejected the agency's stand on Örebro and Växjö. For the case of Mid-Sweden university, the government decided to postpone the decision for several years (Sjölund, 2002). In the case of Mid-Sweden university college, the government later decided to grant it research area status in natural sciences, starting as early as 1^{st} of January 2001. In early 2003 the Swedish government decided that Mid-Sweden would get university status from January 1^{st} 2005 (Gunnmo, 2003). As Sjölund (2002) concluded, the decision to grant university status and research areas in Sweden is usually politically motivated and is not based on quality or quantity of research assessments (supported by Engwall and Nybom (2007) as well).

Lastly, one should mention a later development, the merger between Växjö University and Kalmar College. In 2010, following years long cooperation, a merger between the two neighboring higher education institutions took place, creating Linnaeus University (Ljungberg and McKelvey, 2015). Due to a data limitation, detailed in Section 3.1, this research will regard to Linnaeus University and not to Växjö University. Importantly, prior to the merger, the differences between Växjö University and Kalmar College were not stark. As Ljungberg and McKelvey (2015) noted: "At the time of the merger, the two HEIs [higher education institutions] were similar in size and had similar, and complementary, profiles ... Moreover, both were ranked low in national rankings" (p. 69).

To conclude, the process that began in the mid-1990s could be characterized as unpredictable and full of surprising turns of events. The historical record shows how, in a hierarchal decision-making structure, a great level of uncertainty dominated the process ending with the establishment of three universities in 1999 and another one in 2005. The level of unpredictability was not similar for all four institutions. On the one hand, Karlstad faced increased certainty regarding the outcome of its application for university status, given the favorable feedback it received at each of the process's junctions. Further, the case of Mid-Sweden University demonstrated consistency, with all bodies involved in the process of assessing its application holding the same view. Mid-Sweden university also received 'a notice' that it might become a university two years in advance (in comparison to about half a year in the case of the other three). On the other hand, Örebro's and Växjö's path to university status was full of unexpected turn of events, when at almost every junction, an unexpected decision was taken by the respective bodies. This review would be proven useful in Section 3.2, where the identification strategy is presented.

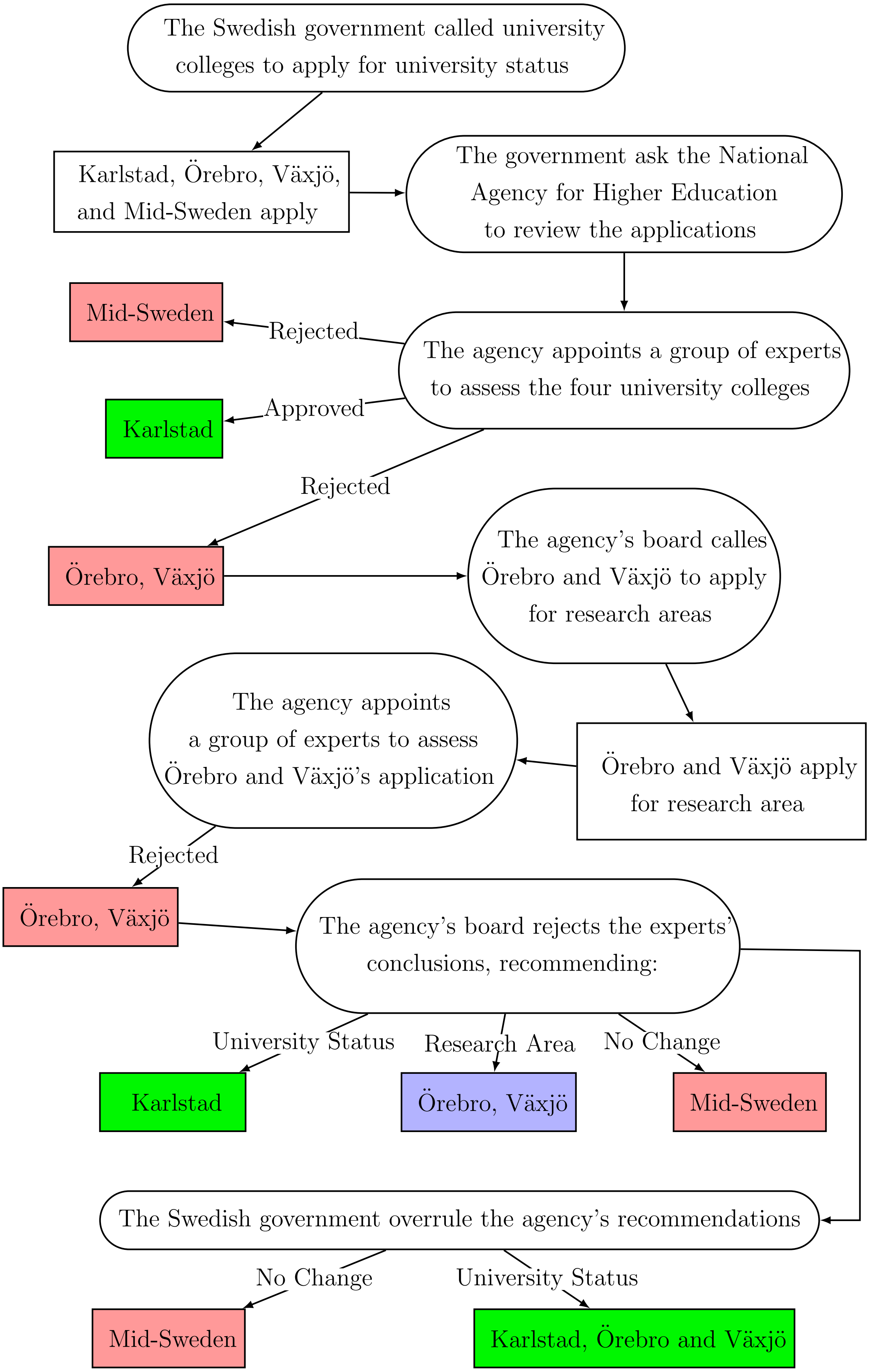


Figure 2.1: The Process of the 1999 Expansion

2.3 Funding Research in Sweden

So far, the organizational changes in the Swedish higher education system have been reviewed. Further, the review of the processes leading to the 1999 expansion demonstrated the substantial role of political consideration. This in turn resulted in an increased level of unpredictability, which will later be used to facilitate this work's identification strategy. This section will briefly review the developments in the ways research funds are distributed in the Swedish higher education system. The main objective of this section is to verify that the allocation of research funds is not directly determined by output (such as publications) measurements.

Before diving into the Swedish developments, some general understandings should be outlined. First, and almost needless to say, "[r]esearch costs money – lots of money"(Stephan, 2012, p. 112). Second, scientific knowledge should be regarded as a public good due to its low level of excludability. Due to this characteristic of scientific production, it makes it unlikely to be funded by the private sector. Despite the appropriability issue, the system of incentives for scientists has evolved so that the incentive to produce knowledge is addressed by mechanisms of recognition and prestige (Stephan, 1996, 2012). However, these do not solve the lack of incentives to allocate private resources, this could only be addressed by public funding (Stephan, 2012). The ways universities are funded differ between societies, with a clear distinction between the American and the European approach to higher education and research funding.

Traditionally, European governments fund research institutions through block grants. Studying the way these funds are allocated are of great importance for the purpose of this work. In their work, Auranen and Nieminen (2010) formed a theoretical framework to assess the structure of research funding. The scholars presented two dimensions. The first measures the extent to which research funding is external to the block grants universities are allocated. The second dimension measures the research's core funding orientation. The authors identify two possible orientations, input, and output. When output-oriented regards funding structures that include measurements of research outputs such as publications or citations and input-oriented schemes consider the institutions' size (in terms of facilities and employees), age, and reputation. The input-oriented structure is considered more static than the output-oriented structure and therefore results in fewer changes to the total funds allocated to each institution. The authors argue that Sweden's research funding structure, relative to other OECD states is more input-oriented, with a greater share of external funding.

As demonstrated above, the Swedish higher education system underwent many dramatic reforms and structural changes since the 1960s. These shifts also included reforms in the research funds allocation mechanisms. As early as the 1940s, research funds were mainly distributed using public block grants per each institution[1] in the small Swedish academic higher education system. Here one should note that even before 1940, a small fraction of universities' total research budgets came from private research funds. In 1940, alongside public block grants, public funding for specific research projects was introduced (Engwall and Nybom, 2007). This status quo persisted until the pivotal year of 1977 when significant changes to the structure occurred (see Section 2.1)

As part of the 1977 reforms, the government reorganized some of the existing research funds. First, it facilitated "the Council for Planning and Co-ordination of Research (Forskningsrådsnämnden, FRN)" (Engwall and Nybom, 2007, p. 39), with the goal of directing research funds to interdisciplinary projects. Second, societal relevance became a criterion for research funds. Third, new funds were established, these funds were subject-specific and formed by government ministries and agencies. At the start, the allocation of funds by the ministries and government agencies was politically motivated. This changed during the 1980s when a more professional and independent approach was introduced. The next milestone occurred during the 1990s with the prevalence of so-called 'academic capitalism'.

During the 1990s, a political shift brought a conservative government to power, leading to changes in higher education policy (see Section 2.2). The new conservative coalition followed the global trend towards 'academic capitalism', which in terms of funding meant the assessment of input and output indicators in the research funds allocation process. According to Engwall and Nybom (2007), allocating Swedish research funds is mainly controlled through institutional and input mechanisms. That is, the government controls the research activity by deciding which institutions could be included in the eligible group. The main institutional tool at the government's disposal is its monopoly on university status and research area recognition. Engwall and Nybom (2007)'s conclusions include two key, for the sake of this study, takeaways. First, they argued that even though the government attempted to promote a higher level of competition on research funds, a direct link between publications and funding was negligible. In their words: "we can conclude output control is still relatively soft in Sweden" (p. 45). This is in line with the findings of Auranen and Nieminen (2010). Second, as noted above, they stress the centrality of university status for the accessibility of higher education institutions and their researchers to public research funds.

Additionally, one should mention the relationship between public and private

[1]As noted in Hallonsten and Silander (2012), university faculties or departments were the recipients of block grants, for example, the department of economic history (Ekonomisk-historiska institutionen) and not Lund University.

funds. Muscio et al. (2013) argued, utilizing a database of Italian engineering and physics university departments, for a strong complementary relationship between public and private funding of research. Adding to this notion, Lanahan et al. (2016) found a 'domino effect', when increasing the federal government's funding of a university, results in an increase in funding from other resources (non-profit, industry, state and local, university, and others). If these findings hold in the Swedish case, obtaining university status will not only indicate greater access to public funds but also to private funds.

While Engwall and Nybom (2007)'s work concluded that the use of output indicators in determining research funds allocation was small yet growing, in 2009 this trend reaches a pivotal moment. Recent publications noted that Sweden included output indicators in the funding schemes (European Commission, 2010; Hicks, 2012; Checchi et al., 2019). The major change was the inclusion of "bibliometric indicators" (European Commission, 2010, p. 124). Perhaps one might argue that these changes facilitate a direct link between research publications and funding, lowering the importance of university status recognition. This argument might be correct and calls for greater inspection of the changes in research funding patterns following this reform. However, these changes were only implemented in 2009, while this thesis is covering 1996-2011, meaning, that only the last three years in this work's database (2009-2011) are affected by this change. Notwithstanding, Hallonsten and Silander (2012) conducted a qualitative analysis of the Swedish research funding policy changes in the early 2000s. They found that while there has been a rhetorical shift, a greater emphasis on the university management level (and not the departments or projects level) was the main actual difference in funding policy. More on how this work will address this issue in Section 4.2.

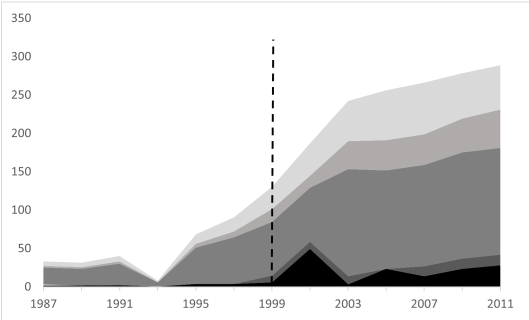
A closer inspection of the distribution of research funds in Sweden reveals valuable insights. Using Swedish data from 2006-2010, Hallonsten and Silander (2012) presented the dominance of the old and established universities in the allocation of Swedish research funds. For example, on average, the four new universities accounted for only 5% of the total research expenditure of the Swedish higher education system. This share increases to 6% of all governmental block grants but sharply declines to only 2% of the total funds allocated by the Swedish Research Council. To put it in perspective, the corresponding shares of Lund University alone are 13%, 13%, and 19%, respectively. (Hallonsten and Silander, 2012). The years covered here represents the last years covered by this work, embodying the changes in research funds accesses obtained by the new 1999 universities. These figures demonstrate the dominance the established universities have in obtaining research funds, while the new ones fall behind.

Figure 2.2 allows the readers to examine the trends in research expenditure in all four 1999-2005 universities and to compare it to the corresponding trend for Lund university as a baseline[2]. The reason Lund University was chosen to serve as a baseline is its position as one of the biggest, oldest, most prestigious and established universities in Sweden. Therefore, the trends in its research expenditure could mirror the overall Swedish trend. First, in the case of Karlstad, Örebro, and Linnaeus universities, the trends in funding seem similar to the one of Lund before the 1999 reform. Second, the research expenditure data strengthen the argument that obtaining university status leads to an increase in research funding. Notable is the dramatic boost in expenditure following 1999 when the amount of funds spent on research is doubled in less than five years. Third, comparing these trends with the one of Lund University, an old and established university, shows that these observed boosts in funding were indeed greater for the new universities. Lastly, the data for Mid-Sweden University following its upgrade in 2005 is not consistent with the expectation. As visible in 2.2 (d), leading to the status change a substantial increase in funding is observed. However, following the recognition, there is a slight decline in funding, differing from the observed trend for the 1999 universities and Lund university.

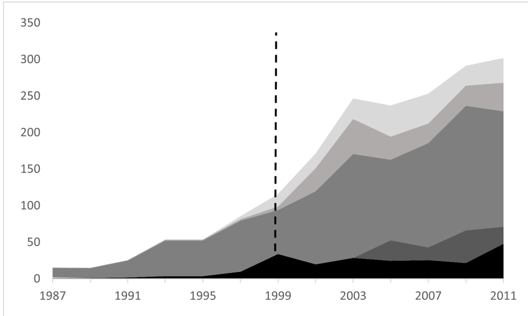
Moreover, international comparisons of the Swedish national research funding structures reveal that Sweden is positioned among states with greater external research funding, while the allocation of public funding is input-oriented. For example, while 90% of Dutch universities' research was funded by public funding in 1981, and about 75% in 2000, the corresponding Swedish figures were 70% and less than 50%. Further, although argued to be relatively less efficient, though Sweden demonstrated some efficiency gains during the 1990s (Auranen and Nieminen, 2010). This finding of low efficiency of the Swedish university research was confirmed by Sandström and Van den Besselaar (2018) who also attributed it to the input-oriented allocation scheme. These findings, published in 2018, meaning after the 2009 inclusion of bibliometric indicators is reassuring and could be used as a justification to include all available years covered by the database.

To conclude, several main characteristics dominated the Swedish research funding policy during this work's examined time frame. First, block grants played a major role, however, relative to past years as well as to other states, the role of competitive funds is significant (Engwall and Nybom, 2007; Ljungberg and McKelvey, 2015; Auranen and Nieminen, 2010; Hallonsten and Silander, 2012). Second, the allocation of research funds was not linked to research productivity (output-oriented) but was mainly input-oriented European Commission (2010); Hallonsten and Silander (2012); Auranen and Nieminen (2010). Third, obtaining a university status

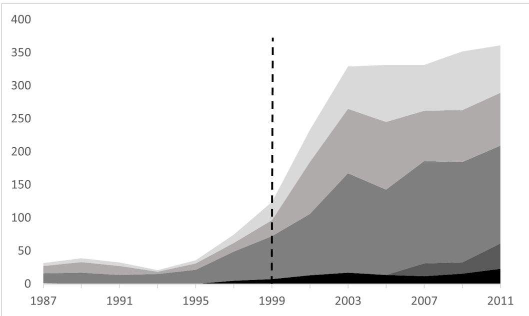
[2] The scales in Figure 2.2 differ between each institution.



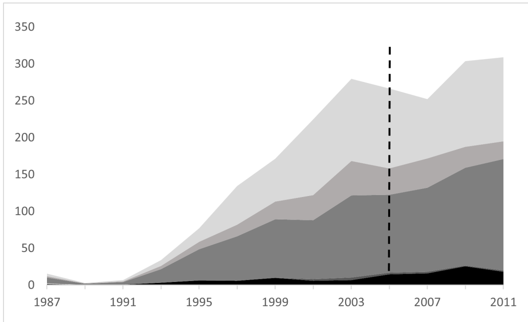
(a) Karlstad University



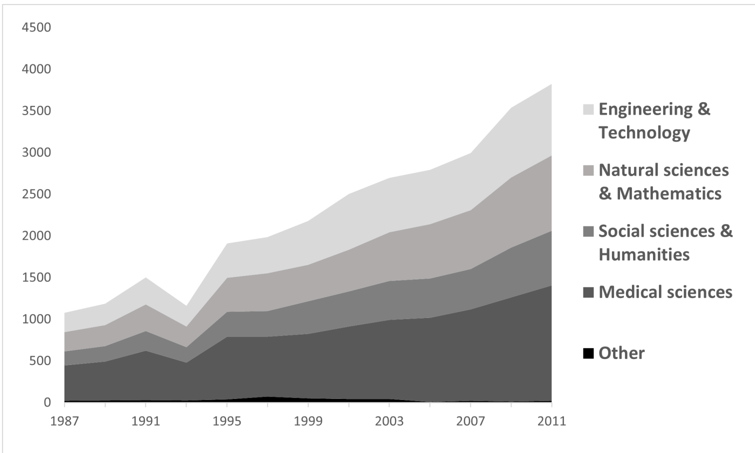
(b) Örebro University



(c) Linnaeus University



(d) Mid-Sweden University



(e) Lund University

Figure 2.2: Research Expenditure By Scientific Field, 1987-2011

Notes:

Values in million Swedish Kronor (constant 2011).

The scales differ between the institutions.

Source: Based on data from Statistics Sweden (SCB), and further analysis made by Ejermo and Källström (2016).

granted increased access to research funds (Engwall and Nybom, 2007; Hallonsten and Silander, 2012). This is validated both by analysis of the system's structure and a review of actual research funds expenditure. The following section will review the existing literature on the drivers of research publications.

2.4 Literature Review

The literature dealing with the drivers of research publication is rich and goes back to the mid-1970s. Past studies could be grouped in different ways, by their level of analysis, by the groups they study, or by the methods implemented to answer their respective research questions. For example, concerning the level of analysis, scholars researched the macro (nations), meso (universities, departments), or micro (researchers) levels. This section will review the existing literature on the drivers of research publications, with a focus on the role of funding structure and incentives.

2.4.1 The Relationship Between Research Funding and Scholars' Publications

While personal characteristics and institutional settings play a respected role (and will be reviewed in the following subsection), scholars debated the role of access to funds on research output. Payne and Siow (2000) used instrumental variables to estimate the effect of federal research funding on research output. The researchers instrumented the number of alumni US house representatives serving in the house appropriations committees to address the potential link between research output and funding. They found a positive and substantial impact of increased funding on the number of publications, but with no significant effect on citations. Besides the contribution of their results to existing knowledge, their study stressed the difficulty in identifying a causal link between research output and funding.

Following Payne and Siow (2000), using a database documenting applications to the US National Science Foundation grants, Arora and Gambardella (2005) aimed to estimate the effect of these grants on research output. The scholars found a small positive effect on research output. This effect differed between junior and senior scholars when a larger effect was estimated for juniors. Also using an American-based sample, Adams (2009) found that increased funding of university research leads to increased publication of scientific studies. However, when examining the effect on citations, no such effect was found. In line with these two studies, Jacob and Lefgren (2011) used a sample of the National Institute of Health grants' recipients and found a small increase in research publications attributed to obtaining these financial resources. A supporting evidence was provided by Zucker et al. (2007), also finding a positive impact of funding on publications. Further, the scholars also found that the stock of knowledge accumulated in a region (from all scientific fields) boosts the region's knowledge creation. Whalley and Hicks (2014) supported the argument of a positive effect that funding poses on publications, with no similar relationship between funding and citations. They also found that the positive impact does not differentiate between public and private institutions (in the American setting).

Moreover, based on an American database focused on knowledge production in the chemistry field, Rosenbloom et al. (2015) found a positive impact of increased funding on research publications. Unlike the previous studies, the scholars found a positive effect on citations as well. Similarly, Ebadi and Schiffauerova (2016) used a database of Canadian engineering and natural sciences scholars and found a positive impact of funding on both publications and citations. Using a database of Canadian nanotechnology researchers, Beaudry and Allaoui (2012) not only found a positive effect of public funding on research publications but also that no likewise relationship between private funding and publications persisted. Earlier work by Bolli and Somogyi (2011) found that while public funding indeed increases scientific publications, private funding boost knowledge transfers. Additionally, Goldfarb (2008) found that commercial sponsorship of a researcher holds a negative impact on scientific publications. However, the scholar questioned the use of publications and citations measurements as proxies for the short-term value-added of research.

2.4.2 Other Determinants of Research Output

While the previous subsection focused on relationship between funding and research publications on the individual level, this subsection will provide a brief review of other determinants of research output. First, on the macro level scholars attempted to estimate the impacts of different national higher education structures and their funding mechanisms on the productivity and efficiency of the system. As mentioned above, Auranen and Nieminen (2010) sought to establish a link between funding incentives and research productivity using a sample of 8 countries. However, the scholars failed to find a systemic relationship. Later, Sandström and Van den Besselaar (2018) were able to establish a weak correlation between the characteristics of the higher education system and its efficiency. Namely, they found that systems with a higher level of university autonomy, ex-post evaluation mechanisms, and higher usage of competitive funding for projects seem to be less efficient than those with high institutional funding, and lower levels of university autonomy. They also used a sample of (11) OECD states. Two studies dealing with the experience of South Korea's National higher education system found some indication for a positive link between research funding and research productivity (Shin, 2009; Lee, 2020).

Second, on the meso level of analysis, scholars aimed to identify the drivers of research publication focusing on universities and departments. In a research using matching techniques of North-American computer sciences researchers, Way et al. (2019) found a strong and significant positive effect of the department's prestige and reputation on research publications of young researchers.

The individual-level drivers of research productivity are wide and regard structural, personal, and economic elements. In the mid-1970, scholars argued for the existence of a productivity life cycle, according to which publications peaked at the age of 40-45 (Bernier et al., 1975), supporting these results, Cole (1979) found an increase in productivity at the age of 30, followed with a decrease around the age of 50. As noted above, personal financial gains are argued to have little effect on research activity (Stephan, 2012), Levin and Stephan (1991) found that in the case of physics scholars, the 'religious quest' (p. 114) to solve problems is a major driver. The scholars also verified the life cycle argument, however, they disputed the notion that years of doing research are negatively correlated with research productivity (what they called the 'vintage effect'). In a later study, Gonzalez-Brambila and Veloso (2007) disputed the findings of Levin and Stephan (1991) and earlier scholars on the decline in research productively with age (the life cycle hypothesis). Using a database of Mexican scholars, they found that older scholars remain as productive as young scholars. Further, the scholars find an effect of reputation on citations, but no such effect was found concerning publications.

Further, the issue of gender effects on research productivity has also been intensively researched. Scholars found that women tend to publish less than men (Turnera and Mairesse, 2003; Fox and Stephan, 2001; Fox and Colatrella, 2006), and this negative gender effect decreases with the age of the scholar (Long, 1992). In a long-term perspective, Xie and Shauman (1998) found the gender publication gap decreased substantially. They found that the ratio between women's and men's publications increased from 60% in the early 1960s, to 80% in the 1990s. Moreover, Allison and Stewart (1974) found a positive link of scholar's accumulated number of publications on their research productivity, this was suggested to be due to the increased access to resources that comes with scientific reputation.

2.4.3 Studies of the Swedish Higher Educations Expansion

As noted in Sections 2.1 and 2.2, the Swedish higher education system underwent great changes during the second half of the previous century. However, the effects of the 1977 and 1999 expansions have not been intensely researched. First, in their work Andersson et al. (2009) utilized the 1977 expansion of the Swedish higher education system to estimate its effects on regional development and innovation.

According to their findings, investment in university-based research increased the productivity of workers in communities neighboring the recipient institution. They also found an increase in patent grants. Interestingly, they found that these effects are stronger when the investments are directed towards existing 'young' institutions as well as in cases where new institutions were established. These findings are in line with the notion that decentralization and regionalization of higher education might resemble the effects of "local fiscal policy" (Andersson et al., 2009, p. 4). One should note here that the scholars found no evidence that Swedish policymakers intended to pursue such policy.

The only work dealing with the effects of the 1999 university status change of Karlstad, Örebro, and Växjö universities was published by Bonander et al. (2016). The scholars aimed to expand the knowledge on the impact of research institutions on regional growth and development. The identification strategy of Bonander et al. (2016), sought to use "the 1999 university reform as a natural experiment" (p. 199). While the same underlined rationale is applied in this thesis, their work applied a synthetic control methodology to estimate the effects of the 1999 reform. Results indicated that the upgrade from a university college status to a university status increases the number of professors and doctorate students[3]. However, the number of students was not affected by the upgrade. This makes sense given the initial role of university colleges which was to provide higher education, without research activities. Further, no robust effect of university status on patenting, number of startup firms, regional GDP per capita, and wages was found.

To conclude, the existing literature on the relationship between research funding and output (publications and citations) is substantial. As reviewed above, there seems to be a consensus regarding the positive effect of university status on the quantity of research output. However, there is no consistent understanding of the impact on the quality of publication (in the form of citations). Most of these studies were conducted in the US, and no research dealt with the Swedish, Nordic, or even European institutional setting. Therefore, this work seeks to join the debate, by capitalizing on the 1999-2005 university status grants to four Swedish institutions.

[3]Evidence to this increase in university research staff following an upgrade in institutional status is also found in this work's database, see: Appendix A Figure A.1.

3

Data and Econometric Model

3.1 The PARIS Database

Studying the effects of university status on scholars' scientific output in Sweden demands access to an individual-level database. The work on such dataset started in 2014, as part of a research project dealing with *academic careers, mobility, and scientific productivity* led by Prof. Olof Ejermo from Lund University, Department of Economic History. This study uses the Publications of Academic Researchers In Sweden (PARIS) database, constructed by Prof. Ejermo and his team. In this section, a review of the data gathering process will be provided. It will be followed by a discussion of the database's coverage and potential limitations. This section will include a subsection providing summary statistics, and an analysis of the outcome variables at hand.

The first step in creating the PARIS database was to send requests to Swedish higher education institutions to provide lists of their research staff. The scholars requested lists containing: social security number, name, email address, department, faculty, type of position, and professional title of the institution's research staff. Legally, this request was covered by Swedish law, making this information public, and requires public institutions to provide it. In addition, Lund University's infrastructure reassured the provided personal information was kept safe.

Once a database of Swedish higher education scholars was at their disposal, the team obtained publications and citations data from the Scopus bibliographic database. The Scopus database, available online[1], was introduced in 2004 and is regarded as one of the best bibliographic databases existing today, in terms of coverage. This database includes information on an array of research outputs, such as patents, books, articles, and more. The platform covers all scientific disciplines, and it mainly includes publications written in English. Geographically, most of the

[1]See: https://www.scopus.com/.

publications are centered in North America and Europe. At the time the PARIS database was constructed, Scopus mainly included full details of publications after 1996. Some information about the pre-1996 period existed, however, it was not complete (did not include information about citations).

At this point, the second stage of the project aimed to match the two databases. A joint effort of both scholars from the Centre for Innovation Research at Lund University (CIRCLE) and Fraunhofer ISI, Karlsruhe, worked on matching the publications data from the Scopus database, with the Swedish academic staff data collected. Ejermo et al. (2016) provided a lengthy and detailed presentation of the matching process, not to be repeated in this study. However, some central challenges, addressed by Ejermo et al. (2016) would be mentioned next.

Matching individual-level databases that do not share similar unique identifiers for each individual, might result in some common mistakes. That was a great challenge faced by the PARIS developers. Two common errors were identified. The first one occurs when a scholar in one database is matched with the wrong one in the other database. Ejermo et al. (2016) named it a *false positive* error. The second one, a *false negative* error, is when no match was found to a scholar that should have been matched. Importantly, the scholars stated that given the aim of the final database, which is to allow individual-level microanalysis, they "were more concerned about getting false positives than false negatives" (Ejermo et al., 2016, p. 6). The researchers addressed these worries with the implementation of four main matching strategies (by order of priority):

1. Email and last name
2. Synthetic email and last name
3. Full name
4. Full name, unique initials

Later, the scholars addressed the two most common sources of mistakes. First are cases of common names, for example, two Sven Svensson in a given university department. Second are cases of missing scholars in the staff list. For example, due to mobility between institutions, scholars with multiple affiliations, or part-time employment. Ejermo et al. (2016) attempted to minimize the risk for errors leading to possible biases in what seems to be a sufficient and convincing way. The scope of this section does not permit further elaboration of all methods and strategies applied. The last part of the process was to merge the publication database with Statistics Sweden (SCB) database containing information on all higher education employees. Following, the coverage of the PARIS database, directly impacting the time frame covered by this thesis, will be presented.

Several elements determined the coverage of the PARIS database. As stated above, at the first stage, the team constructing this database requested research staff lists from Swedish universities and university colleges. Almost all of Sweden's higher education institutions received a request (besides some art and music schools). The scholars requested the information to run back in time, as far as possible. Only a few rejected the request, or did not reply[2], among them were the Swedish University of Agricultural Sciences (SLU) and Stockholm School of Economics (SSE)[3].

In total, 25 institutions sent their staff lists, with different time-frames covered. The research team approached a total of 31 institutions, out of which, 28 performs meaningful research. Therefore, the staff lists covered between 81-89% of the Swedish higher education institutions. Table 3.1 presents a summary of the information obtained from the Higher education institutions. It is possible to notice that due to the difference in starting year, the database is unbalanced. Moreover, almost all institutions reported their staff lists until 2013[4]. However, while the staff lists coverage played an important role in determining the time coverage of the database, the availability of bibliographic data from Scopus restricted it to 1996-2011.

When it comes to the limitations of the final, matched database, three concerns should be stressed. First, as noted above, the Scopus database is fairly English-dominated. This might hinder the representation of publication in Swedish-dominated fields or subfields. Intuitive examples might be Swedish literature or linguistics. Second, scholars in disciplines that tend to publish more books might also be insufficiently represented in the database. The fields are mainly social sciences and humanities (Ejermo et al., 2016). However, while accepting the fact that the database could not cover 100% of publications, the PARIS database is more than sufficient for this research. Here one should note that the citations variable resembles the number of citations per paper during the three years following its publication. This variable is used as a proxy for the quality of the research (Ejermo et al., 2020). Third, as noted in Section 2.2, Växjö University and Kalmar College merged in 2010 to what today is known as Linnaeus University. However, the database in the version used for this research regards scholars from both Växjö and Kalmar prior to the merger as scholars from Linnaeus University. This is of course a limitation of the database. Yet mediating this faulty, as previously noted, is the fact that the differences between them at the eve of the merger were small, and the

[2]These are: The Swedish Defence University, The Swedish School of Sport and Health Sciences, Ersta Sköndal University College, and the University of Gävle (besides the two mentioned in the main text).

[3]According to Ejermo et al. (2016), SSE refused to provide the information, arguing SSE, a private university, is not covered the legal obligation to provide such information.

[4]Only Lund and Örebro Universities included staff lists for 2014.

Table 3.1: *First Year of Coverage – Higher Education Institutions' Staff-Lists*

First Year Covered	Higher Education Institution	
1983	Lund University	
1990	Gothenburg University	Mid Sweden University
	Örebro University	Umeå University
1993	Dalarna University	
1994	Uppsala University	Linnaeus University
1995	Kristianstad University	
1996	**First Year of Scopus Coverage**	
1997	Jönköping University	Karlstad University
	Södertörn University	
1998	Blekinge Institute of Technology	Malmö University
	Chalmers University of Technology	
1999	Royal Institute of Technology	
2001	Karolinska Institute	Linköping University
	Mälardalen University	
2002	University of Skövde	University West
	Luleå Technical University	
2003	Halmstad University	
2004	Stockholm University	
2013	University of Borås	

two cooperated and complemented each other before they were merged (Ljungberg and McKelvey, 2015).

3.1.1 Summary Statistics

For the reader to get a better understanding of the PARIS database, this subsection will provide a brief review of its characteristics. Before diving into the data, one should mention that the group of 'treatment' refers to scholars from Karlstad, Örebro, Linnaeus, and Mid-Sweden Universities. Both before and after the introduction of treatment, unless stated otherwise. The 'control' group includes all scholars from all other universities. Additionally, in the PARIS database, Kalmar University College and Växjö University are already merged, hence there is no possible way to differentiate between them. Following, a review of the apparent differences in characteristics between the two groups will be provided.

Table 3.2, presents summary statistics by groups, and of the total database.

First, the total number of observations in this database is 376,104. This number represents scholar-year observations. The number of observations in the treatment and control groups are 24,060 and 352,044, respectively. The number of individuals in the database is 71,367, when it distributes between the treatment and control group as followed: 5,054 and 67,787, respectively. The database includes several personal characteristics, such as gender (male or female), age, position, science field, and place of birth. These variables will be reviewed next.

While on some characteristics, there is no meaningful difference between the control and treatment groups, some indicators show stark gaps. The share of women scholar-year observation is almost identical between the two groups. The mean age in the treatment group is slightly higher than in the control group. When it comes to places of birth, a higher share of the observations in the new universities are Swedish born. The shares of professors, postdocs, and Ph.D. students are lower in the treatment group. The share of associated professors is substantially higher in the treatment group in relation to the control one. This perhaps is a result of the difficulty the new universities faced when attempting to recruit professors, postdocs ans Ph.D. students. Possible reasons to this difficulties are, among others, the lack of physical and financial resources, insufficient research capacity, geographical location, or reputation and branding related issues.

When it comes to the scientific fields of study, Table 3.2 corresponds to the data presented in Section 2.3 and specifically in Figure 2.2. Almost half (45%) of the treatment group's observations are in social sciences and humanities, compared to less than a quarter in the control group. This is mirrored in the share of observations within life sciences, 45% for the control group, and 29% for the treatment group.

Table 3.3 presents summary statistics for both possible outcome variables: publications and citations. One could draw four interesting insights from Table 3.3. First, in the database, the number of observations declines systematically between publications and citations. This is a result of the database construction process, in which the scholars made sure all observations receive a publication value of 0 or higher[5]. The team constructed the database did not force a value on citations (Ejermo et al., 2016). Second, comparing by treatment status, one could easily see both the mean of publications and citations in the control group are almost double the one in the treatment group. Additionally, for those included in the treatment group, the average number of publications more than doubles itself before and after the introduction of treatment. A smaller increase, of about 40%, is observed in the

[5]In their technical report, Ejermo et al. (2016) detailed the statistical method (probit regression) they used to predict which non-publishing individual should be included in the database, with a value of 0 in the publications field. Meaning, in some cases, where no data was available, the scholars assigned zero as the value of publications.

Table 3.2: Summary Statistics: Personal Characteristics

	Treatment		Control		Total	
Variable	mean	sd	mean	sd	mean	sd
Female	0.61	0.49	0.62	0.48	0.62	0.48
Age	44.92	11.72	41.49	12.04	41.71	12.05
Position						
Professors	0.12	0.32	0.15	0.36	0.15	0.35
Associate professors	0.48	0.50	0.25	0.43	0.26	0.44
Guest researchers	0.03	0.18	0.02	0.15	0.02	0.15
Postdocs	0.02	0.15	0.05	0.21	0.04	0.21
PhD-students	0.29	0.45	0.37	0.48	0.36	0.48
Other	0.06	0.24	0.17	0.38	0.16	0.37
Science Field						
Engineering & Technology	0.12	0.32	0.17	0.38	0.17	0.37
Life sciences	0.29	0.45	0.45	0.50	0.44	0.50
Natural sciences & Mathematics	0.14	0.35	0.15	0.36	0.15	0.36
Social sciences & Humanities	0.45	0.50	0.23	0.42	0.24	0.43
Place of Birth						
Swedish	0.85	0.36	0.77	0.42	0.78	0.41
Nordic	0.03	0.16	0.03	0.17	0.03	0.17
EU25	0.05	0.21	0.08	0.27	0.08	0.27
Europe	0.02	0.15	0.03	0.16	0.03	0.16
North America	0.01	0.11	0.01	0.12	0.01	0.12
South America	0.01	0.08	0.01	0.09	0.01	0.09
Former USSR	0.00	0.04	0.00	0.07	0.00	0.06
Asia	0.03	0.17	0.05	0.23	0.05	0.22
Oceania	0.00	0.04	0.00	0.05	0.00	0.04
Africa	0.01	0.08	0.01	0.09	0.01	0.09
Individuals	5054		67787		71367	
Observations	24060		352044		376104	

A single observation in this table represents a researcher-year observation.

Treatment refers to all observations linked to Karlstad, Örebro, Linnaeus, and Mid-Sweden Universities, before and after the treatment was introduced.

The years covered by the database are 1996-2011.

number of citations.

Third, the data suggest that professors publish more, and their publications are more influential in terms of citations. They are followed by postdocs and those in the 'other' group. Publishing the least are guest researchers and Ph.D. students. Fourth, the average number of publications for scholars in social sciences is 0.18, when the corresponding mean for scholars in engineering and technology, life sciences, and natural sciences and mathematics ranges between 0.85-1, indicating substantial differences in the scientific traditions and practices between the fields. Finally, the mean number of publications per year stands at 0.73 with a standard deviation of 2.22, a further inspection of the distribution of publications will be provided in Section 3.2.2.

Table 3.3: Summary Statistics: Outcome Variables

		Publications			Citations		
Group		mean	sd	obs.	mean	sd	obs.
By Treatment Status							
Treatment	Before	0.19	0.89	4173	6.36	12.37	374
	After	0.41	1.52	19887	8.86	65.17	3445
	Both	0.37	1.43	24060	8.62	62.02	3819
Control		0.76	2.26	352044	18.96	50.52	83558
Total		0.73	2.22	376104	18.51	51.12	87377
By Position							
Professors		2.10	4.18	55006	31.72	72.53	22915
Associate professors		0.54	1.70	98480	12.04	33.45	19121
Guest researchers		0.17	1.00	8542	13.56	45.59	573
Postdocs		1.18	2.33	16860	19.17	44.09	6520
PhD-students		0.32	1.04	135437	9.83	34.96	23742
Other		0.68	1.89	61779	20.28	50.39	14506
By Science Field							
Engineering & Technology		0.97	2.41	63157	9.11	20.95	20093
Life sciences		0.85	2.42	166902	24.44	57.19	41806
Natural sciences & Mathematics		1.00	2.59	55842	20.89	65.49	17409
Social sciences & Humanities		0.18	1.00	90203	6.08	20.89	8069

A single observation in this table represents a researcher-year observation.

Treatment refers to all observations linked to Karlstad, Örebro, Linnaeus, and Mid-Sweden Universities. For the first three, the treatment year is 1999, for Mid-Sweden university, the treatment year is 2005.

The years covered by the database are 1996-2011.

3.2 Identification Strategy

As detailed in the previous chapter, the 1999-2005 expansion was not directly linked to research publications and citations. The econometric analysis presented in this section will capitalize on this nature of university status grants in order to conduct a quasi-experimental analysis. That is, using real-life observations to estimate the effects of university status on Swedish scholars' publications. Therefore, using the PARIS database, the outcome variables will be the yearly number of an individual scholar's publications and the corresponding number of citations. The treatment or intervention will be the Swedish government's decision to grant university status to four university colleges in the time frame covered by the PARIS database. This section will outline this work's identification strategy seeking to estimate the effect of university status on the number of scholar's scientific output.

One of the most common methods used to estimate policy effects in the economic literature is the well-known Difference-in-Difference (DiD) methodology. A classic and basic DiD setting includes two groups when one group is subjected to treatment at some point, and the second group is not. The first group is called the treatment group, and the second is called the control group. A crucial pre-condition in this methodology is the existence of parallel trends in outcomes prior to treatment timing (Cunningham, 2021). What this method does is to estimate the difference in outcomes trends after the introduction of the treatment, after accounting for the existing (pre-treatment) trend difference between the groups. This canonical DiD design is also known as the 2X2 DiD setup. However, this basic version of the DiD methodology does not work when there are multiple treatment groups, with different timing of treatment. Next, the two-way fixed-effects DiD methodology will be presented.

In recent years, the most used DiD design used in empirical studies is the two-way fixed-effects. This design allows scholars to estimate the average treatment effect when treatment timing varies between groups (Cunningham, 2021). A central reason this design enjoys high popularity is the federal structure of the United States, where frequently state-level policies are implemented at different points in time. Regardless of its popularity and widespread use, Goodman-Bacon (2018) argued that "[i]n contrast to our substantial understanding of the canonical 2x2 DD model, we know relatively little about the two-way fixed effects DD model when treatment timing varies" (p. 2). as a result, the scholar sought to expand our understanding of the estimation process and the estimator of interest in such a setting. Useful for the purpose of this work, he presented a simplified example of two-way fixed effects DiD structure, that includes three groups when two receive the treatment in different timings, and the third does not receive any treatment. Following a presentation of the main econometric model used in this study, a return to the example presented by Goodman-Bacon (2018) will help explain how to interpret this work's coefficient of interest.

More specifically, this work's main model will be inspired by the one in Ejermo et al. (2020), who also used the PARIS database to estimate the effects of scholars' mobility on research publications. Therefore, the central model implementing two-way fixed-effects DiD to estimate the effect of university status on research publications and citations is:

$$E[y_{iut}|D_{ut}, \gamma_u, \lambda_t, \delta_i] = Exp[\gamma_\tau D_{ut} + \gamma_u + \lambda_t + \delta_i] \tag{3.1}$$

Where i is an individual scholar marker, u represents the university or higher education institutions, and t represents years. The main outcome variable is y_{iut} which represents the number of research publications or citations attributed to individual i affiliated with university u in year t. γ_u and λ_t are sets of university and year fixed effects. δ_i is a set of individual fixed effects, included in the model to capture time-invariant unobservable variance (for example, motivation or talent). Following Ejermo et al. (2020), the standard errors are clustered in the individual level in order to address possible serial correlation with the error term.

D_{ut} is the treatment dummy variable. It turns on (gets a value of 1) only for treated universities after the treatment was introduced. The coefficient of interest is γ_τ and it will represent the average treatment effect of university status on research publications or citations. Following the prescription of Ejermo et al. (2020), in order "to interpret the coefficient as an elasticity" (p. 610), the following transformation should be implemented:

$$Exp[\gamma_\tau] - 1 \tag{3.2}$$

The work of Goodman-Bacon (2018) prescribes the right interpretation of γ_τ. This research includes three groups, two treated with different treatment timing, and one control. The first treatment group includes all researchers based in the three 1999 universities (Karlstad, Örebro, Linnaeus). The second group includes Mid-Sweden's scholars, and the control group is home for all the rest. This setting is similar to the example in Goodman-Bacon (2018), which will be used to explain the meaning of γ_τ. According to the scholar, in this setting, one could estimate four possible 2X2 DiD models:

1. Treatment group: Karlstad, Örebro, Linnaeus. Time frame: 1996-2011. Treatment timing: 1999. Control group: all other (excluding Mid-Sweden).

2. Treatment group: Karlstad, Örebro, Linnaeus. Time frame: 1996-2005. Treatment timing: 1999. Control group: Mid-Sweden (excluding all the rest).

3. Treatment group: Mid-Sweden. Time frame: 1996-2011. Treatment timing: 2005. Control group: all other (excluding Karlstad, Örebro, Linnaeus).

4. Treatment group: Mid-Sweden. Time frame: 1999-2011. Treatment timing: 2005. Control group: Karlstad, Örebro, Linnaeus (excluding all the rest).

The coefficient γ_τ according to Goodman-Bacon (2018), is a weighted average of these four scenario's DiD coefficients. When the weights are determined based on the "group sizes and the variance of the treatment dummy within each pair" (Goodman-Bacon, 2018, p. 2). To conclude, conditioned on the validity of the parallel trends assumption, this work's coefficient of interest should be interpreted as the average treatment effect of university status on research publications.

3.2.1 The Parallel Trends Assumption

If this work aims to suggest any causal link between university status and publications, it must demonstrate, in a convincing fashion, that the parallel trends assumption holds. In the words of Cunningham (2021) "the parallel trends assumption is actually just a restatement of the strict exogeneity assumption ... What we are saying when we appeal to parallel trends is that we have found a control group that approximates the traveling path of the treatment group and that the treatment is not endogenous". Unfortunately, the literature provides no standard statistical test that validates if this assumption holds. The parallel trends assumption is requiring that all groups (treatment and control) have the same trends in a no-treatment world. However, in a quasi-experimental setting, the counterfactual data is clearly not available making it impossible to test this assumption directly. Therefore, Cunningham (2021) proposes several possible methods that come close to reassure the assumption is not violated.

The means of securing the critical parallel trends assumption differ by the setting of the quasi-experiment. In a classical 2X2 DiD setting, it is common to use data visualization as proof for the validity of the assumption. This approach is less feasible when in a two-way fixed-effects setting, due to the complexity of visualizing parallel trends between several groups, with several treatment timings (Cunningham, 2021). Figure 3.1 presents an attempt to provide evidence for the validity of the assumption in this work's setting, using the visualization approach. As demonstrated in Figure 3.1 the trends prior to the 1999 expansion seem relatively parallel between all three groups. The period between 1999 and 2005 is ambiguous, making it hard to assess whether the assumption holds. Assessing the validity of the assumption in each of the four settings outlined above is therefore a challenge posed to the ambitious reader.

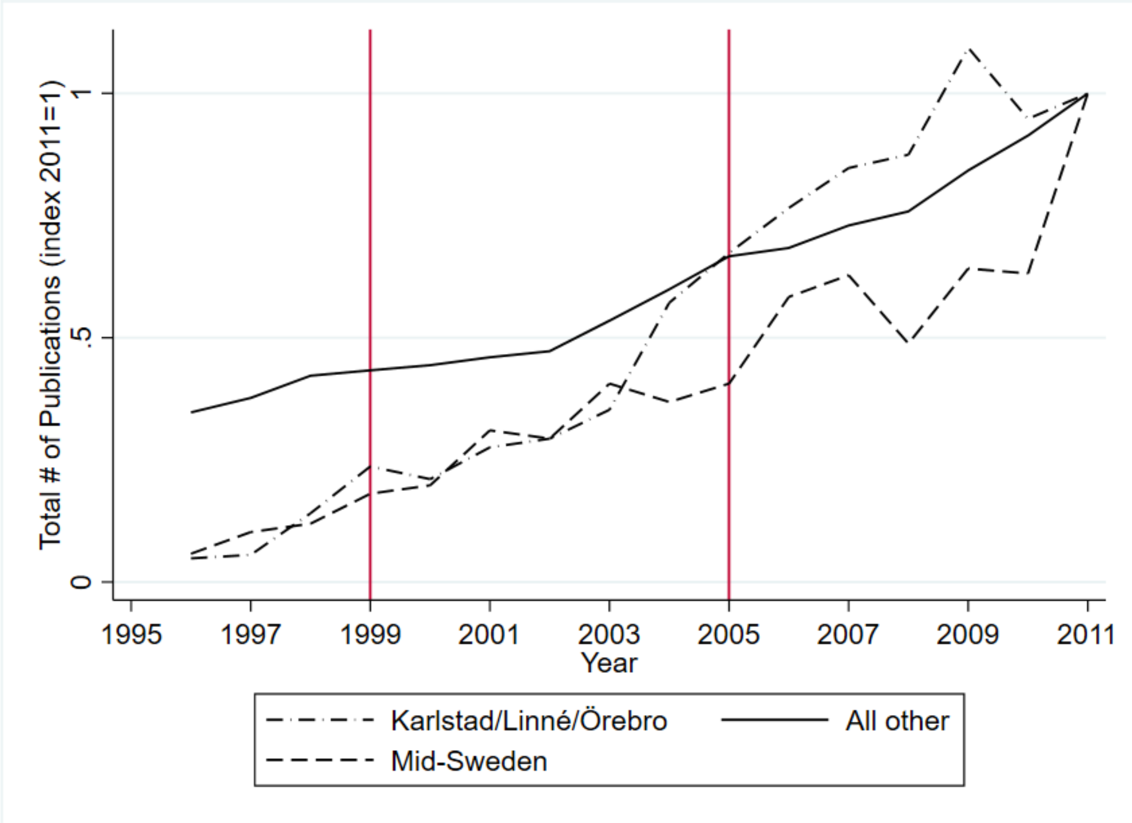


Figure 3.1: Trends in Research Publications - Examining the Parallel Trends Assumption

As expected, Figure 3.1 painted an unclear image, calling for additional inspection seeking to validate the parallel trends assumption. A prevalent method used by scholars is the estimation of a leads and lags model, also known as panel event study (Cunningham, 2021). This method is fairly straightforward, the main idea is to estimate an econometric model, related to the one presented in model 3.1. However, instead of having a binary treatment variable (D_{ut}) switching on when an individual is included in the treatment group after the treatment was introduced, a leads lags model includes sets of dummy variables, representing the time after and before the treatment. If results of this estimation will establish a statistically significant link before the year of treatment, this might indicate that the parallel trends assumption does not hold and vice versa. For this research, the leads lags model estimated is the following:

$$E[y_{iut}|\, \{D_{ut}\}_{\tau=-q,\tau\neq 0}^{m}, \gamma_u, \lambda_t, \delta_i] = Exp[\sum_{\tau=-q,\tau\neq 0}^{m} \gamma_\tau D_{u\tau} + \gamma_u + \lambda_t + \delta_i] \qquad (3.3)$$

The structure of this model is similar to the one presented in 3.1, yet instead of having one treatment variable, this model includes a set of variables representing time from treatment. q and m denote the number of lead and lag years, respectively. This work will apply three lead years($q = 3$), and twelve lag years ($m = 12$) due to two main reasons. The first reason is purely practical, as described in the previous section (Section 3.1), the PARIS database begins in 1996. This gives only three years prior to the 1999 expansion, which affects the biggest treatment group, and twelve years after. The second reason is more of a justification than a reason. In his work, Roth (2019) reviewed 12 empirical studies that included event study methods, a third of them included three or fewer lead periods. Knowing that having three lead years or less is prevalent in the literature is reassuring.

Estimating the leads lags model yields the results presented in Figures 3.2 and 3.3. As demonstrated in Figure 3.2, in all three years leading to the introduction of treatment, the coefficient for publications is statistically insignificant[6]. The first five years following the introduction of treatment are also insignificant, but for five out of seven years starting at the sixth year after treatment, the coefficient is both statistically significant, and with an economic significance. Figure 3.3, however, demonstrates no statistically significant effect on citations. The most important takeaway from this leads lags model, is that according to this estimation, no pre-trends were found.

3.2.2 The Count Data Nature of Publications

Since the outcome variable used in this research is the yearly number of publications per researcher, one should note some known challenges of this type of data. The possible number of yearly publications per scholar ranges between 0 to (theoretically) infinity. However, because of the time, effort, resources, and creativity needed to produce a single research publication, let alone multiple yearly publications, one could assume that the distribution of publications should be skewed to the left. This type of non-negative data is called *count data* (Coxe et al., 2009). This feature of this work's outcome variable will be addressed next.

The nature of the publications variable is presented in Figure 3.4. One could easily observe that most of the observations in this work's database are 0 (more than 75%). Observations with one and two publications are the second and third largest groups, with around 9% and 5% of the database, respectively. Only about 10% of the database includes three or more publications per year. This distribution meets the expectation of a reasonable person about the nature of publishing a research publication. Further, an informed reader will identify the Poisson distribution pattern visualized in Figure 3.4.

Once established that the outcome variable at hand, the publications variable, distributes in a Poisson fashion, some challenges must be addressed. First developed by Hausman et al. (1984) Poisson regression model sought to meet some threats to

[6] Statistically significant coefficient at the level of 95% are those who do not cross the 0 line.

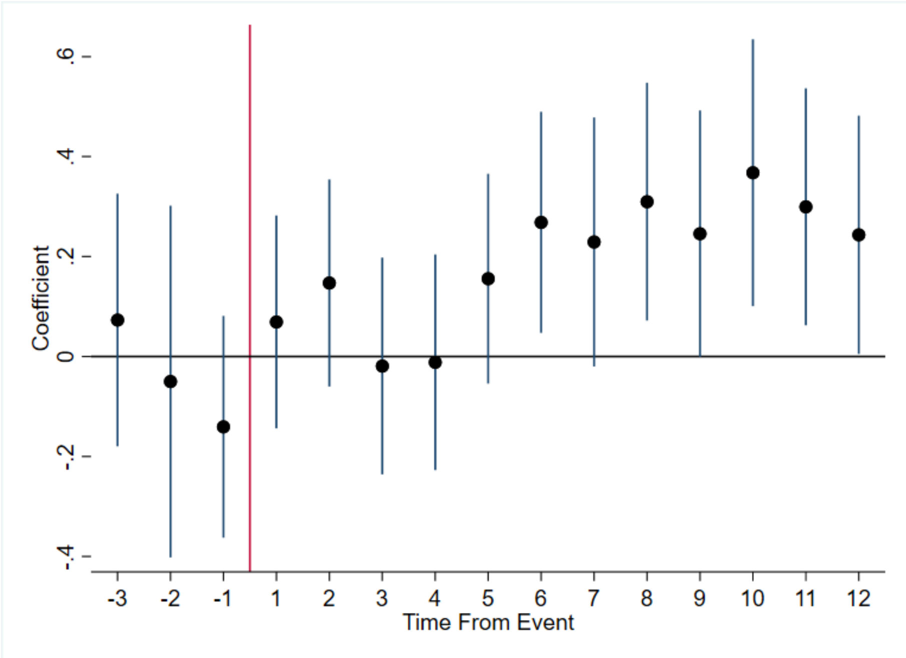


Figure 3.2: Leads Lags Model - Publications

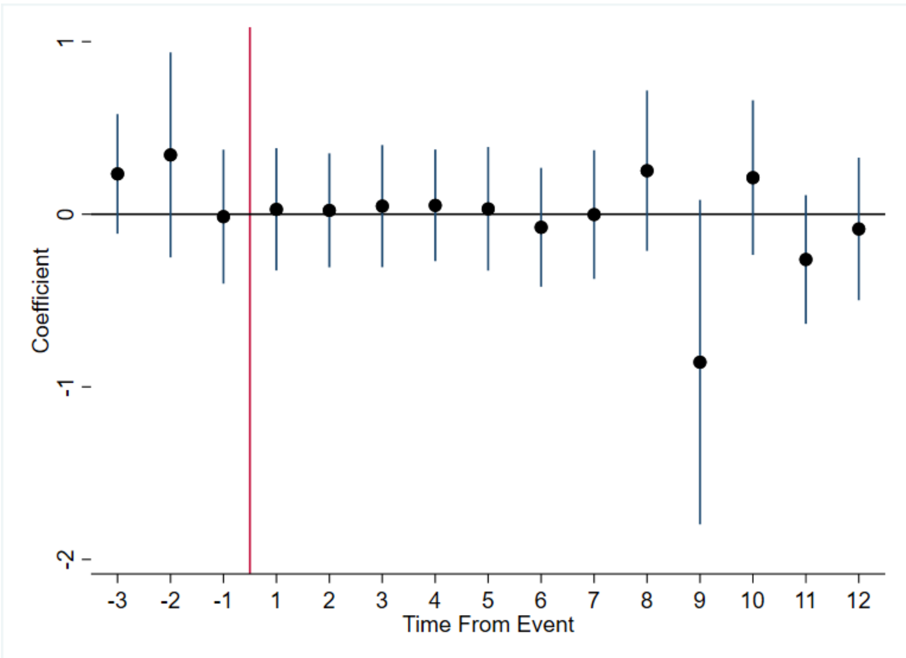


Figure 3.3: Leads Lags Model - Citations

the OLS regression assumptions posed by count data. According to Coxe et al. (2009), using count data with a mean smaller than 10 results in a typical OLS estimation to be fraudulent[7]. Specifically, the estimation might bring about biased coefficients, standard errors, and significance tests. Two assumptions, at the heart of an OLS model, are violated if one is using count data with a small mean as an outcome variable. The non-negative, skewed to the left nature of the outcome variable's distribution results in a violation of the conditional normality and the heteroscedasticity assumptions. As a result, scholars promoted the use of Poisson regression models in cases of count data, arguing it addresses the violation of these assumptions (Coxe et al., 2009).

On a technical note, this study used STATA for its analysis. STATA users have the possibility to use the *xtpoisson* command when implementing Poisson regression in panel data setting[8]. However, scholars produced a better, faster, and more accurate method of estimating econometric models that include a large number of fixed-effects (Correia et al., 2020). Based on the commonly used command for linear regression models *reghdfe*, Correia et al. (2020) developed a STATA command for estimation of pseudo-Poisso maximum likelihood regression models with multiple high-dimensional fixed-effects: *ppmlhdfe*. Without going into too many details, this command address two main limitations of alternative commands. First, it provides a better way to deal with the extreme prevalence of zeros in the outcome variable. Second, it provides a faster (in terms of running time) estimation of regression models with multiple fixed-effects. Correia et al. (2020) (p. 96) even specify models that include research outputs (citations) as main beneficiaries of the commend they developed:

> "[I]n the presence of nonnegative data with possibly many zeros, if one wants to make minimal assumptions about the distribution of the data ... This situation is likely to occur across many areas of research, particularly when working with highly granular data (for example, when modeling ... patent citation counts"

Lastly, an interesting observation in the data, also apparent in Figure 3.4 and Table 3.4, is that in 552 observations the number of publications per year stood on more than 20. For 23 observations, the number of yearly publications stood at more than 50. When the mean number of publications per year stands on less than one (see Table 3.3) these figures are astonishingly high. The maximum number of publications recorded for one individual-year observation in the PARIS database is 97, meaning, this scholar published a research every 2-3 days. At first, one might think

[7] Coxe et al. (2009) provided a "rule of thumb, a Poisson distribution with an expected value greater than 10 approaches a normal distribution in shape and symmetry" (p. 123).

[8] Similar to the *xtreg* commend, just for Poisson models.

Table 3.4: The Distribution of Publications

# of Yearly Publications	# of obs.	% of obs.
0	288727	76.77
1	35063	9.32
2	18344	4.88
3	10438	2.78
4	6578	1.75
5	4304	1.14
6-10	9109	2.43
11-20	2989	0.81
21-50	529	0.12
>50	23	0.00

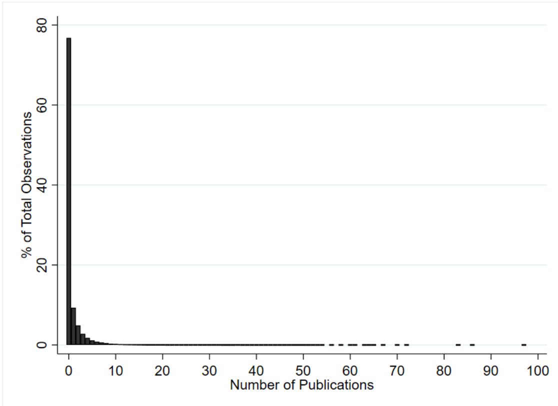


Figure 3.4: The Distribution of Publications

these numbers are surprisingly high, and perhaps even call for further inspection. However, the literature on scholars' productivity identified those unique individuals. Ioannidis et al. (2018) named these scholars as *hyperprolific*, and defined them as those who published more than 72 papers a year (every five days). Using the Scopus database as well, Ioannidis et al. (2018) found that a majority of *hyperprolific* scholars in their sample studied medicine and life sciences. They conducted a survey among *hyperprolific* scholars and found that many of them lead big research teams, mentor many young researchers, and have increased access to resources and data, among other things. Importantly, Ioannidis et al. (2018) found "no evidence that these authors are doing anything inappropriate" (p. 167). Therefore, these observations, who represent the far-right-tail of the Poisson distribution, should and will be included in the analysis that follows.

4

Empirical Analysis

4.1 Results

The results of estimating model 3.1 demonstrate a positive effect of university status on publications, and a negative one on citations. This subsection will present the results of different estimations and will provide interpretations of the estimated coefficients using the transformation in 3.2. The results of the main estimations of this study are available in Table 4.1. Similar sets of estimations were conducted for both citations and publication, to be reviewed next.

Table 4.1: The Effects of University Status on Research Publications and Citations

	Publications				Citations			
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	0.225**	0.173*	0.235**	0.187*	-0.272*	-0.284*	-0.258*	-0.267*
	(0.099)	(0.100)	(0.099)	(0.100)	(0.152)	(0.152)	(0.153)	(0.153)
University FE	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓
Position FE	*X*	*X*	✓	✓	*X*	*X*	✓	✓
Science Field FE	*X*	✓	*X*	✓	*X*	✓	*X*	✓
Observations	158,134	158,134	158,134	158,134	79,080	79,080	79,080	79,080
Num. Singletons	217970	217970	217970	217970	8297	8297	8297	8297
Num. Clusters	20929	20929	20929	20929	14832	14832	14832	14832
Pseudo R-sq.	0.467	0.468	0.469	0.470	0.657	0.657	0.658	0.658

Standard errors clustered at the individual level in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

First, Table 4.1 columns (1) and (5) includes the estimation results for model 3.1, with publications and citations as the outcome variable, respectively. The estimated coefficient for publications is statistically significant at a 5% confidence level and equals 0.225. In order to understand the economic meaning of this coefficient the following transformation is conducted: $Exp[0.225] - 1 = 0.252$. Therefore, obtaining university status is suggested to cause an increase of 25.2% in research publications. The effect on citations is in the opposite direction, where university status is associated with a decline of 23.8% in citations.

Moreover, one might argue that including controls for the field of research and the position of the researcher might increase the explanatory power of the model. This suggestion is reinforced when remembering the differences between the control and the treatment group, discussed in the summary statistics section (Section 3.1.1). Specifically, the treatment group is characterized by an increased share of social sciences and humanities research, while the control group seems to have greater shares in all other fields (see Table 3.2). In addition, the control group includes more scholars defines as Associate Professors and guest researchers, while the control group has more professors, postdocs, Ph.D. students, and those classified as other. Differences in age and place of birth also exist, however, both variables could not be included in the model. The age is multicollinear with the individual and year fixed-effects. Place of birth is a time-invariant variable, therefore, it will not add variance to the model.

The estimated effects of university status after the inclusion of position and field of research controls remain statistically significant but differ slightly in economic significance. First, as presented in column (2), adding a science field fixed-effects to the model reduces the magnitude of the effect on publications, from 25.2% to 18.8%. The level of statistical significance, declines as well, from 5% to 10%. The effect on citations, visible in column (6) is almost unchanged. Further, in columns (3) and (7), the model includes position fixed-effects, without science field fixed-effects. The effect on publications is higher than in the previous two specifications, and stands at 26.5%, with a statistical significance level of 5%. When examining the effect on citations, this specification yields the lowest effect, with a decline of 22.7%.

Furthermore, column (4) and (8) presents a complete model, with both position and science field fixed-effects. The effect on publication (column (4)) indicates a 20.6% increase, with a statistical significance level of 10%. The effect of citations (column (8)) demonstrates a decrease of 23.4%. Therefore, the estimated effect of university status on research publications ranges between an increase of 18.8% to 26.5%. The effect on citation ranges between a decrease of 24.7% to 22.7%.

In addition to the estimated effect, Table 4.1 also reports the number of observations, singletons, clusters, and the estimated pseudo R^2. As reflected from the pseudo R^2, the model's strength increase with the inclusion of position and science field's fixed-effects. This is clearer in the publications models (1-4) than in the citations models (5-8) where the increase only occurs when position fixed-effects are included. More, the number of observations halves between the publications and citations models. This is an expected behavior since not all publication gets cited by others, and some scholars' work never gets cited. While in the case of Publications, no missing values are allowed, no such restriction exists for citations, also resulting in a smaller number of observations. Further, the number of singletons is in the database is substantial and is driven mainly by individuals who never published. In fact, less the 1% of omitted singletons published a constant number that is greater than 0. Lastly, since the standard errors in this model are clustered at the individual level, the number of clusters indicates the number of individuals included in each estimation.

4.2 Robustness Checks

This section will provide additional testings to the results presented in the previous section. The results, as presented in Table 4.1, seems consistent across all four specifications, both for publications and citations. Therefore, this section will address some sources of concern, identified in Sections 2.2 and 2.3. The main objective of this section is to further test the results presented in Table 4.1.

The first four columns in Tables 4.2 and 4.3, estimate model 3.1 with different modifications of the treatment group. First, column (1) estimated the model after dropping Mid-Sweden university from the database. It leaves the treatment group only with the three 1999 universities (Karlstad, Örebro, and Linnaeus). The reasoning behind this specification is rooted in the review of the 1999-2005 expansion process detailed in Section 2.2. Mid-Sweden University College applied for university status in 1998, but its request was denied. Importantly, in its final decision, the government signaled that the institution will become a university in the following years, giving some sort of certainty that perhaps might hinder the exogenous nature necessary for the empirical setting. The results of this estimation, omitting Mid-Sweden university observations, are statistically significant in a 1% level, higher than all of Table 4.1. The estimated effect, in this case, is substantially larger than the one estimated in all of Table 4.1 estimations and stands on an increase of 62.9% in publications.

The second specification excludes Karlstad university from the database, leaving the treatment group only with Örebro, Linnaeus, and Mid-Sweden University. As described in Section 2.2, Karlstad university was the only institution that enjoyed a (positive) consensus surrounding its qualification to become a university. It is therefore possible to suspect that Karlstad University might have demonstrated better

Table 4.2: *The Effects of University Status on Publications - Robustness checks*

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DiD	0.488***	0.185*	0.512***	0.472***	0.223**	0.192*	0.243***
	(0.132)	(0.109)	(0.172)	(0.176)	(0.106)	(0.106)	(0.093)
University FE	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓
Sample Excluding	MIU	KAU	MIU, ORU, LNU	MIU, KAU	Switchers #1	Switchers #2	$Year > 2009$
Observations	156,264	156,070	150,877	154,206	124,700	151,565	112,955
Num. Singletons	214812	214612	206589	211448	181970	210198	178771
Num. Clusters	20727	20722	20204	20519	17566	20316	16167
Pseudo R-sq.	0.468	0.467	0.468	0.468	0.464	0.468	0.465

Switchers #1: All individuals switching between institutions.

Switchers #2: Only individuals switching between treatment institutions to control ones.

Standard errors clustered at the individual level in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

performance already prior to its status change, threatening the identification strategy. The results of an estimation omitting all of Karlstad university's observations are presented in Table 4.2 column (2). The results maintain statistical significance at a reduced level of 10%, and the estimated positive effect stands at 20.3%. Based on the same rationale, the third specification only included Karlstad university and dropped all other three institutions from the sample. The estimated effect, in this case, is the largest, and stands on an increase of 66.9% in publications, at a 1% significance level.

The fourth specification restricted the sample so that the treatment group will only include the two 'surprise' universities, Örebro, and Linnaeus. The review process of these two institutions conducted by the National Higher Education Agency concluded time and again that they do not qualify to be granted university status. However, the government ignored the agency's recommendations and decided to upgrade these two institutions. This unexpected decision is presumably ensuring the exogeneity requirement. The result of this estimation is indeed statistically significant at a 1% level, and the estimated effect stands at 60.3%.

Other threats to identification are addressed in columns (5) and (6) of Table 4.2. These two estimations aimed at addressing a possible selection into treatment bias, resulted by individuals moving from one university to the other, and specifically, from the treatment group to the control group. Column (5) includes an estimation excluding all individuals who moved from one institution to the other. As one could see, this leads to a decline of almost 30,000 observations. However, the estimated effect is consistent with the main results of this paper, suggesting an increase of 25% in publications at a 5% statistical significance level. Only dropping individuals who switch between treatment and control reduces the number of observations dropped to less than 3000. Yet the estimated effect, standing on 21.2% increase in publications is statistically significant at a reduced level of 10%.

As mentioned in Section 2.3, dealing with research funding in Sweden, changes to the funding system were introduced in 2009, these will be addressed next. Risking this work's identification strategy is the introduction of output-oriented indicators such as bibliographic measurements in the funds' allocation process since 2009 (European Commission, 2010; Hicks, 2012; Checchi et al., 2019). The reason it is a cause for concern is the direct link it creates between funding and publications and citations, undermining the fundamental notion this research is based on. One should note that the impact of these changes on the funding mechanisms is questionable (Hallonsten and Silander, 2012). Notwithstanding, Table 4.2 column (7) presents the results of an estimation using a database covering 1996-2008. All observations from 2009 onwards were omitted. The results of this specification demonstrate an increase in significance level, to 1%. The estimated effect is in line with the results of Table 4.1, and stands on an increase of 27.5%.

Furthermore, all seven robustness checks conducted for publications were also estimated in the case of citations. The results of these estimations are presented in Table 4.3. While the robustness checks for publications demonstrated a great level of resilience, the corresponding checks for citations seem to perform poorly. Out of seven specifications, two returned statistically significant, four lost their significance, and one (specification (6)) did not converge. The two specifications that have demonstrated statistical significance at a 10% level were (2) and (7), representing the samples without Karlstad university, and the post-2009 observations, respectively. These estimations suggest a decline of 25.8% (for (2)) and 21.2% for (7), in line with the effect demonstrated in the previous section.

4.3 Discussion

The results presented in the previous two sections suggest that obtaining university status in Sweden boosts research publications of scholars robustly and substantially. In all specifications, conducted in this research, a positive and statistically significant positive effect of university status on research publications was found. The magnitude of this effect ranges between 18.8%-66.9%, a wide range to all accounts that call for further inspection.

Indeed, a closer look at the results reveals a difference between the estimated effect in specifications that included Mid-Sweden University observations, and those from which they were omitted, which differed in magnitude. The estimations with Mid-Sweden university observations yielded an estimated increase in publications

Table 4.3: The Effects of University Status on Citations - Robustness checks

VARIABLES	(1)	(2)	(3)	(4)	(5)	(7)
DiD	-0.000	-0.298*	-0.064	0.025	-0.204	-0.238*
	(0.159)	(0.170)	(0.190)	(0.210)	(0.139)	(0.123)
University FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓
Sample Excluding	MIU	KAU	MIU, ORU, LNU	MIU, KAU	Switchers #1	$Year > 2009$
Observations	78,346	78,353	76,395	77,620	63,424	56,699
Num. Singletons	8187	8207	7980	8096	7334	6507
Num. Clusters	14700	14699	14345	14567	12223	11289
Pseudo R-sq.	0.657	0.657	0.656	0.657	0.663	0.659

Switchers #1: All individuals switching between institutions.
Standard errors clustered at the individual level in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

of between 18.8% to 26.5%. Those without them suggested an increase of 60.3%-66.9%. In addition, including Mid-Sweden University in the treatment group led to a reduction in the statistical significance of the DiD coefficient. All three estimations excluding these observations enjoyed a high level of statistical significance (1%), while non of those that included Mid-Sweden University observations reached a similar significance level (reneged between 5%-10%).

A possible explanation for this might be found in Figure 2.2 (d), where one could observe the trends in Mid-Sweden's research expenditure over time and by scientific field. As previously discussed, unlike the experience of the three 1999 universities, following the introduction of treatment, the expenditure on research seems to have only mildly increased (and at times even declined). This might have countered the expected effect of university status, which arguably leads to greater access to funds. In addition, as detailed in Section 2.2, Mid-Sweden University was only granted a university status in 2005, concluding a more gradual process (compared to the other three). Importantly, prior to the 2005 status changes, the institution received several indications it might be upgraded. For example, while the final decision to upgrade the three 1999 universities was made half a year prior to the actual date of status change, the decision regarding Mid-Sweden University was made almost two years in advance[1] Therefore, further research on the Mid-Sweden University case is required.

Furthermore, as demonstrated in the leads lags estimation for the publications'

[1]An estimation of a leads lags model, similar to the one in 3.3 is presented in Appendix A Figure A.2. One could identify some statistically significant lead effects estimated, this in turn increase the importance of the specifications excluding Mid-Sweden University.

model (see Figure 3.2), a lag of six years in the effect on publication is observed. This is an interesting finding since it is not necessarily intuitive. One could expect research institutions that did not enjoy great access to funds, will have to invest greatly in the construction of facilities and recruitment of faculty members. Discussed in the historical background section (see Section 2.1). The 1977 expansion of the Swedish higher education system led to the establishment of new university colleges, which primarily aimed at providing higher education to meet the growing demand. These institutions were not planned to conduct research, and only with time, they developed the tenancy and capacity to do so. As a result, one could assume an upgrade from a university college to university status, that initiates greater access to funds, will result in great investment in research infrastructure, seeking to close the gap with existing universities. Also, in order to attract productive scholars, universities need to engage in marketing and reputation-building activities. These operations take time and perhaps contribute to the lagged effect of university status on publications.

Unlike the seemingly robust effect on publications, the effect on citations is questionable. This paper's main estimations provided an indication for a statistically significant negative effect of university status on citations, ranging between a decrease of 21.2%-25.8%. Perhaps a possible explanation of this suggested negative effect is related to the process of expanding the research capacity of the new universities. Once they received recognition, they could offer greater research funds to their existing staff as well es hire new researchers. Yet, as visible in Table 3.2, the shares of Professors, postdocs and 'other' from the total research staff in the treatment group is smaller than in the control group. These scholars are also the ones who get cited the most (on average), as observed in Table 3.3. Therefore, the channels leading to the suggested negative effect on citations call for further research. However, the robustness checks revealed an unsteady effect, when only two out of seven tests returned statistically significant. The estimation of a leads lags model for citations also casts doubts on the validity of the results. Concluding that in contrast with the substantial and robust increase in the number of publications, no robust effect on their quality was found.

The results of this work stand in line with the existing literature. On the one hand, this work provides evidence for a causal link between university status and research publications. The identification strategy of this work is based on the notion that university status could be used as a proxy for increased access to research funds, and therefore the robust positive impact on publications is attributed to the boom in research funding. Further, similar to most previous literature, this work failed to identify a robust effect on citations.

5

Conclusions

This research aimed to identify and quantify the effects of university status on scholars' scientific output in Sweden. To do so, this work utilized the 1999 expansion of the Swedish higher education system. In late 1999, four university colleges (Karlstad, Örebro and Växjö, and Mid-Sweden) applied to be granted university status. Unexpectedly, Karlstad, Örebro, and Växjö obtained it and were added into the Swedish universities club. Mid-Sweden's request was postponed, and eventually, the institution receive university status in 2005. Importantly, in Sweden, there is a direct link between the amount of funds accessible for scholars and the status of the institutions they are based in. Meaning, obtaining university status facilitates greater access to research funds for scholars working in the institution. These features of the Swedish higher education system provide a good basis for research of the effects of increased access to research funds on scientific output.

This work capitalized on the 1999-2005 expansion as a quasi-natural experiment. Using the Publications of Academic Researchers In Sweden (PARIS) database, a two-way fixed-effects difference-in-difference with multiple treatment timing method was implemented. The results of this study stand in line with most of the existing literature. First, a positive and statistically significant increase of 18.8%-66.9% in publications was found to be robust. Second, while some specifications indicated a negative effect on citations, these results were not stable, making it difficult to argue for a negative impact on the quality of publications.

While the results of this research enrich the existing body of literature, it also contributes to the understanding of policymakers. When examining whether a university college is meeting the minimum requirements to become a university, policymakers should take note of the findings of this research. It seems like obtaining university status, and the financial benefits it entails unleashes a concealed potential for knowledge production. This means the increase in scientific output resulted from the decision to award university status should be included in the assessment and decision-making process.

The findings of this study call for future research of several different aspects. First, as reviewed in the historical review section of this thesis, a university college could potentially obtain access to increased research funds without being awarded university status. In order to gain assess to research funds in designated research fields, non-university institutions could apply for a 'research area' status. Future research could perhaps develop a more nuanced index, of access to research funds, to be used as a treatment variable. Alternatively, collecting the data on university status and research areas could be used to assign each individual scholar its treatment status. For example, if Karlstad would have been granted university status in 1999 in the social sciences and humanities fields of study, and only in 2003 a full university status. One could potentially facilitate an identification strategy that regards social science scholars as treated already at 1999 and not 2003.

Further, future works could aim to expand the existing PARIS database. One of the reasons the PARIS database begins in 1996 is that at the time it was developed, its source of publications and citations data, the Scopus database, was limited in coverage of the years leading to 1996. However, today the coverage of the Scopus database ranges back to 1970[1]. This development is substantial since it allows to estimate the effects of the two biggest expansion reforms (in 1977 and 1999) of the Swedish higher education system.

Lastly, further research might implement more complex econometric methods to address potential selection problems. Since this research is based on a real world data, and hence individuals are not distributed randomly between treatment and control groups, there might be systemic selection into treatment issues. A common method that could address this problem is the Synthetic Control Method which allows to construct a control group that serves as a better counterfactual Cunningham (2021). Alternatively, one could implement a matching technique to identify a better suited control group. This method was implemented by Ejermo et al. (2020) who used a non-parametric coarsened exact matching (CEM) algorithm.

[1]According to the Scopus content coverage guide, see: https://www.elsevier.com/__data/assets/pdf_file/0007/69451/Scopus_ContentCoverage_Guide_WEB.pdf

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Appendix A

Additional Tables and Figures

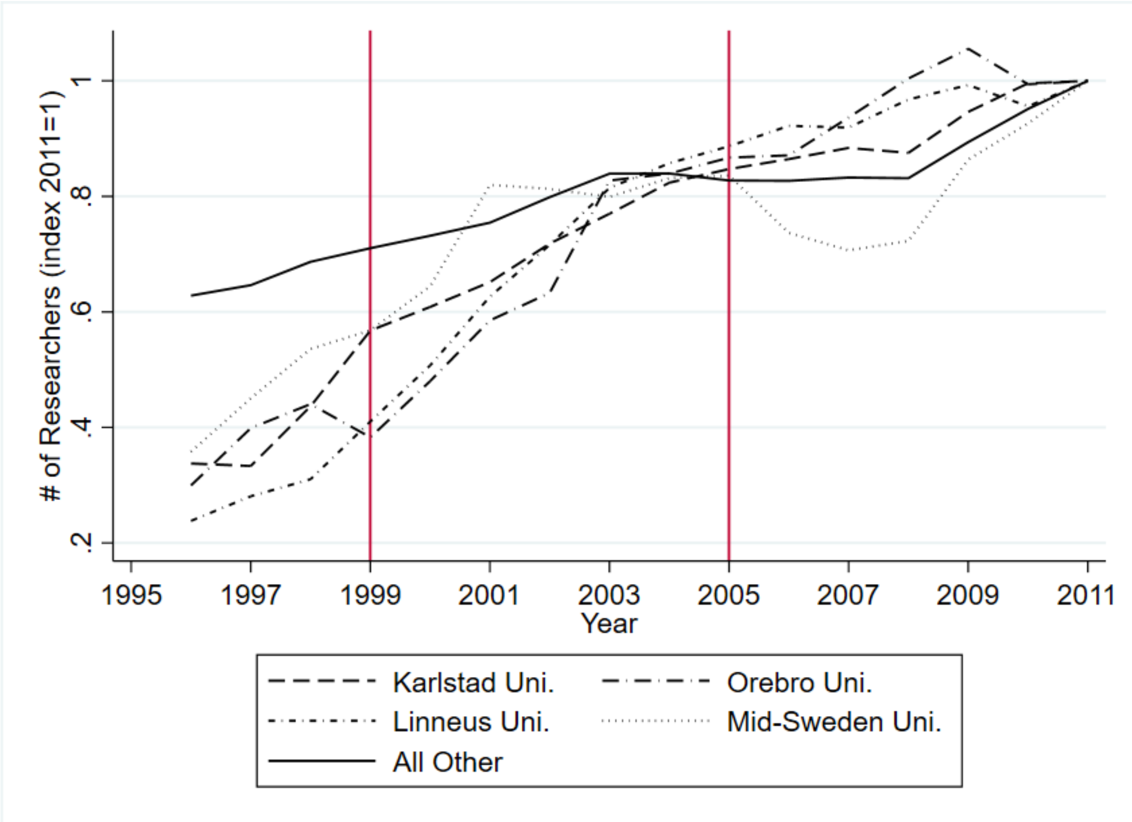

Figure A.1: Trends in Research Staff - Before and After University Status

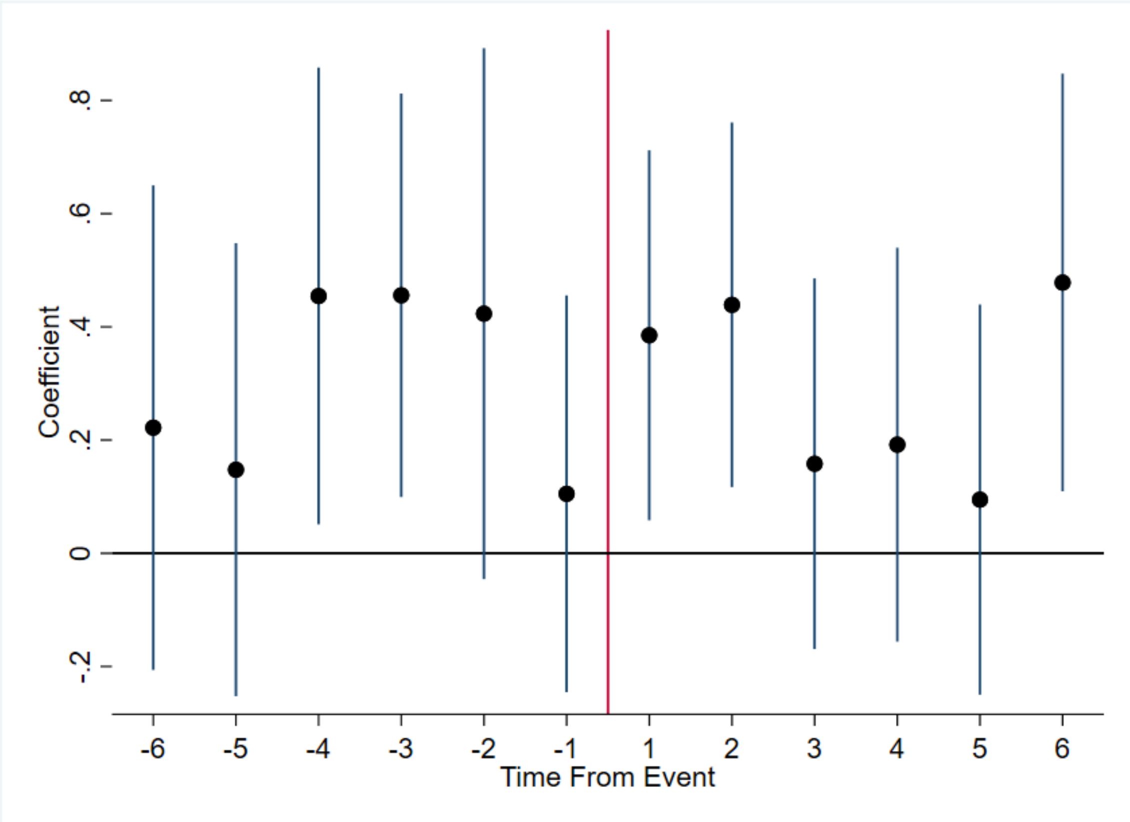

Figure A.2: Testing a Publications Leads Lags Model - for Mid-Sweden University