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Peer Effects in Science - Evidence from the Dismissal of Scientists in Nazi Germany

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Abstract

This paper analyzes peer effects among university scientists. Specifically, it investigates whether the number of peers and their average quality affects the productivity of researchers in physics, chemistry, and mathematics. The usual endogeneity problems related to estimating peer effects are addressed by using the dismissal of scientists by the Nazi government as a source of exogenous variation in the peer group of scientists staying in Germany. Using a newly constructed panel dataset covering the universe of physicists, chemists, and mathematicians at all German universities from 1925 until 1938 I investigate peer effects at the local level and among co-authors. There is no evidence for localized peer effects, as neither department level (e.g. the physics department) nor specialization level (e.g. all theoretical physicists in the department) peers affect a researcher's productivity. Among co-authors, however, there is strong and significant evidence that peer quality affects a researcher's productivity. Loosing a co-author of average quality reduces the productivity of an average scientist by about 13 percent in physics and 16.5 percent in chemistry.

Keywords: peer effects, Nazi Germany, science, university, higher education, spillovers, co-authors
JEL Classifications: I20, I21, I23, I28, J24, L31, L38, N34, N44, O31, O38

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1 Introduction

This paper analyzes peer effects among university scientists. It is widely believed that peer effects are important among academic researchers. However, when individual researchers choose the best university to carry out their research they do not necessarily consider these effects. This may result in a misallocation of talent and underinvestment in academic research. Having a good understanding of peer effects is therefore crucial for researchers and policy makers alike. Despite the widespread belief in the presence of peer effects among university researchers there is only limited empirical evidence for these effects.

This is due to the fact that obtaining causal estimates of peer effects is very challenging. An important problem for any estimation of peer effects is caused by sorting of scientists. Highly productive scientists often work alongside other productive researchers. If sorting is taking place it is not clear whether successful scientists are more productive because they are collaborating with successful peers or because their productivity is higher per se. Another problem complicating the estimation of peer effects is the presence of unobservable factors which affect a researcher’s productivity but also the productivity of his peers. The construction of a new laboratory which the econometrician cannot observe, may be such a factor. Most of these unobserved factors would lead to an upward bias of peer effect estimates. Furthermore, estimates of peer effects may be distorted because of measurement problems. In this context the main problem is the correct measurement of a researcher’s peer group. It is not only difficult to identify the peers of any given scientist but also to quantify the quality of these peers. A promising strategy to obtain unbiased estimates of peer effects is therefore to analyze a scientist’s productivity if his peer group changes due to reasons which are unrelated to his own productivity.

This paper proposes the dismissal of scientists by the Nazi government as an exogenous and dramatic change in the peer group of researchers in Germany. Almost immediately after Hitler’s National Socialist party secured power in 1933 the Nazi government dismissed all Jewish and so called "politically unreliable" scholars from German universities. Around 13 to 18 percent of all scientists were dismissed between 1933 and 1934 (13.6 percent of physicists, 13.1 of chemists, and 18.3 percent of mathematicians). Many of the dismissed scholars were outstanding members of their profession, among them the famous physicist and Nobel Laureate Albert Einstein, the chemist Georg von Hevesy who received the Nobel Prize in 1943, and the Hungarian mathematician Johann von Neumann. Scientists at the affected departments were thus exposed to a dramatic change in their peer group. This shock persisted until the end of my sample period because the majority of the open positions could not be filled immediately. Scientist in departments without Jewish or "politically unreliable" scholars did not experience any dismissals and thus no change to their peer group.

In this paper I use the dismissal to identify peer effects among physicists, chemists, and mathematicians. I focus on these subjects because advancements in these fields are widely believed to be an important source of technological progress. Furthermore, a scientist’s productivity can be well approximated by analyzing publications in academic journals. Scientists published their results in refereed scientific journals already in the 1920s and 1930s, the time period studied in this paper. Another reason for concentrating on the sciences is the attempt of the Nazi regime to ideologize all parts of society after 1933. These policies also affected university research. The impact on different subjects, however, varied a lot. Subjects such as economics, psychology, history, or sociology were affected much more than the sciences.[1] The last reason for focusing on physics, chemistry, and mathematics is the fact that researchers at German universities were among the leading figures in those fields in the early 20th century. Examples for the leading role of German science at the time are the Nobel Prize awards to researchers from German universities. Between 1910 and 1940, 27 percent of Nobel laureates in physics and 42 percent of Nobel prize winners in chemistry were affiliated with a German university. This is a much larger fraction than that of any other country at the time. If peer effects are an important determinant of a researcher's productivity they are likely to be especially important in a flourishing research environment such as Germany in the early 20th century.

In order to investigate peer effects, I use historical university calenders to construct a panel dataset of the universe of physicists, chemists, and mathematicians teaching at all 33 universities in Germany from 1925 until 1938. I do not consider the years after 1938 because of the start of World War II in 1939. I also compile a list of all dismissals from a number of different archival sources. Finally, I obtain data on publications and citations of these researchers in the leading academic journals of the time. More details on the data sources are given in the data section below.

The collaboration of researchers can take different levels of intensity. A very direct way of peer interaction is the collaboration on joint research projects involving joint publication of results. There are, however, more subtle interactions of colleagues in universities. Scientists may also discuss ideas and comment on each other's work without copublishing any of their work. Yet another way in which peers may affect a researcher's productivity is through peer pressure. A scientist's work effort may depend on the effort of his peers because he may want to match or surpass their research output. Having more (less) productive peers would thus increase (reduce) a researcher's productivity. The definition of peer effects in this paper encompasses any of these different types.

In addition to these different levels in the intensity of peer interactions there are two main dimensions of peer groups which matter for academic research. The first dimension is the *number* of peers a researcher can interact with. Another important dimension of a scientist's peer group is the *quality* of his colleagues. This paper is the first to separately identify the importance of these two aspects of peer interactions.

Another novelty of this paper is that my setup allows me to investigate different geographic dimensions of spill-over effects. I can analyze *localized* peer effects at the level of a scientist's department (e.g. the physics department) and specialization within his department (e.g. among theoretical physicists within the department). The dismissal is a very strong and precise predictor of changes in the number and the average quality of peers at the local level. I find, however, that neither the number of dismissed colleagues nor the dismissal induced reduction in average

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[1] The sciences were not completely unaffected by the Nazi regime. The most famous example is the "German Physics" movement by a small group of physicists trying to ideologize physical research. The consensus among historians of science, however, is that the movement never mangaged to have a strong impact on the physics community. See Beyerchen (1977) for details.

peer quality significantly affects the productivity of physicists, chemists or mathematicians at the local level. I also estimate a more structural model of peer effects instrumenting for the number of peers and their average quality with the dismissal. I do not find any significant effects of the number of peers or their average quality at the *department* or *specialization* level. The standard errors of these estimates are small. These results therefore indicate that *localized* peer effects do not play a role in this environment.

In addition to those localized peer effects I investigate peer effects among *coauthors* for physics and chemistry. Due to the very low level of coauthorship in mathematics I cannot analyze spill-over effects for coauthors in mathematics. I find that losing a coauthor of average quality reduces the average researcher's productivity by about 13 percent in physics and 16.5 percent in chemistry. Losing coauthors of higher than average quality leads to an even larger productivity loss. Furthermore, I show that the effect is solely driven by recent collaborations. The productivity of scientists who lose a colleague with whom they did not coauthor in the last four years before the dismissal does not fall after the dismissal. It is not entirely clear whether one would like to characterize the joint publication of papers a real spill-over effect. I therefore investigate whether authors who lose a coauthor also publish less if one focuses on the publications which were not coauthored with the dismissed coauthor. Finding a drop in these publications after the dismissal would suggest classic spill-over effects between coauthors. Indeed, I find a negative and significant effect from losing a high quality coauthor even on those publications. These results suggest that peer effects are important among coauthors.

There is of course a worry that the dismissals affected the productivity of scientists through other channels. I discuss these threats to the identification strategy below and show evidence that the dismissals are uncorrelated with changing incentives in the affected departments, and the number of ardent Nazi supporters in the department. I also investigate whether different funding patterns might explain my results. The fact that my results are very similar for theoretical physicists and mathematicians, where laboratories are not important, suggests that counterbalancing funding is not likely to contaminate my estimates. Furthermore, I show that different productivity trends of affected and unaffected departments do not seem to be important in this setup.

Understanding the effects of the dismissal of a large number of scientists during the Nazi period is interesting in its own right. Recently other economists have analyzed aspects of the Nazi rise to power. Ferguson and Voth (2008), for example, show that firms supporting the Nazi movement experienced unusually high stock-market returns in the first months of the Nazi regime. The findings of my paper may also lead to a better understanding of similar events which occurred in other countries. One example is the purge of thousands of scientists who did not adhere to the communist ideology in the Soviet Union under Stalin. The scope of this paper, however, goes beyond the understanding of historical events, because it allows the identification of peer effects using an exogenous variation in a researcher's peer group. The question remains whether evidence on peer effects in Germany in the 1920s and 1930s can be used to understand peer interactions today. A number of reasons suggest that the findings of this study may be relevant for understanding spill-overs among present-day researchers. The three subjects studied in this paper were already well established at that time; especially in Germany. Scientific research followed practices and conventions which were very similar to current research methods. Researchers were publishing their results in refereed academic journals, conferences were common, and researchers were surprisingly mobile. Unlike today, they could not communicate via E-mail. They did, however, vividly discuss research questions in letters. Given the dramatic fall in communication and transportation costs it is quite likely that localized peer interactions are even less important today than in the 1920s and 1930s. The increased specialization in scientific research makes it harder to find researchers working on similar topics in the same department. This will further contribute to the fact that today's localized peer effects are less important than in the past.

As described before, I find that peer effects among *coauthors* are important. Reductions in transportation and communication costs suggest that potential benefits from collaborating with researchers who are located in a different university may be even more important today. The increased importance of teams in the production of scientific research and increased cooperation between researchers from different universities and even countries may partly be driven by peer effects among coauthors.[2] If lower communication costs are indeed facilitating the interaction of coauthors across different departments my results would provide a lower bound for peer effects among coauthors today.

This study contributes to a growing literature on peer effects among university researchers. To my knowledge, it is the first to analyze *localized* peer effects among scientists using credibly exogenous variation in peer quality. It is also the first study to separate the effects of the number of a scientist's peers and their average quality.

Azoulay, Wang, and Zivin (2007) investigate peer effects among coauthors in the life sciences. Using the death of a prolific researcher as an exogenous source of variation in a scientist's peer group they find that deaths of coauthors lead to a decline in a researcher's productivity. They find stronger effects for more prolific coauthors. Their setup does not allow them, however, to directly analyze *localized* peer effects which are widely believed to be important. In my setup I can observe the universe of all university researchers in physics, chemistry, and mathematics. Azoulay et al. only observe the coauthors of dying researchers and not all peers in their department or specialization. The fact that their results on coauthors are very similar to my coauthor results in early 20th century Germany suggests that my findings may indeed shed light on peer effects today. Oettl (2008) extends the analysis of Azoulay et al. and shows that coauthor peer effects are large not only if the dying coauthor was very productive but also when he was considered very helpful by his surviving coauthors.

A recent study by Weinberg (2007) analyzes peer effects among Nobel Prize winners in physics. He finds evidence for mild peer effects among physics Nobel laureates. Using the

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[2] Wuchty, Jones, and Uzzi (2007) show that the number of coauthors in science research increased dramatically since 1955. Furthermore, Adams et al. (2005) show an increase in the geographic dispersion of research teams in the US. Recently, Agrawal and Goldfarb (2008) have shown that falling communication costs have increased collaborations of engineers across universities in the US.

timing of starting Nobel Prize winning work he tries to establish causality. It is very likely, however, that this does not fully address the endogeneity problem which may affect his results on spill-overs. Kim, Morse, and Zingales (2006) estimate peer effects in economics and finance faculties and find positive peer effects for the 1970s, and 1980s, but negative peer effects for the 1990s. They argue that their results are not contaminated by endogeneity problems. The regression specifically analyzing peer effects, however, does not control for endogenous selection of peers.[3],[4]

The remainder of the paper is organized as follows: the next section gives a brief description of historical details. A particular focus lies on the description of the quantitative and qualitative loss to German science. Section 3 gives a more detailed description of the data sources used in the analysis. Section 4 describes the identification strategy. The effect of the dismissal on the productivity of department level and specialization level peers remaining in Germany is analyzed in section 5. Using the dismissal as an exogenous source of variation in peer quality I then present instrumental variable results of localized peer effects in section 6. Regressions presented in Section 7 probe the robustness of these findings. In section 8 I present evidence on peer effects among coauthors. Section 9 concludes.

2 The Expulsion of Jewish and 'Politically Unreliable' Scholars from German Universities

Just over two months after the National Socialist Party seized power in 1933 the Nazi government implemented the "Law for the Restoration of the Professional Civil Service" on the 7th of April of 1933. Despite this misleading name the law was used to expel all Jewish and "politically unreliable" persons from civil service in Germany. At that time most German university professors were civil servants. Therefore the law was directly applicable to them. Via additional ordinances the law was also applied to university employees who were not civil servants. Thus the law affected all researchers at the German universities. The main parts of the law read:

> *Paragraph 3:* Civil servants who are not of Aryan descent are to be placed in retirement... (this) does not apply to officials who had already been in the service since the 1st of August, 1914, or who had fought in the World War at the front for

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[3] Another related strand of the literature focuses on regional spill-over effects of patent citations. Jaffe, Trajtenberg, and Henderson (1993) use an ingenious method to control for pre-existing regional concentration of patent citations. They find that citations of patents are more geographically clustered than one would expect if there were no regional spill-over effects. Thompson and Fox-Keane (2005) challenge those findings in a later paper.

[4] In addition to papers analyzing peer effects among university researchers there is a growing literature examining peer effects in other, mostly low skill, work environments. Mas and Moretti (2008) show that grocery store cashiers increase their productivity when working alongside high productivity peers. Furthermore, Bandiera, Barankay, and Rasul (2007) show that the productivity of fruit pickers conforms to a common norm set by their peers.

> the German Reich or for its allies, or whose fathers or sons had been casualties in the World War.
>
> *Paragraph 4:* Civil servants who, based on their previous political activities, cannot guarantee that they have always unreservedly supported the national state, can be dismissed from service.
>
> ["Law for the Restoration of the Professional Civil Service", quoted after Hentschel (1996)]

In a further implementation decree it was specified that all members of the Communist Party were to be expelled. The decree also specified "Aryan decent" as: "Anyone descended from Non-Aryan, and in particular Jewish, parents or grandparents, is considered non-Aryan. It is sufficient that one parent or one grandparent be non-Aryan." Thus scientists who were Christians were dismissed if they had a least one Jewish grandparent. The law was immediately implemented and resulted in a wave of dismissals and early retirement from the German universities. A careful early study by Harthorne published in 1937 counts 1111 dismissals from the German universities and technical universities between 1933 and 1934.[5] This amounts to about 15 percent of the 7266 university researchers present at the beginning of 1933. Most dismissals occurred in 1933 immediately after the law was implemented. Not everybody was dismissed as soon as 1933 because the law allowed Jewish scholars to remain in office if they had been in office since 1914, if they had fought in the First World War, or had lost a father or son in the War. Nonetheless, many of the scholars who could stay according to this exception decided to leave voluntarily; for example the Nobel laureates James Franck and Fritz Haber. They were just anticipating a later dismissal as the Reich citizenship laws (*Reichsbürgergesetz*) of 1935 revoked the exception clause.

Table 1 reports the number of dismissals in the three subjects studied in this paper: physics, chemistry, and mathematics. Similarly to Harthorne, I focus my analysis on researchers who had the Right to Teach (*venia legendi*) at a German university. According to my calculation about 13.6 percent of the physicists who were present at the beginning of 1933 were dismissed between 1933 and 1934.[6] In chemistry and mathematics the loss was 13.1 and 18.3 percent, respectively.[7] It is interesting to note that the percentage of dismissals in these three subjects and at the German universities overall was much higher than the fraction of Jews living in Germany. It is estimated that about 0.7 percent of the total population in Germany was Jewish at the beginning of 1933.

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[5] The German university system had a number of different university types. The main ones were the traditional universities and the technical universities. The traditional universities usually covered the full spectrum of subjects. The technical universities focused on technical subjects.

[6] This number is consistent with the number obtained by Fischer (1991) who reports that 15.5 percent of physicists were dismissed between 1933 and 1940.

[7] Deichmann (2001) calculates a loss of about 24 percent from 1933 to 1939. The difference between the two figures can be explained by the fact that she includes all dismissals from 1933 to 1939. Furthermore my sample includes 5 more universities which all have below average dismissals. Unfortunately there are no comparable numbers for mathematics by other researchers.

My data does not allow me to identify whether the researchers were dismissed because they were Jewish or because of their political orientation. Other researchers, however, have investigated this issue and have shown that the vast majority of the dismissed were either Jewish or of Jewish decent. Deichmann (2001) studies chemists in German and Austrian universities (after the German annexation of Austria in 1938 the Nazi government extended the aforementioned laws to researchers at Austrian universities). She finds that about 87 percent of the dismissed chemists were Jewish or of Jewish decent. The remaining 13 percent were dismissed for political reasons. Siegmund-Schultze (1998) estimates that about 79 percent of the dismissed scholars in mathematics were Jewish.

Before giving further details on the distribution of dismissals across different universities I am going to provide a brief overview over the fate of the dismissed researchers. Immediately after the first wave of dismissals in 1933 foreign émigré aid organizations were founded to assist the dismissed scholars with obtaining positions in foreign universities. The first organization to be founded was the English "Academic Assistance Council" (later renamed into "Society for the Protection of Science and Learning"). It was established as early as April 1933 by the director of the London School of Economics Sir William Beveridge. In the US the "Emergency Committee in Aid of Displaced Scholars" was founded in 1933. Another important aid organization, founded in 1935 by some of the dismissed scholars themselves, was the Emergency Alliance of German Scholars Abroad ("Notgemeinschaft Deutscher Wissenschaftler im Ausland"). The main purpose of these and other, albeit smaller, organizations were to assist the dismissed scholars in finding positions abroad. In addition to that prominent individuals like Eugen Wigner, Albert Einstein or Hermann Weyl tried to use their extensive network of personal contacts to find employment for less well-known scientists. Due to the very high international reputation of German physicists, chemists, and mathematicians many of them could find positions without the help of the aid organizations. Less renowned and older scientists had more problems in finding adequate positions abroad. Initially many dismissed scholars fled to European countries. Many of these countries were only temporary refuges because the dismissed researchers often obtained temporary positions, only. The expanding territory of Nazi Germany in the early stages of World War II led to a second wave of emigration from the countries which were invaded by the German army. The main destinations of dismissed physicists, chemists, and mathematicians were the United States, England, Turkey, and Palestine. The biggest proportion of dismissed scholars in all three subjects eventually moved to the United States. For the purposes of this paper it is important to note that the vast majority of the emigrations took place immediately after the researchers were dismissed from their university positions. Further collaborations with researchers staying in Germany were thus extremely difficult and did hardly occur. A minority of the dismissed, however, did not leave Germany and most of them died in concentration camps or committed suicide. Very few, managed to stay in Germany and survive the Nazi regime. Even these scientists who stayed in Germany were no longer allowed to use university laboratories and other resources. The possibility of ongoing collaboration of the dismissed scientists with researchers staying at the German universities was thus extremely limited.

The aggregate numbers of dismissals hides the fact that the German universities were affected very differently by the dismissals. Even within a university there was a lot of variation across different departments. Whereas some departments did not experience any dismissals others lost more than 50 percent of their personnel. The vast majority of dismissals occurred in 1933 and 1934. Only a small number of scientists was dismissed after these years. The few dismissals occurring after 1933 affected researchers who had been exempted under the clause for war veterans or for having obtained their position before 1914. In addition to that, some political dismissals occurred during the later years. In order to have a sharp dismissal measure I focus on the dismissals in 1933 and 1934. Table 2 reports the number of dismissals in the different universities and departments. An example for the huge variation in dismissals is the university of Göttingen, one of the leading universities at the time. It lost 40 percent of its researchers in physics and almost 60 percent in mathematics. In chemistry, however, not a single scholar was dismissed from the department between 1933 to 1934.

Table 3 gives a more detailed picture of the quantitative and qualitative loss in the three subjects. The dismissed physicists were younger than the average but made above average scientific contributions; they received more Nobel Prizes (either before or after the dismissal), published more papers in top journals, and received more citations for their publications.[8] The scientific excellence of the dismissed physicists has already been noticed by Fischer (1991). In chemistry the dismissed were more similar to those who stayed in Germany. The dismissed mathematicians were of even higher excellence compared to the average researchers than the physicists.

About 33 percent of the publications in top journals were co-written papers in physics. About 11 percent of all papers were co-published with a coauthor holding a faculty position at a German university. This fraction is much lower than the overall level of co-publishing because of two reasons. A large fraction of coauthors were assistants or Ph.D. students. Secondly, some coauthors were teaching at a foreign university or were employed by a research institute. The last line of Table 3 shows the low level of cooperation within a department; only about 4 percent of all publications were coauthored with a member of staff from the same university. In chemistry 76 percent of papers were coauthored, 12 percent were coauthored with a coauthor holding a faculty position at a German university and only 5 percent of publications were coauthored with a faculty member from the same university. In mathematics these numbers were 11 percent, 6 percent, and 3 percent, respectively.

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[8] For a more detailed description of the publications data see the Data section.

3 Data

3.1 Data on Dismissed Scholars

The data on dismissed scholars is obtained from a number of different sources. The main source is the "List of Displaced German Scholars". This list was compiled by the relief organization "Emergency Alliance of German Scholars Abroad". With the aid of the Rockefeller Foundation it was published in 1936. The list should facilitate the finding of positions for the dismissed researchers in countries outside Germany. Overall, the list contained about 1650 names of researchers from all university subjects. In the introductory part of the list the editors explain that they have made the list as complete as possible. Most historians of science working on the dismissal of researchers in Nazi Germany have used this list as the basis for their research. I extracted all dismissed physicists, chemists, and mathematicians from the list. In the appendix I show a sample page from the physics section of the list. Interestingly, four physicists who had already received the Nobel Prize or were to receive it in later years appear on that page. Out of various reasons, for example if the dismissed died before the List of Displaced German Scholars" was compiled, a small number of dismissed scholars did not appear in the list. To get a more precise measure of all dismissals I complement the information in the "List of Displaced German Scholars" with information from other sources.[9]

The main additional source is the "Biographisches Handbuch der deutschsprachigen Emigration nach 1933 - Vol. II : The arts, sciences, and literature". The compilation of the handbook was initiated by the "Institut für Zeitgeschichte München" and the "Research Foundation for Jewish Immigration New York". Published in 1983 it contained short biographies of artists and university researchers who emigrated from Nazi Germany. Kröner (1983) extracted a list of all dismissed university researchers from the handbook. I use Kröner's list to append my list of all dismissed scholars.

In addition to these two main data sources I rely on data compiled by historians who studied individual academic subjects during the Nazi era. Beyerchen (1977) included a list of dismissed physicists in his book about the physics community in Nazi Germany. I use the information included in that list to amend my list of dismissed scholars. Furthermore, I use data from an extensive list of dismissed chemists which was compiled by Deichmann (2001). Similarly, I complement my list with the information listed in Siegmund-Schultze's (1998) book on dismissed mathematicians.

It is important to note that my list of dismissals also contains the few researchers who were initially exempted from being dismissed but resigned voluntarily. The vast majority of them would have been dismissed due to the racial laws of 1935 anyway and were thus only anticipating their dismissal. All of these voluntary resignations were directly caused by the discriminatory policies of the Nazi regime.

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[9] Slightly less than 20 percent of 1933 to 1934 dismissals do only appear in those additional sources.

3.2 Data on all Scientists at German Universities between 1925 and 1938

To investigate the impact of the dismissals on the researchers who stayed at the German universities I construct a full list of all scientists at the German universities from 1925 to 1938. Using the semi-official University Calendar[10] I compile an annual roster of the universe of physicists, chemists, and mathematicians from the winter semester 1924/1925 (lasting from November 1924 until April 1925) until the winter semester 1937/1938. The data for the technical universities starts in 1927/1928, because the University Calendar included the technical universities only after that date. The University Calendar is a compilation of all individual university calenders listing the lectures held by each scholar in a given department. If a researcher was not lecturing in a given semester he was still listed under the heading "not lecturing". From this list of lectures I infer the subject of each researcher to construct yearly faculty lists of all physics, chemistry, and mathematics departments.[11,12]

To assess a researcher's specialization I consult seven volumes of "Kürschners deutscher Gelehrten-Kalender". These books are listings of German researchers compiled at irregular intervals since 1925.[13] The editors of the book obtained their data by sending out questionnaires to researchers asking them to provide information on their scientific career. I use this information to ascertain a scientist's specialization. Because of the blurred boundaries of the specializations in mathematics a lot of mathematicians did not specify their specialization. In those cases I infer the specialization from the main publications they list in the "Gelehrtenkalender". As the participation of the researchers in the compilation was voluntary not all of them provided their personal information to the editor. If I cannot find a scientist's specialization in any of the volumes of the "Gelehrtenkalender", which occurs for about 10 percent of scientists, I conduct an internet-search for the scientist to obtain his specialization. Overall I obtain the

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[10] The University Calender was published by J.A. Barth. He collected the official university calenders from all German universities and compiled them into one volume. Originally named "Deutscher Universitätskalender". It was renamed "Kalender der deutschen Universitäten und technischen Hochschulen" in 1927/1928. From 1929/1930 it was renamed "Kalender der Deutschen Universitäten und Hochschulen". In 1933 it was again renamed into "Kalender der reichsdeutschen Universitäten und Hochschulen".

[11] At that time a researcher could hold a number of different university positions. Ordinary Professors held a chair for a certain subfield and were all civil servants. Furthermore there were different types of Extraordinary Professors. First, they could be either civil servants (*beamteter Extraordinarus*) or not have the status of a civil servant *(nichtbeamteter Extraordinarius).* Universities also distinguished between extraordinary extraordinary professors *(ausserplanmäßiger Extraordinarus)* and planned extraordinary professors *(planmäßiger Extraordinarius).* Then as the lowest level of university teachers there were the *Privatdozenten* who were never civil servants. Privatdozent is the first university position a researcher could obtain after the 'venia legendi'.

[12] The dismissed researchers who were not civil servants (Privatdozenten and some Extraordinary Professors) all disappear from the University Calendar between the winter semester 1932/1933 to the winter semester 1933/1934. Some of the dismissed researchers who were civil servants (Ordinary Professors and some Extraordinary Professors), however, were still listed even after they were dismissed. The original law forced Jewish civil servants into early retirement. As they were still on the states' payroll some universities still listed them in the University Calendar even though they were not allowed to teach or do research anymore. My list of dismissals includes the exact year after which somebody was barred from teaching and researching at a German university. I thus use the dismissal data to determine the actual dismissal date and not the date a dismissed scholar disappears from the University Calendars.

[13] The first volume was compiled in 1925. The other volumes I have used were published for the years 1926, 1928/29, 1931, 1935, 1940/41, and 1950.

scientist's specialization for about 98 percent of all researchers.[14] Table A1 in the appendix gives an overview of all specializations and the fraction of scientists in each of them.

3.3 Publication Data

To measure a researcher's productivity I construct a dataset containing the publications of each researcher in the top academic journals of the time. At that time most German researchers published in German journals. The quality of these German journals was usually very high because many of the German physicists, chemists, and mathematicians were among the leaders in their field. This is especially true for the time before the dismissal as is exemplified by the following quote; "Before the advent of the Nazis the German physics journals (*Zeitschrift für Physik, Annalen der Physik, Physikalische Zeitschrift*) had always served as the central organs of world science in this domain [...] In 1930 approximately 700 scientific papers were printed in its (the Zeitschrift für Physik´s) seven volumes of which 280 were by foreign scientists." (American Association for the Advancement of Science (1941)). Simonsohn (2007) shows that neither the volume nor the content of the "Zeitschrift für Physik" changed dramatically in the post dismissal years until 1938. Not surprisingly, however, he finds that the dismissed physicists published less and less in the German journals after the dismissal. It is important to note, that the identification strategy outlined below relies on changes in publications of researchers in different German departments which were differentially affected by the dismissal. A decline in the quality of the considered journals would therefore not affect my results as all regressions are estimated including year fixed effects.

The list of top publications is based on all German speaking general science, physics, chemistry, and mathematics journals which are included in the "ISI Web of Science" for the time period 1915 to 1940. Furthermore, I add the leading general journals which were not published in Germany, namely Nature, Science, and the Proceedings of the Royal Society of London to the dataset. I also include four non-German top specialized journals which were suggested by historians of science as journals of some importance for the German scientific community.[15] The "Web of Science" is an electronic database provided by Thomson Scientific containing all contributions in a very large number of science journals. In 2004 the database was extended to include publications between 1900 and 1945. The journals included in that extension were all journals which had published the most relevant articles in the years 1900 to 1945.[16] This process insures that all publications which can be obtained for the early time period 1900 to 1945 were published in the most important journals.

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[14] Some researchers cite more than one specialization. Therefore, physicists and chemists have up to two specializations and mathematicians up to four.

[15] The relevant journals for chemists were suggested by Ute Deichmann and John Andraos who both work on chemistry in the early 20th century. Additional journals for mathematics were suggested by Reinhard Siegmund-Schultze and David Wilkins; both are specialists in the history of mathematics.

[16] For that extension Thomson Scientific judged the importance of a journal by later citatons (cited between 1945 and 2004) in the Web of Science of articles published between 1900 and 1945. For more details on the process see www.thomsonscientific.com/media/presentrep/facts/centuryofscience.pdf.

Table 4 lists all journals used in my analysis. For each of these journals I obtain all articles published between 1925 and 1940 from the "ISI Web of Science". A very small number of the contributions in the top journals were letters to the editor or comments. I restrict my analysis to contributions classified as "articles" as they provide a cleaner measure for a researcher's productivity. The database includes the names of the authors of each article and statistics on the number of subsequent citations of each of these articles. For each researcher I then calculate different yearly productivity measures. The first measure is equal to the sum of publications in top journals in a given year. In order to quantify an article's quality I construct a second measure which accounts for the number of times the article was cited in *any* journal included in the Web of Science in the first 50 years after its publication. This includes citations in journals which are not in my list of journals but which appear in the Web of Science. The measure includes citations from the international scientific community. It is therefore less heavily based on German science. I call this measure citation weighted publications and it is defined as the sum of citations (in the first 50 years after publication) of all articles published in a certain year. The following simple example illustrates the construction of the citation weighted publications measure. Suppose a researcher published two top journal articles in 1932. One is cited 5 times the other 7 times in any journal covered by the Web of Science in the 50 years after its publication. The researcher's citation weighed publications measure for 1932 is then 5+7=12. Furthermore, I construct normalized (citation weighted) publications by normalizing the aforementioned measures with the number of coauthors.

Table A2 lists the top researchers for each subject according to the citation weighted publications measure. The researchers in this table are the 20 researchers with the highest yearly averages of citation weighted publications for publications between 1925 and 1932. It is reassuring to realize that the vast majority of these top 20 researchers are well known in the scientific community. Economists will find it interesting that Johann von Neumann is the most cited mathematician. The large number of Nobel laureates among the top 20 researchers indicates that citation weighted publications are a good measure of a scholar's productivity. Nevertheless, the measure is not perfect. As the "Web of Science" only reports last names and the initial of the first name for each author there are some cases where I cannot unambiguously match researchers and publications. In these cases I assign the publication to the researcher whose field is most closely related to the field of the journal in which the article was published. In the very few cases where this assignment rule is still ambiguous between two researchers I assign each researcher half of the (citation weighted) publications. Another problem is the relatively large number of misspellings of authors' names. All articles published between 1925 and 1940 were of course published on paper. In order to include these articles into the electronic database Thomson Scientific employees scanned all articles published in the historically most relevant journals. The scanning was error prone and thus lead to misspellings of some names. As far as I discovered these misspellings I manually corrected them.

I merged the publications data to the roster of all German physicists, chemists, and mathematicians. From the list of dismissed scholars I can identify the researchers who were dismissed and those who stayed at the German universities. The end result is a panel dataset of the universe of physicists, chemists, and mathematicians at all German universities from 1925 until 1938 with detailed information on their publications in the top academic journals and their dismissal status.

4 Identification

Using this panel dataset I estimate peer effects among scientists. The standard approach when estimating peer effects consists of regressing an individual's productivity on the average productivity of his peers. The productivity of academic researchers, however, is not only affected by the average quality of their peers but also by the number of peers they can interact with. Having smart colleagues may be useful in many ways: coauthored work may be of higher quality and comments from prolific peers may be useful for their own work. Furthermore, peers may attract more research funding to the department, or have better contacts to researchers outside the department. Having more colleagues in your department may be important because all these interactions are more likely to occur if there are more peers to interact with, especially because it may be easier to find colleagues who are working on similar research questions. Researchers in larger departments may also benefit from a lower teaching load and from teaching more specialized courses which are more related to their current research.

As university departments differ substantially in the average quality of its researchers and also in size, it is important to distinguish these two dimensions of peer effects for academic research. In order to estimate peer effects among scientists I therefore propose the following regression:

$$
\begin{aligned}
(1) \qquad \#\ \text{Publications}_{iut} &= \beta_1 + \beta_2(\#\text{ of Peers})_{ut} + \beta_3(\text{Avg. Peer Quality})_{ut} \\
&\quad + \beta_4\text{Age Dummies}_{iut} + \beta_5\text{YearFE}_t + \beta_6\text{UniversityFE}_u + \beta_7\text{IndividualFE}_i + \varepsilon_{iut}
\end{aligned}
$$

I regress the number of publications of researcher i in university u and year t on measures of the peer group and other controls. In order to control for the quality of a published article I use citation weighted publications as an alternative dependent variable. I estimate these regressions separately for physics, chemistry, and mathematics because the subjects in consideration have different publication and collaboration patterns. The peer group measures are a researcher's number of peers and the average quality of these peers. Average peer quality is calculated as the mean of the average productivity of a researcher's peers.[17],[18] Over time changes in the average peer quality measure will only occur if the composition of the department changes. Yearly

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[17] Say a department has 3 researchers in 1930. One published on average 10 (citation weighted) publications between 1925 and 1938. The other two have 20 and 15 citation weighted publications respectively. Then the average peer quality variable for researcher 1 in 1930 will be (20+15)/2 = 17.5. Average peer quality for researcher 2 will be (10+15)/2 = 12.5 and so on.

[18] I use the department mean of average productivity between 1925 and 1938. An alternative way of calculating the average peer productivity uses only the pre-dismissal years 1925 to 1932. This measure is, however, not defined for researchers who join after 1933. I therefore present the results using the first measure. Using the alternative measure does not affect my findings.

fluctuations in publications of the same set of peers will not affect the peer group measure. The underlying assumption is therefore that Albert Einstein always has the same effect on his peers independent of how much he publishes in a given year.

It is quite likely that the effect of peers is only measurable after a certain time lag. Peers influence the creation of new ideas and papers before the actual date of publication. Another delay is caused by the publication lag (the time it takes for a paper to appear in a journal after the paper was submitted by the author). Science research, however, is published faster than research in other subjects like economics. Anecdotal evidence suggests that the effect of peers should be measured with a lag of about one year. An illustrative example of the timing of peer interactions in science research at the relevant time is the postulation of the "uncertainty principle" by Heisenberg in 1927. In 1926 Heisenberg was working with Niels Bohr in Copenhagen. It is reported that during that time Heisenberg and Bohr spent days and nights discussing the concepts of quantum mechanics in order to refine them. Early in 1927, Niels Bohr went on a holiday and it was during that time that Heisenberg discovered and formulated his famous "uncertainty principle". He published this discovery in the "Zeitschrift für Physik" in 1927.[19] Therefore I use a lag of one year for the peer group variables when estimating equation (1).[20]

As further controls I include a full set of 5-year age group dummies to control for life-cycle changes in productivity when estimating equation (1).[21] Furthermore, I control for yearly fluctuations in publications which affect all researchers by including year fixed effects. To control for individual differences in a researcher's talent I also add individual fixed effects to all specifications. Furthermore, I add university fixed effects to control for university specific factors affecting a researcher's productivity. These can be separately identified because some scientists change universities. I show below that the results are hardly affected by including university fixed effects in addition to individual fixed effects.

Estimating equation (1) using OLS will lead to a number of problems. One problem is caused by the fact that a researcher's productivity is affected by his peers but at the same time the researcher affects the productivity of his peers. Manski (1993) refers to this problem as the reflection problem. It is therefore important to keep in mind that the estimated effects will be total effects after all productivity adjustments have taken place.

Other problems, however, are potentially more severe in this context. An important problem is caused by selection effects. These occur not only because of self selection of researchers into departments with peers of similar quality but also because departments appoint professors of similar productivity. Furthermore, larger departments tend to hire researchers with above average qualities. The inclusion of university fixed effects would in principle address this problem. Differential time trends of different departments, however, would make selection issues an important problem even in models which include university fixed effects. These selection effects introduce a correlation of the peer group measures with the error term and will thus bias the

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[19] For a detailed historic description of the discovery of the uncertainty principle see Lindley (2007).

[20] Using different lags does not affect the results.

[21] Levin and Stephan (1991) show that age is an important determinant of scientists' productivity.

estimates of β_2 and β_3.

Another problem may be caused by omitted variables, such as the construction of a new laboratory which may not be observed by the econometrician. Omitted factors may not only affect a researcher's productivity but also the size of the department or the average productivity of his peers at the same time. Not controlling for unobserved factors would introduce another bias.

Furthermore, measurement error could bias the estimates of regression (1). An important measurement problem is the actual peer group of a researcher. In addition to that, even good measures of peer quality, such as the average number of citation weighted publications, are by no means perfect. Even if one were to believe that such measures could perfectly quantify peer quality, misspellings of names in the publication data would introduce measurement error. These measurement problems will introduce further biases of β_2 and β_3.

An instrumental variables strategy can deal with selection, omitted variables bias, and measurement error. I therefore propose the dismissal of scholars by the Nazi government as an instrument for the scientists' peer group. Figure 1 shows the effect of the dismissal on the peer group of physicists.

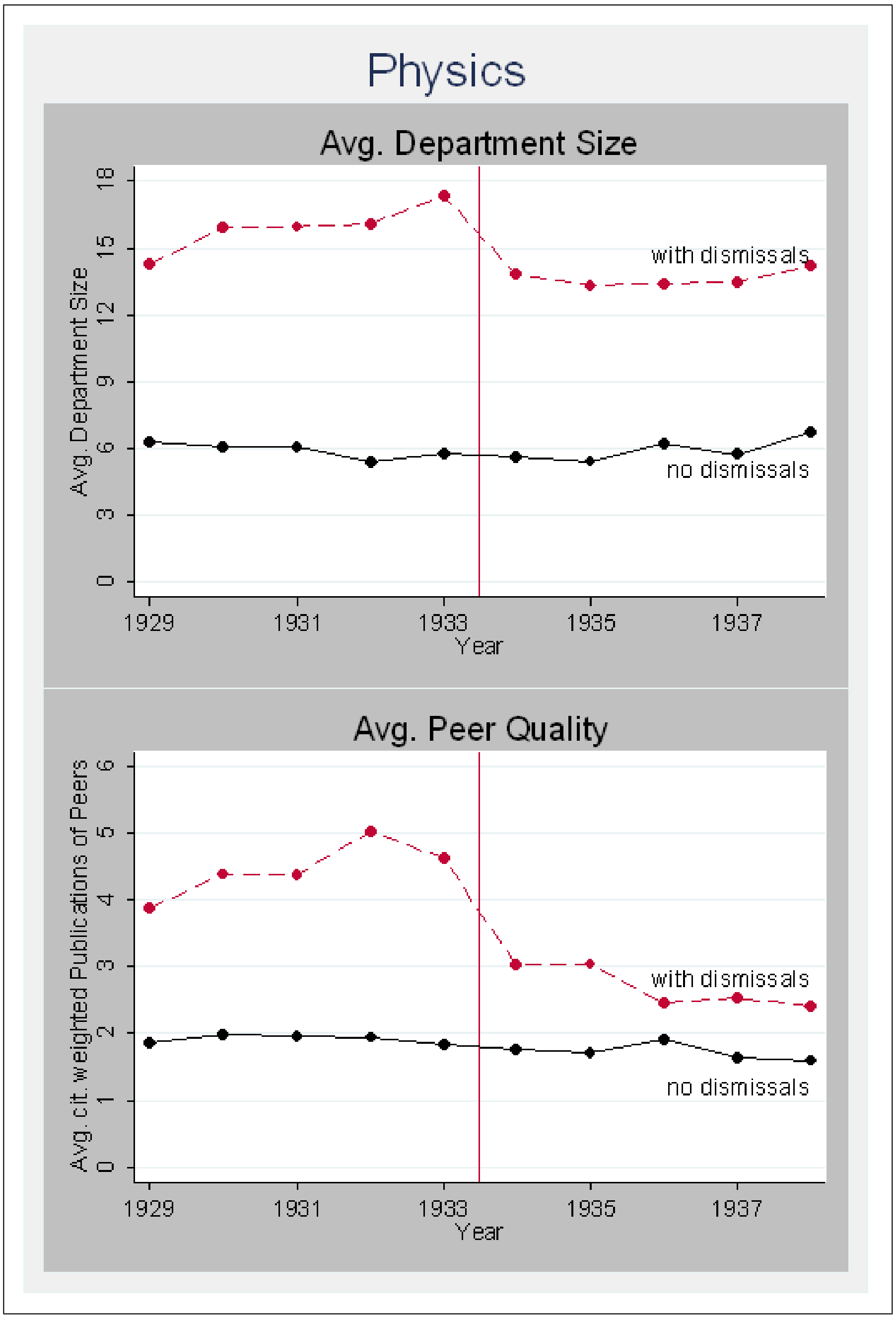

Figure 1: First Stages Physics

The top panel shows the average department size for two groups of physicists: physicists in departments with dismissals in 1933 or 1934 and physicists in departments without dismissals. Figure 1 shows that the affected departments were of above average size. The size of departments without dismissals did hardly change over this time period. In the affected departments the dismissal led to a strong reduction in the number of physicists which persisted until the end of the sample period. The dismissed were not immediately replaced because of a lack of suitable researchers without a position and the slow appointment procedures. Successors for dismissed chaired professors, for example, could only be appointed if the dismissed scholars gave up all their pension rights because the dismissed professors were originally placed into early retirement. The states did not want to pay the salary for the replacement and the pension for the dismissed professor at the same time. It thus took years to fill open positions in most cases. Highlighting this problem, Max Wien a physicist in Jena, wrote a letter to Bernhard Rust the Minister of Education in late November 1934. Describing the situation for chaired professorships at the German universities he stated in his letter that "out of the 100 existing [chaired professor] teaching positions, 17 are not filled at present, while under natural retirements maybe two or three would be vacant. This state of affairs gives cause for the gravest concern..." (cited after Hentschel, 1996).

The second panel of Figure 1 shows the evolution of average peer quality in the two types of departments. Obviously, one would expect a change in average peer quality only if the quality of the dismissed was either above or below the pre-dismissal department average. The bottom panel of Figure 1 demonstrates two interesting points: the dismissals occurred at departments of above average quality and within those departments the dismissed were on average more productive than the physicists who were not dismissed. As a result the average quality of peers in affected departments fell after 1933. The graph only shows averages for the two groups of departments. As can be seen from Table 2 some departments with dismissals also lost below average peers. Average department quality increased in those departments. Overall, however, the dismissal reduced average department quality in physics.

Figure 2 explores the effect of the dismissal on the peer group of chemists. Like in physics most of the dismissals occurred in larger departments and had a strong effect on department size. The affected departments were of above average quality, as well, but the difference was less pronounced than in physics. As suggested by the summary statistics presented before, the dismissal had a smaller overall effect on average quality. Despite the fact that the dismissal did not have a large effect on peer quality for the average across *all* departments it strongly affected average quality in many departments as can be seen from Table 2. The effects in departments with reductions in peer quality and in departments with improvements in peer quality, however, almost cancel out in the aggregate.

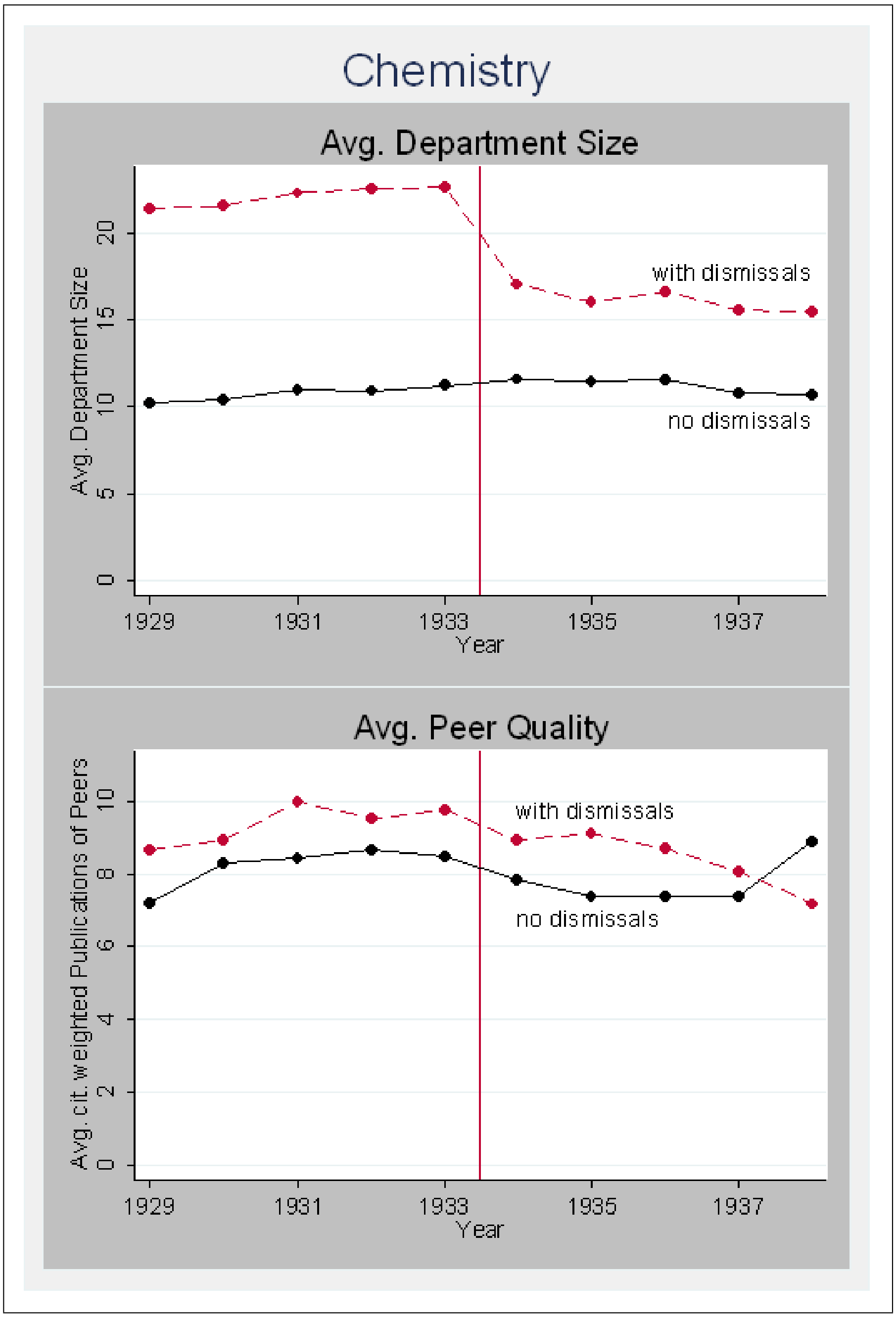

Figure 2: First Stages Chemistry

Figure 3 investigates the effect of the dismissals on the peer group of mathematicians. Similarly to physics and chemistry the affected departments were larger before the dismissal. After 1933 department size fell sharply in the affected universities. The mathematicians in the affected departments were of above average quality before the dismissal. Due to that average peer quality fell drastically in departments with dismissals.

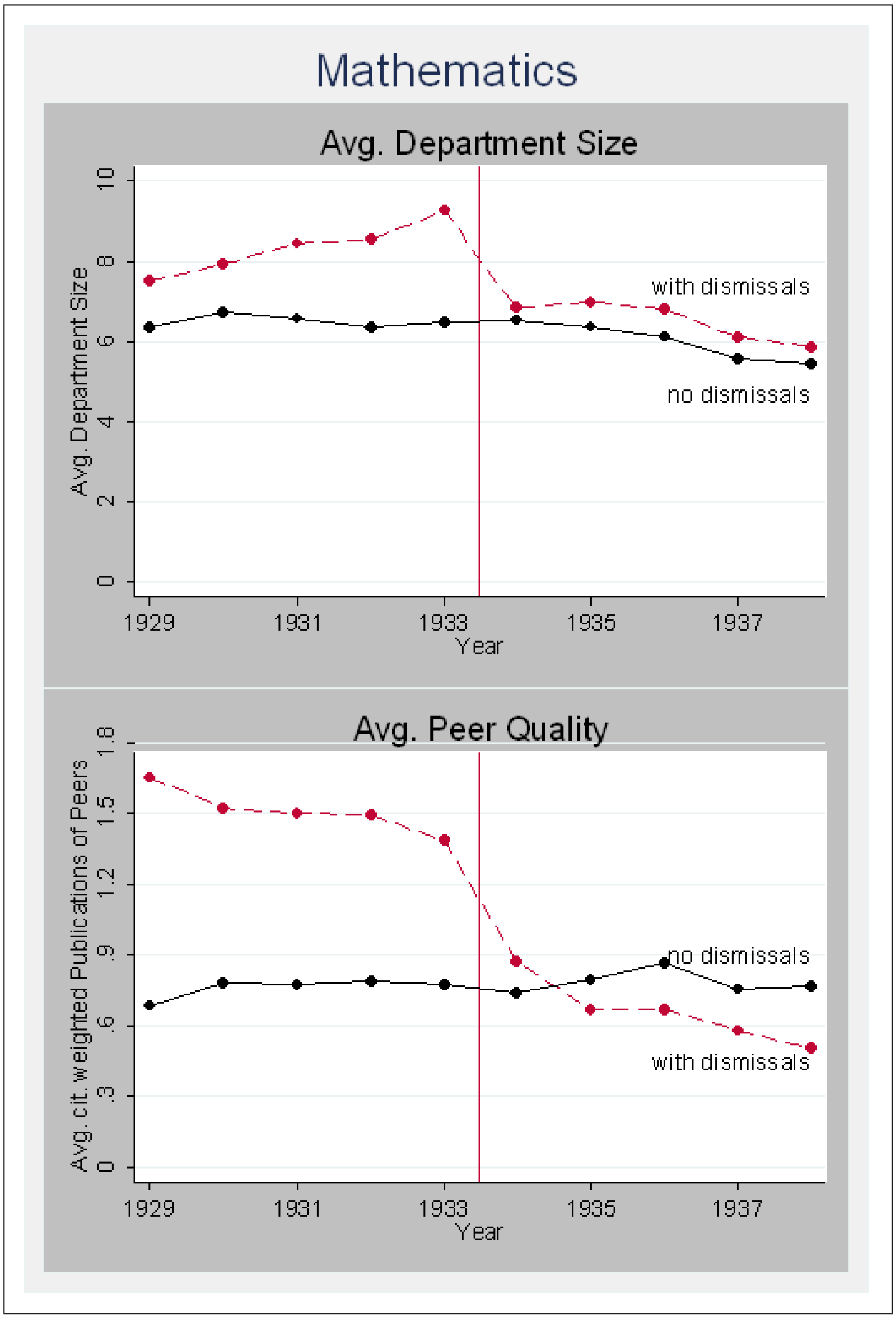

Figure 3: First Stages Mathematics

Figures 1 to 3 suggest that the dismissal had a strong effect on the number of peers and their average quality. It is therefore possible to use the dismissal as an instrument for the endogenous peer group variables. As mentioned before, there are two endogenous variables in this setting: the number of peers and their average quality. This gives rise to two first stage equations:

$$(2) \qquad \#\text{ of Peers}_{ut} = \gamma_1 + \gamma_2(\#\text{ Dismissed})_{ut} + \gamma_3(\text{Dismissal induced Reduction in Peer Quality})_{ut} \\ + \gamma_4\text{Age Dummies}_{iut} + \gamma_5\text{YearFE}_t + \gamma_6\text{UniversityFE}_u + \gamma_7\text{IndividualFE}_i + \varepsilon_{iut}$$

$$(3) \qquad \text{Avg. Peer Quality}_{ut} = \delta_1 + \delta_2(\#\text{ Dismissed})_{ut} + \delta_3(\text{Dismissal induced Reduction in Peer Quality})_{ut} \\ + \gamma_4\text{Age Dummies}_{iut} + \gamma_5\text{YearFE}_t + \gamma_6\text{UniversityFE}_u + \gamma_7\text{IndividualFE}_i + \varepsilon_{iut}$$

It is important to note that all regressions estimated in this paper are estimated for scientists who were present at the beginning of 1933 and were not dismissed (the so called stayers). The dismissal is then used as a source of exogenous variation in their peer group. Equation (2) is the first stage regression for department size. The main instrument for department size is the number of dismissed peers between 1933 and 1934 in a given department which is 0 until 1933 and equal to the number of dismissals thereafter.[22] I also include another instrument which captures the dismissal induced reduction in average quality of peers. This will be more important for equation (3), the first stage equation for average peer quality. The dismissal induced reduction in average peer quality is measured as the pre-dismissal average quality of all researchers in the department minus the average quality of the researchers who were not dismissed. The variable is 0 until 1933 in all departments. Researchers in departments with dismissals of colleagues of *above* average quality (relative to the department average) have a *positive* value of the dismissal induced reduction in peer quality variable after 1933. The variable will remain 0 for researchers who did not experience any dismissal in their department or for scientists who lost peers whose quality was below the department level average. The implicit assumption is therefore that below average dismissals did not affect the productivity of scientists. An alternative way of defining "dismissal induced reduction in peer quality" would be to allow the dismissal of *below* average peers to have a *positive* impact on the productivity of scientists. In specifications not reported in this paper I have explored this. The results do not change.[23] The dismissals between 1933 and 1934 may have caused some researchers to switch university after 1933. This switching behavior, however, will be endogenous and thus have a direct effect on researchers' productivity. To circumvent this problem I assign each scientist the relevant dismissal variables for the department he attended at the beginning of 1933.

The effect of the dismissal is likely to be correlated for all stayers in a department. I therefore account for any dependence between observations within a department by clustering all results at the department level. This not only allows the error to be arbitrarily correlated for all researchers in one department at a given point in time but it also allows for serial correlation of these error terms.

Using the dismissal as an instrumental variable relies on the assumption that the dismissal had no other effect on a researcher's productivity than through its effect on the researcher's peer group. It is important to note that any factor affecting all researchers in Germany in a similar way, such a possible decline of journal quality, will be captured by the year fixed effects and would thus not invalidate the identification strategy. As the unaffected departments act as a control group, only factors changing at the same time as the dismissal and exclusively affecting

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[22] This variable is 0 until 1933 for all departments (As I use a one year lag in the peer group variables it is 0 for 1933 inclusive). In 1934 it is equal to the number of researchers who were dismissed in 1933 in a given department. From 1935 onwards it is equal to the number of dismissals in 1933 and 1934. The following example illustrates this. In Göttingen there were 10 dismissals in mathematics in 1933 and one dismissal in 1934. The # dismissed variable for mathematicians in Göttingen will therefore take the value 0 until 1933. It will be 10 in 1934 and 11 from 1935 onwards.

[23] Not surprisingly, the first stage becomes stronger if one allows dismissals of below average quality to positively affect average department quality, as department quality (the endogenous variable) is always computed including all researchers. I report the results for the more conservative measure in the paper.

the departments with dismissals (or only at those without dismissals) may be potential threats to my identification strategy.

One may worry that the dismissals changed the incentive structure for stayers in the affected departments. Researchers in departments or specializations with many dismissals may have an incentive to work more to obtain one of the free chairs within the department. Their incentives could also be affected in the opposite direction if they lost an important advocate who was fostering their career. In this case they may decide to work less as the chances of obtaining a chair either in their own department or at another university could be lower. In order to address this concern I estimate a regression which regresses a dummy variable of ever being promoted on the dismissal variables and the same controls as in the regressions proposed before.[24] The results from this regression are presented in Table A3. The coefficients on the dismissal variables are all very small and none of them is significantly different from 0. This suggests that the results of this paper are probably not contaminated by changes in the incentive structures in the affected departments.

Another worry is that departments with more ardent Nazi supporters would increase their productivity because they received more research funding or by receiving other priviledges. This would threaten the identification strategy if the number of Nazi supporters was correlated with the number of dismissals. Looking at the number of party members to investigate this issue would not be very helpful because most university researchers eventually joined the Nazi party. In November 1933, however, 839 university professors (out of more than 10,000 professors in Germany) signed the "Commitment of Professors at the German Universities (...) to Adolf Hitler and the National Socialist State..." This list should signal the professors' support of the new Nazi government and was widely publicized. Most people signing the list were probably strong supporters of the Nazi regime and would therefore have benefited from any differential treatment. To test this hypothesis I regress a dummy for signing the support list on the dismissal variables and other controls. The results are reported in Table A4. The coefficients on the dismissal variables are all small and none of them is significantly different from 0, indicating that strong support of the Nazi party was not different in departments with dismissals.[25]

Another worry is that scientists in departments with many dismissals took over laboratories from the dismissed and thus increased their productivity. I show below that the results are very similar for mathematicians and theoretical physicists. This is reassuring because the two groups of scientists usually carry out their research outside the laboratory.

The identification strategy may also be invalidated if the Nazi government did increase the funding of affected departments in order to counterbalance possible negative dismissal effects.

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[24] The estimated regression is:

$(\text{Ever Promoted})_{iut} = \beta_1 + \beta_2(\#\ \text{Dismissed})_{ut} + \beta_3(\text{Dismissal induced} \downarrow \text{in Peer Quality})_{ut} + \beta_4\text{Age Dummies}_{iut} + \beta_5\text{YearFE}_t + \beta_6\text{UniversityFE}_u + \beta_7\text{IndividualFE}_i + \varepsilon_{iut}$

[25] As there is no time variation in the dependent variable I estimate the regression including all scientists who were present in November 1933. The estimated regression is:

$(\text{Signed Support List})_{iu} = \beta_1 + \beta_2(\#\ \text{Dismissed})_u + \beta_3(\text{Dismissal induced} \downarrow \text{in Peer Quality})_u + \beta_4\text{Age Dummies}_{iu} + \beta_5\text{UniversityFE}_u + \varepsilon_{iu}$

Alternatively, one could estimate this regression without University FEs. This does not change the results.

Salaries for university employees were paid by the states and were closely linked to the position or the researcher. They did not change dramatically over the time period and not differentially across different departments. Scientists could also apply for funding of individual research projects. The main provider of research grants in the 1920s and 1930s was the "Emergency Association of German Science" (Notgemeinschaft der Deutschen Wissenschaft) which was jointly funded by the state and donations from companies.[26] The grants were approved by a panel of specialists based on the quality of the grant proposal and covered costs of experiments, such as materials or expensive equipment. Unfortunately, there is no readily available consistent yearly data on supported scientists. Nonetheless, I mange to obtain comparable data on scientists who received funding for two years: the academic year 1928/1929 before the dismissal and for 1937/1938 after the dismissal. The data is relatively coarse as the reports only state whether a scientist received funding from the Notgemeinschaft but not how much he received. To check whether funding patterns changed after the dismissal, I regress an indicator of receiving funding on the dismissal variables on a sample of stayers in the two years.[27] The results are reported in Table A5. All but one of the coefficients are very small and not significantly different from 0 indicating that changes in funding are not related to the dismissal. The coefficient on the reduction in peer quality for physics at the department level is negative, indicating that stayers in departments with high quality dismissals received less funding after the dismissal. There is therefore no worry that compensatory funding can explain my results. Any bias due to changing funding patterns would go against my finding that department level peer effects in physics are not important.

A further worry are general disruption effects at the affected departments. I show below that my results are unchanged if I exclude the turbulent years 1933 and 1934 from the regressions. These disruption effects could, however, have persisted even after 1934 given that the dismissed could not be rapidly replaced. Scientists in affected departments might have had to take over more administrative or teaching responsibilities. These effects would most probably lead to an upward bias of the instrumental variable results. The fact that I do not find evidence for peer effects neither at the department level nor at the specialization level, however, reduces the worry that this problem affects the findings of this paper.

Lastly any difference-in-differences type strategy relies on the assumption that treatment and control groups did not follow differential trends. I address this concern in two ways. First, I show that the results presented below are not affected by including linear university specific time trends in the regressions. This approach would not address the problem if differential trends were nonlinear. I therefore estimate a so-called placebo experiment only using the pre-dismissal period. I then estimate the same model but I move the dismissal from 1933 to 1930. The results are reported in Table A6 and indicate that departments with dismissals do have

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[26] The Notgemeinschaft was renamed in "Deutsche Gemeinschaft zur Erhaltung und Förderrung der Forschung" in 1937 and is still the main funding source for individual researchers in Germany under the name "Deutsche Forschungsgemeinschaft".

[27] I regress the following regression for one pre-dismissal and one post-dismissal year:
$(\text{Received Notgemeinschaft Funding})_{iut} = \beta_1 + \beta_2(\#\text{ Dismissed})_{ut} + \beta_3(\text{Dismissal induced} \downarrow \text{in Peer Quality})_{ut} + \beta_4\text{Age Dummies}_{iut} + \beta_5\text{UniversityFE}_{ut} + \varepsilon_{iut}$.

different productivity trends compared to the unaffected departments. Overall, I believe that the dismissal provides a valid instrument to estimate peer effects.

5 Effect of Dismissal on Scientists remaining in Germany

5.1 Department Level Dismissal Effect

There is no doubt that the dismissal of Jewish and "politically unreliable" scholars had a negative impact on the German universities. In this context it is especially interesting to investigate how the dismissal affected the researchers who stayed at the German universities. Did their research productivity suffer because they had fewer and less productive peers? The following figures try to give a graphical answer to this question. Figure 4 plots the publications for stayers in two sets of physics departments: those with dismissals and those without dismissals. The yearly fluctuation in top journal publications is relatively large. Despite this fluctuation, the figure suggests that the dismissal did not have an obvious effect on the publications of the stayers.

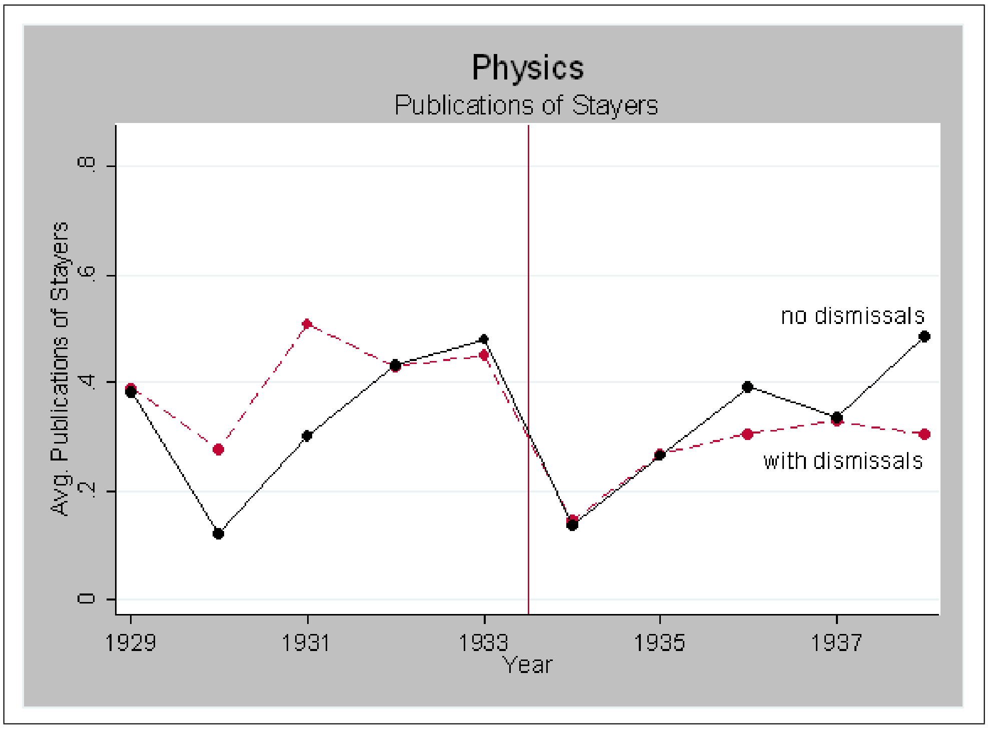

Figure 4: Reduced Form Physics

Figure 5 shows the evolution of the stayers' publications in chemistry departments. The figure suggests no effect of the dismissal on the stayers' productivity in chemistry.

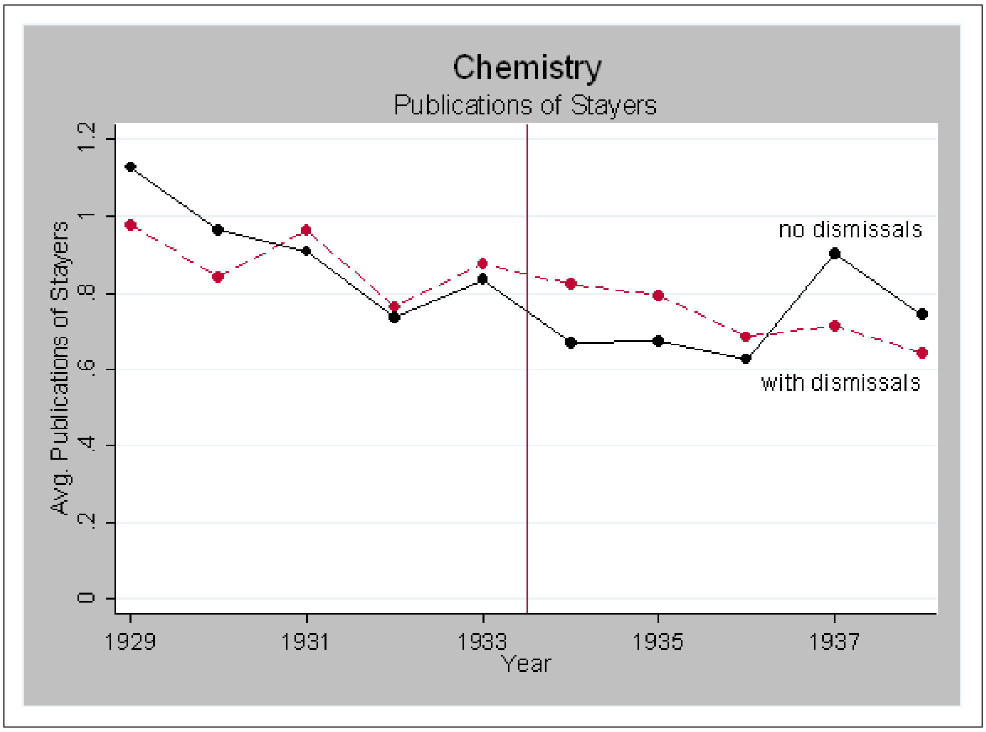

Figure 5: Reduced Form Chemistry

Figure 6 plots the top journal publications of mathematicians. Similarly to the other two subjects the dismissal does not seem to have a pronounced effect on the publications of the stayers.

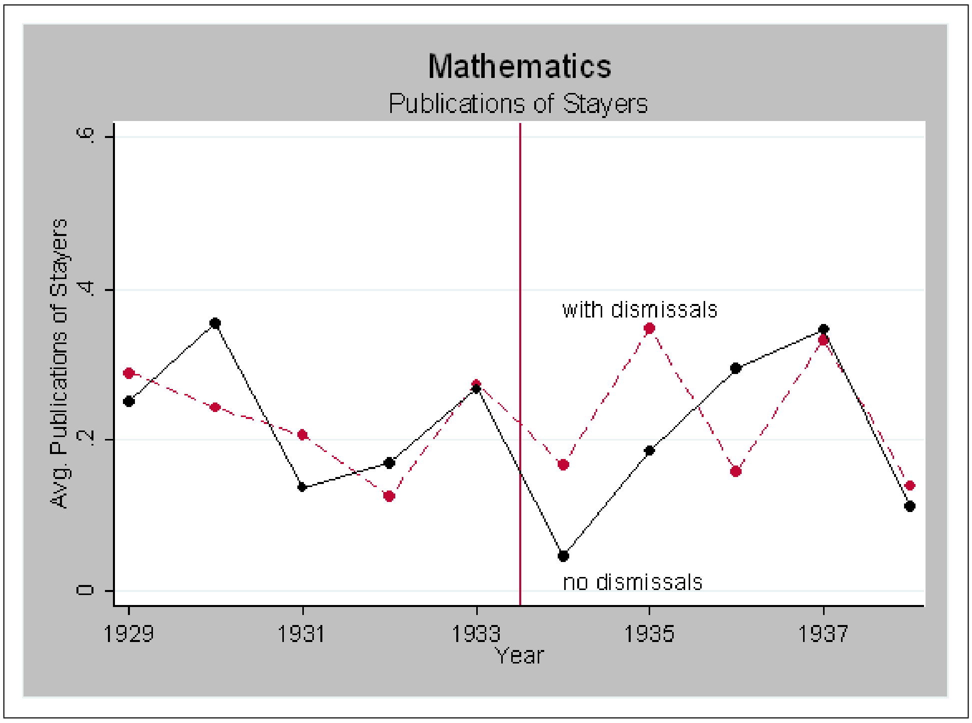

Figure 6: Reduced Form Mathematics

Figures 4 to 6 suggest no effect of the dismissal on the publications of stayers in the affected departments. In order to verify this finding and to quantify the effect of the dismissal on the stayers I estimate the following reduced form equation.

$$\text{(4)}\qquad \#\text{ Publications}_{iut} = \beta_1 + \beta_2(\#\text{ Dismissed})_{ut} + \beta_3(\text{Dismissal induced Reduction in Peer Quality})_{ut} \\ + \beta_4\text{Age Dummies}_{iut} + \beta_5\text{YearFE}_t + \beta_6\text{UniversityFE}_u + \beta_7\text{IndividualFE}_i + \varepsilon_{iut}$$

Using only stayers below 70 years of age, I regress the researchers' (citation weighted) normalized publications in each year on the instruments proposed above. Researchers in departments which were not affected will have a value of 0 for the dismissal variables.[28] Researchers in departments with dismissals will have 0 until 1933 and then the relevant value for the department to which they were affiliated at the beginning of 1933. This regression is essentially a difference-in-differences estimate of the dismissal effect. It compares the change in publications from the pre to the post dismissal period for researchers in the affected departments to the change between the two periods for unaffected researchers.

Table 5 reports the reduced form results using the peers in a researcher's department as the relevant peer group. If the dismissal had a negative effect on the number of publications one would expect negative coefficients on the dismissal variables. Both the coefficient on the number of dismissed researchers and the one on the dismissal induced reduction in peer quality are very close to 0 and not significant in any of the specifications. Not surprisingly the coefficients in specifications with citation weighted publications as the dependent variable are larger because the mean of citation weighted publications is much larger than the one for publications. The coefficient on the reduction in peer quality even has the 'wrong' sign in most specifications if one assumes that losing high quality peers should negatively affect a researcher's productivity. The results indicate that the dismissal did not affect the productivity of the stayers. These results are a first indication that peers, measured at the department level, may not affect the productivity of scientists. As departments are comprised of scientists with different specializations I want to investigate whether the dismissal had an effect on the stayer's productivity if one considers a narrower peer group definition. These results are reported in the next subsection.

5.2 Specialization Level Dismissal Effect

If a scientist mostly benefits from interactions with peers in his specialization within the department the specialization level peer group could be more relevant. The idea is that theoretical physicists mostly interact with other theoretical physicists in the department and less with experimental physicists. I therefore explore the dismissal effect using only the peers from a researcher's own specialization.[29] The regression is the same as regression (4) but instead of

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[28] I focus on stayers below 70 which was the usual age of retirement for university professors in the early years of my sample period. Older scientists, who were still teaching at a very high age are thus not very representative. Including those older scientists does hardly affect the results.

[29] If a researcher has more than one specialization his relevant peer group is defined as the sum of the peers of his specializations.

using the number of department level dismissals I use the number of specialization level dismissals. Similarly, I use the reduction in average peer quality in a researcher's specialization instead of the reduction at the department level.

The results for the specialization level peers are reported in Table 6.[30] The estimated coefficients are very close to 0 and all insignificant not only for publications but also for citation weighted publications. Furthermore, many results have the wrong sign if one were to expect a negative dismissal effect.

Both the department and specialization level dismissal results suggest that *localized* peer effects may not be very important in this research environment. The following section explores this in further detail by estimating the peer effects equation (1) instrumenting the endogenous peer group variables with the dismissal.

6 Using the Dismissal to Identify Localized Peer Effects in Science

6.1 Department Level Peer Effects

As suggested by Figures 1 to 3 the dismissal had a strong effect on the peer group of the stayers at the German universities. I therefore use this exogenous source of variation in a researcher's peer group to identify localized peer effects. I start by analyzing department level peer effects. As explained in the identification section I estimate two first stage equations: one for the number of peers (i.e. department size) and one for the average quality of peers in a researcher's department. The first stage results are presented in Table 7.

Columns (1) and (2) report the first stage results for physicists. The first column shows the first stage regression for department size. The number of dismissed physicists in a researcher's department has a very strong and significant effect on department size. Reassuringly, the dismissal induced reduction in average peer quality does not have a large effect on department size. The first stage regression for average peer quality in physics is presented in column (2). The number of dismissals in the department does not have a significant effect on the average quality of peers. The dismissal induced reduction in peer quality, however, is a very strong and significant predictor of average peer quality for physicists. Columns (3) to (6) report the first stage regressions for chemists and mathematicians. The results are very similar: the number of dismissals in a department is a very good predictor for department size and the dismissal induced reduction in peer quality is a very good predictor for the average quality of peers. The dismissal is a strong instrument not only for department size but also for the average quality of peers.

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[30] Due to a small number of missing values for the specialization of a researcher the number of observations is slightly lower than for the department level specifications.

Table 8 reports results from estimating the peer effects model as proposed in equation (1). The first columns of Table 8 show the results for physicists. The OLS results are not very informative due to the problems illustrated in the identification section. I therefore turn immediately to discussing the IV results where I use the dismissal to instrument for the peer group variables.[31] Column (2) report the results for publications as the dependent variable. The coefficients on the peer group variables are very small and never significantly different from 0. The coefficient on the number of peers indicates that one can rule out any effects greater than 0.09 with 95 percent confidence. The coefficient on average peer quality even has the wrong sign if one were expecting positive peer effects from interactions with high quality peers. The standard error implies that one can rule out positive effects greater than 0.03 with 95 percent confidence. These are precisely estimated effects because the mean of the publication variable is about 0.4. The results for citation weighted publications are very similar, but with larger coefficient estimates because of the higher mean of the citation weighted publications measure.

The chemistry and mathematics results are reported in the next few columns of Table 8 and are very similar. The coefficients on department size and on average peer quality are all very close to 0 and insignificant. For chemistry one can rule out positive effects of department size larger than 0.021 (0.013 for mathematics) using publications as the dependent variable. For average peer quality one can rule out positive effects larger than 0.014 (0.082 for mathematics). These are small effects given the mean of the normalized publication variable which is 0.9 (0.3 in mathematics).

The results presented in Table 8 show no evidence for department level peer effects in any of the three subjects. The fact that the results are very similar for all three subjects can be seen as a first confirmation that there are indeed no department level peer effects in this setting. Also the fact that I find very similar results for publications and citation weighted publications is reassuring. This indicates that differences in citation behavior of articles from scientists in departments with or without dismissals cannot explain these findings.

6.2 Specialization Level Peer Effects

The results presented in the previous section used the department as the relevant peer group of scientists. In the following regression I use a researcher's *specialization* to define his peer group. The peers of an experimental physicist are now only the other experimentalists in his department; not theoretical physicists, technical physicists or astrophysicists. The first stage results are reported in Table 9 showing that the dismissal is a good predictor for a scientist's

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[31] In this setup the instruments are strong predictors of the peer group variables. Furthermore, the model is just identified as the number of instruments is equal to the number of endogenous variables. There is thus no worry of bias due to weak instruments. Stock and Jogo (2005) characterize instruments to be weak not only if they lead to biased IV results but also if hypothesis tests of IV parameters suffer from severe size distortions. They propose values of the Cragg-Donald (1993) minimum eigenvalue statistic for which a Wald test at the 5 percent level will have an actual rejection rate of no more than 10 percent. In this case the critical value is 7.03 and thus always below the Cragg-Donald statistic for the first stages for physics, chemistry, and mathematics which is reported at the bottom of Table 8.

number of (specialization level) peers and their respective quality, especially in physics and chemistry. For mathematicians the dismissal variables are less significant because a lot of mathematicians have many specializations.

Table 10 reports the results from estimating equation (1) with specialization level peer variables. Similarly to before, all coefficients on the dismissal variables are very small and none of them is significantly different from 0. The peer group variables even have unexpected signs in many specifications. In physics, the standard errors imply than one can rule out positive effects for the number of peers larger than 0.035 with 95 percent confidence when using publications as the dependent variable. Furthermore, positive effects larger than 0.039 can be ruled out for the quality of peers. Keeping in mind that the mean of the publication variable is about 0.4 for physicists these are precisely estimated zeros. Using citation weighted publications gives very similar results.

For chemistry, one can rule out any positive effect of having one more peer greater than 0.047 with 95 percent confidence. It is also possible to rule out positive effects greater than 0.012 with 95 percent confidence for the average quality of specialization level peers. These are again very small coefficients if one considers the mean of the publication variable for chemistry which is about 0.9.

The results for mathematics are less precisely estimated than for physics and chemistry. Nonetheless, there is no evidence for any significant peer effects in mathematics. The results on peer effects in a researcher's specialization support the conclusion that *localized* peer effects are not important within academic departments. The following section probes the robustness of these results before I investigate peer effects among coauthors.

7 Sensitivity of Department Level IV Results

Tables 11 to 13 show results from a number of robustness checks for the department level results. The physics results are reported in Table 11, chemistry results in Table 12, and mathematics results in Table 13. As mentioned before, the dismissal may have led to disruption effects especially in 1933 and 1934. I therefore reestimate the IV results dropping 1933 and 1934 from the regression. Omitting those turbulent years does not affect my findings as shown in columns (1) and (2).

Peer effects may be especially important in the early or the late stages of a scientist's career. I therefore split the sample into two groups: scientists below 50 and scientists 50 or older. The results are reported in columns (3) to (6). There is no indication that peer effects are especially important in younger or older years as none of the coefficients is significantly different from 0 in any of the subjects.

Furthermore, I check whether high quality or low quality researchers benefit more from their peers by splitting the sample into two different groups: above median productivity researchers and below median productivity researchers. With the exception of one coefficient for the average quality for chemistry which has an unexpected sign, the coefficients are small and insignificant as shown in columns (7) to (10). The physics results for the above median productivity scientists, however, are not precisely estimated due to the weak first stage in this subgroup.

An important check to rule out differential productivity trends in affected and unaffected departments is to include university specific time trends in the regressions. The results for those specifications are reported in columns (11) and (12). Reassuringly, including university specific time trends hardly affects the results.

A further worry is that stayers may have taken over laboratories or experiments from the dismissed in the affected departments. The mathematics results should not be contaminated by such behavior. An additional way of exploring whether this might have happened is by estimating the regression for theoretical physicists, only. Theoretical physicists did not need laboratories for their research. Their productivity should therefore not be affected by taking over laboratories. Columns (13) and (14) of Table 11 show that the results are very similar for theoretical physicists. None of the coefficients on peer quality is significantly different from 0, suggesting that the takeover of laboratories or experiments is unlikely to contaminate the results.

The robustness checks support the evidence that peer effects are indeed nonexistent at the department level. In Tables A7 to A9 I also show that the specialization level findings are unaffected by similar changes to the specification. These results therefore strengthen the view that *localized* peer effects are not important in scientific research, at least in early 20th century Germany.

8 Effect of Dismissal on Coauthors

This section analyzes peer effects among coauthors. Interactions among coauthors can take very different levels of intensity. The most intense form of interaction is the coauthoring of papers. It is not clear whether one would like to characterize the coauthoring of papers as a peer effect as opposed to joint production. Below, I will try to investigate different levels of cooperation among coauthors. These interactions can also me more subtle than coauthoring. A possible example is that coauthors discuss each other's work which they are not planning publish together. They may also exert peer pressure on their coauthors by being very productive or very lazy. These more subtle interactions would be classified as peer effects if one were to use a stricter definition of peer effects.

I investigate peer interactions among coauthors by analyzing the change in productivity of scientists who lose a coauthor due to the dismissal. As the fraction of coauthored papers was very low mathematics, only one mathematician who stayed in Germany lost a coauthor due to the dismissal. Therefore, I cannot analyze coauthor effects for mathematics. In physics and chemistry there were enough researchers who lost a coauthor due to the dismissal. Figure 7 illustrates the impact of losing a coauthor for physics. The figure plots average yearly publications for two groups of researchers; researchers who lost a high quality coauthor due to the dismissal and researchers without dismissed coauthors. Figure 7 suggests that physicists who lost a prolific coauthor experienced a drop in their research productivity but managed to recover after some years.

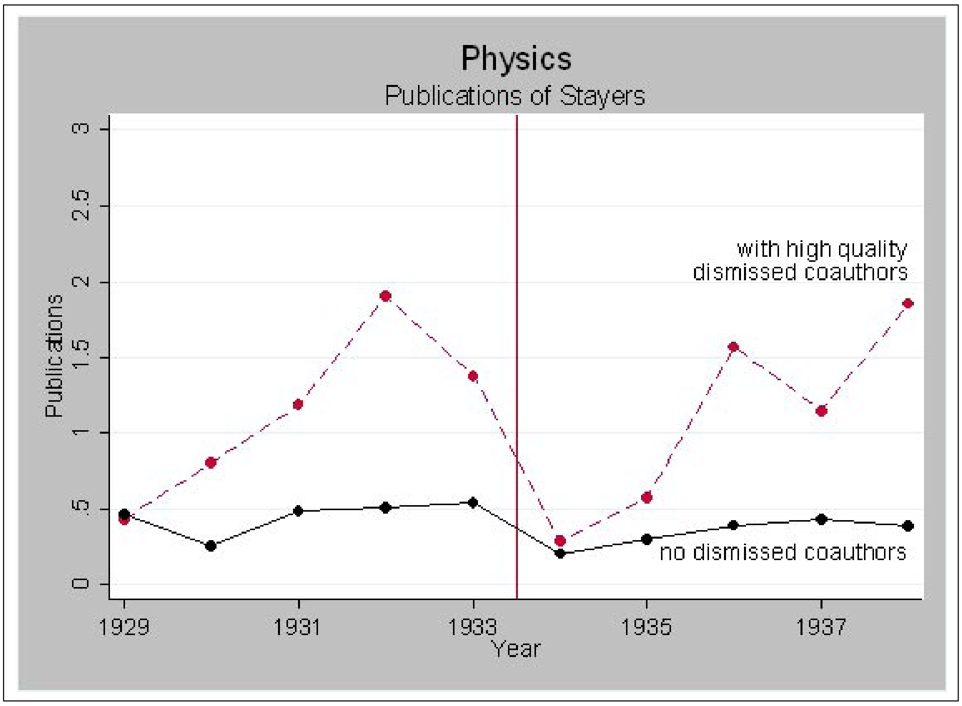

Figure 7: Effect of Dismissal of Coauthors Physics

Figure 8 shows the same graph for chemists. The productivity of chemists who lost a coauthor falls after the dismissal. Similarly to the effect in physics the productivity of chemists with dismissed coauthors recovers some years after the dismissal.

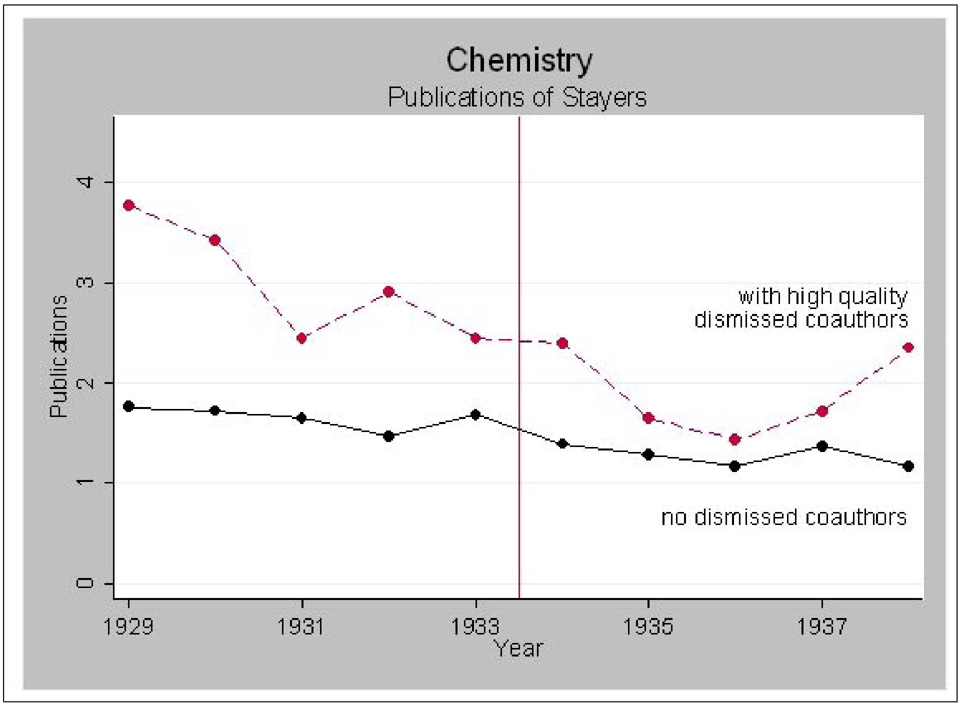

Figure 8: Effect of Dismissal of Coauthors Chemistry

In the following I investigate the effect of the dismissal in further detail. I therefore estimate the following reduced form equation:

$$\text{(5)} \quad \#\ \text{Publications}_{iut} = \beta_1 + \beta_2(\#\ \text{Dismissed Coauthors})_{iut} + \beta_3(\text{Avg. Quality of Dismissed Coauthors})_{iut} \\ + \beta_4\text{Age Dummies}_{iut} + \beta_5\text{YearFE}_t + \beta_6\text{UniversityFE}_u + \beta_7\text{IndividualFE}_i + \varepsilon_{iut}$$

I regress the number of publications of researcher i in period t and university u on the number of dismissed coauthors, the average quality of the dismissed coauthors, and the same controls as in the regressions reported above. For the basic regression a scientist's coauthors are defined as all colleagues who have coauthored a paper with the scientist in the last five years before the dismissal; i.e. from 1928 to 1932. It is important to note that the dismissed coauthors do not have to be from the same department and indeed they often are in different universities. As before I estimate this regression for researchers staying in Germany only. This regression corresponds to the reduced form regressions reported for the department and specialization level peers. An equivalent instrumental variable approach as before is not feasible for coauthors because the timing of the peer interactions cannot be well defined for coauthors. It is neither clear when peer interactions among coauthors start nor when these interactions stop because they are likely to interact also before and after they have coauthored papers. I therefore focus on the reduced form results for coauthors because the dismissal provides a sudden breakup of the coauthor tie. Investigating how this sudden end of the coauthor collaboration affects the productivity of stayers will thus shed light on peer effects among coauthors.

The regression estimates of equation (5) are reported in Table 14.[32] Columns (1) and (2) show the results for physics. The coefficient on the number of dismissed coauthors is not significantly different from 0. The coefficient on the average quality of dismissed coauthors in column (2) indicates that losing a coauthor of average quality reduces the productivity of a physicist of average quality by about 13 percent. The results for chemists are reported in columns (3) and (4). The number of dismissed coauthors does not seem to play an important role for the productivity of chemists. The average quality of the dismissed coauthors is, however, highly significant. The estimated coefficient for citation weighted publications indicates that losing a coauthor of average quality reduces the productivity of an average chemist by about 16.5 percent. The regressions reported in Table 14 use the total number of publications and citations weighted publications as dependent variable. A coauthored publication is counted as a full publication for both coauthors. Another approach is to normalize joint publications by dividing each publication and the citations of each publication by the number of coauthors. Table 15 shows the results obtained when using normalized (citation weighted) publications as the dependent variable. The results are very similar to before.

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[32] I am estimating these regressions on the same sample as the department level regressions reported before. The number of observations differs slightly from the number of observations in the department level specification because the department level specifications include a researcher twice if he has a joint appointment at two universities (This occurs very rarely. Estimating the department and specialization level with weights to account for the few researchers who are appointed at two departments does not alter those results). The number of researchers in the two sets of regressions, however, is exactly the same as can be seen from the number of included researchers.

These results show that scientists who lost high quality coauthors suffered more than scientists who lost less prolific coauthors. The fact that I do not find a significant effect on the number of dismissed coauthors suggests that this effect is not driven by the fact that researchers who lost a coauthor published less because they were lamenting the loss of a coauthor.

The effect of losing a coauthor may depend on the time span which elapsed since the last collaboration. The regressions reported in Table 16 explore this in further detail. I split the dismissed coauthors into two groups: recent coauthors who had collaborated with a stayer between 1929 and 1932, and former coauthors who had co-written papers with the stayer between 1924 and 1928 and not thereafter. As expected, the estimates indicate that only the dismissal of recent coauthors matters for a stayer's productivity. The dismissal of a former coauthor does not affect the productivity of the stayers.

As mentioned above, it is not clear whether the joint publication of papers can be classified as a peer effect. I therefore investigate how the dismissal affected the number of publications excluding joint publications with the dismissed coauthors. Finding a negative effect of the dismissal on the publications without the dismissed coauthors would suggest the presence of peer effects among coauthors which are more subtle than coauthoring. This is a powerful test for spill-over effects because one would expect that researchers who lose a coauthor substitute towards single-authored publications and publications with other coauthors. Any such substitution should reduce the estimated dismissal effect. The results on publications without the dismissed coauthors are reported in Table 17. As before the number of dismissed coauthors does not affect the productivity of scientists. The quality of the dismissed coauthors, however, remains negative and significant. These results suggest the presence of peer effects between coauthors.

9 Conclusion

This paper uses the dismissal of scientists by the Nazi government to identify peer effects in science. I use a newly constructed dataset to estimate a peer effects model including the number of peers and their average quality as determinants of a researcher's productivity. I show that the dismissal was not correlated with a number of factors which might affect researchers productivity through other channels than peer effects. I thus claim that the dismissal can be used as a valid instrument for a scientist's peer group. I do not find evidence for *localized* peer effects. These results are very similar for physicists, chemistry, and mathematics and robust to a number of sensitivity checks.

It is important to note that these results do not imply that being at a good university does not have a positive effect on a researcher's productivity. The regressions reported above include university fixed effects which control for unobserved differences in the quality of laboratories, research seminars, research students, and the like. My results show that university quality matters because the null hypothesis that the university fixed effects are all zero can easily be rejected. There is, however, no evidence for peer effects at the department or specialization level.

Furthermore, I investigate peer effects among *coauthors*. The number of coauthors does not matter for a researcher's productivity. The quality of coauthors, however, is important for the productivity of physicists and chemists. I find that losing a coauthor of average quality reduces the productivity of an average scientists by 13 percent in physics and by 16.5 percent in chemistry. To verify whether this effect constitutes a genuine peer effect as opposed to a joint production effect I investigate the effect of a dismissed coauthor on publications which were published without the dismissed coauthor. I find that the average quality of a dismissed coauthor leads to a substantial reduction in those publications as well, indicating that peer effects are indeed important among coauthors.

As mentioned before, my coauthor results are remarkably similar to the results obtained by Azoulay et. al (2007). They cannot test for localized peer effect in their setup as they do not observe the universe of researchers at a dying scientist's university. They do, however, show that the coauthor effect is not different for coauthors who are co-located compared to coauthors who are located at another university. This supports the view that co-location does not intensify the collaboration among coauthors and thus that localized peer effects may much less important than widely believed.

My paper provides evidence on peer effects among scientists in Germany from 1925 to 1938. I have argued that the research environment of early 20th century Germany is very comparable present day research. I therefore believe that my findings shed light on peer effects in science today. If this was indeed the case it is likely that today's *localized* peer effects are even less important as communication and transportation costs have fallen dramatically in the last decades.

The increasing importance of teams, especially multi-university teams, on the other hand suggests that my estimates of peer effects among *coauthors* constitute a lower bound as coauthored papers have become very common in the sciences.[33]

These results suggest strong policy conclusions. Co-locating researchers in order to increase their productivity through spill-overs does not seem a useful policy to increase total research output. It is probably more important to increase the possibility for coauthorship by fostering the mobility of researchers and their exposure to researchers with similar research interests. The funding of conferences and active support of collaborations among researchers may therefore be a very effective tool to increase total research output.

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[33] See Wuchty et al. (2007) for a description of the increased importance of teams in scientific research.

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10 Tables

Table 1: Number of Dismissed Scientists across different Subjects

	Physics		Chemistry		Mathematics	
Year of Dismissal	Number of Dismissals	% of all Physicists in 1933	Number of Dismissals	% of all Chemists in 1933	Number of Dismissals	% of all Mathematicians in 1933
1933	33	11.5	50	10.7	35	15.6
1934	6	2.1	11	2.4	6	2.7
1935	4	1.4	5	1.1	5	2.2
1936	1	0.3	7	1.5	1	0.4
1937	1	0.3	3	0.6	2	0.9
1938	1	0.3	4	0.9	1	0.4
1939	1	0.3	2	0.4	1	0.4
1940	1	0.3	0	0.0	1	0.4
1933 - 1934	39	13.6	61	13.1	41	18.3

Table 2: Dismissals across different Universities

	Physics				Chemistry				Mathematics			
	Scien-tists	Dismissed 1933-34		Dismissal Induced Δ to Dep.	Scien-tists	Dismissed 1933-34		Dismissal Induced Δ to Dep.	Scien-tists	Dismissed 1933-34		Dismissal Induced Δ to Dep.
University	1933	#	in %	Quality	1933	#	in %	Quality	1933	#	in %	Quality
Aachen TU	3	0	*0*	0	12	2	*16.7*	+	7	3	*42.9*	+
Berlin	38	8	*21.1*	−−	45	15	*33.3*	−	13	5	*38.5*	−−
Berlin TU	21	6	*28.6*	−	41	13	*31.7*	−	14	2	*14.3*	+
Bonn	12	1	*8.3*	+	16	1	*6.3*	−	7	1	*14.3*	+
Braunschweig TU	4	0	*0*	0	8	0	*0*	0	3	0	*0*	0
Breslau	12	2	*16.7*	+	10	1	*10.0*	−	6	3	*50.0*	−−
Breslau TU	1	0	*0*	0	14	2	*14.3*	−	5	2	*40.0*	−−
Darmstadt TU	9	1	*11.1*	+	18	5	*27.8*	−−	9	1	*11.1*	+
Dresden TU	6	1	*16.7*	−−	17	1	*5.9*	−−	10	0	*0*	0
Erlangen	4	0	*0*	0	8	0	*0*	0	3	0	*0*	0
Frankfurt	12	1	*8.3*	−	18	5	*27.8*	+	8	1	*12.5*	+
Freiburg	8	0	*0*	0	15	3	*20.0*	+	9	1	*11.1*	−
Giessen	5	1	*20.0*	−−	10	0	*0*	0	7	1	*14.3*	+
Göttingen	21	9	*42.9*	−−	17	0	*0*	0	17	10	*58.8*	−−
Greifswald	6	0	*0*	0	5	0	*0*	0	3	0	*0*	0
Halle	4	0	*0*	0	9	1	*11.1*	+	7	1	*14.3*	+
Hamburg	11	2	*18.2*	+	11	2	*18.2*	+	8	0	*0*	0
Hannover TU	3	0	*0*	0	14	0	*0*	0	6	0	*0*	0
Heidelberg	8	0	*0*	0	18	1	*5.6*	+	5	1	*20.0*	+
Jena	13	1	*7.7*	+	10	0	*0*	0	5	0	*0*	0
Karlsruhe TU	8	0	*0*	0	14	4	*28.6*	+	6	1	*16.7*	0
Kiel	8	1	*12.5*	−	11	0	*0*	0	5	2	*40.0*	+
Köln	8	1	*12.5*	+	4	1	*25.0*	−−	6	2	*33.3*	+
Königsberg	8	0	*0*	0	11	1	*9.1*	−−	5	2	*40.0*	−
Leipzig	11	2	*18.2*	+	24	2	*8.3*	−	8	2	*25.0*	−
Marburg	6	0	*0*	0	8	0	*0*	0	8	0	*0*	0
München	12	3	*25.0*	+	18	1	*5.6*	−	9	0	*0*	0
München TU	10	1	*10*	+	15	0	*0*	+	5	0	*0*	0
Münster	5	0	*0*	0	12	0	*0*	0	5	0	*0*	0
Rostock	3	0	*0*	0	8	0	*0*	0	2	0	*0*	0
Stuttgart TU	5	0	*0*	0	9	1	*11.1*	+	6	0	*0*	0
Tübingen	2	0	*0*	0	10	0	*0*	0	6	0	*0*	0
Würzburg	3	0	*0*	0	11	0	*0*	0	4	0	*0*	0

This table reports the total number of scientists in 1933. # Dismissed indicates how many scientists were dismissed in each department. % Dismissed indicates the percentage of dismissed scientists in each department. The column "Dismissal Induced Δ to Peer Quality" indicates how the dismissal affected average department quality: −− indicates a more than 50% drop in average department quality; − a drop in average department quality between 0 and 50%; 0 indicates no change in department quality; + indicates an improvement in average department quality between 0 and 50%.

Table 3: Quality of Dismissed Scholars

	Physics				Chemistry				Mathematics			
			Dismissed 33-34				Dismissed 33-34				Dismissed 33-34	
	All	Stay-ers	#	% Loss	All	Stay-ers	#	% Loss	All	Stay-ers	#	% Loss
Researchers (Beginning of 1933)	287	248	39	13.6	466	405	61	13.1	224	183	41	18.3
# of Chaired Profs.	109	97	12	11.0	156	136	20	12.8	117	99	18	15.4
Average Age (1933)	49.5	50.2	45.1	-	50.4	50.5	49.7	-	48.7	50.0	43.0	-
# of Nobel Laureates	15	9	6	40.0	14	11	3	21.4	-	-	-	-
Avg. publications (1925-1932)	0.47	0.43	0.71	20.5	1.69	1.59	2.31	17.9	0.33	0.27	0.56	31.1
Avg. publications (citation weighted)	5.10	3.53	14.79	39.4	17.25	16.07	25.05	19.0	1.45	0.93	3.71	46.8
% Publ. coauthored	33.3	33.6	31.6	-	76.0	75.8	77.1	-	11.3	9.7	14.8	-
% Publ. coauthored (Coaut. at German uni)	10.6	9.9	13.9	-	11.7	12.1	9.7	-	6.3	5.9	6.7	-
% Publ. coauthored (Coaut. same uni)	4.2	3.4	8.7	-	5.1	5.4	3.8	-	2.7	2.0	4.1	-

% Loss is calculated as the fraction of the dismissals among all researchers or as the fraction of Nobel Laureates, publications, and citation weighted publications which were contributed by the dismissed.

Table 4: Top Journals

Journal Name	Published in
General Journals	
Naturwissenschaften	Germany
Sitzungsberichte der Preussischen Akademie der Wissenschaften Physikalisch Mathematische Klasse	Germany
Nature	UK
Proceedings of the Royal Society of London A (Mathematics and Physics)	UK
Science	USA
Physics	
Annalen der Physik	Germany
Physikalische Zeitschrift	Germany
Physical Review	USA
Chemistry	
Berichte der Deutschen Chemischen Gesellschaft	Germany
Biochemische Zeitschrift	Germany
Journal für Praktische Chemie	Germany
Justus Liebigs Annalen der Chemie	Germany
Kolloid Zeitschrift	Germany
Zeitschrift für Anorganische Chemie und Allgemeine Chemie	Germany
Zeitschrift für Elektrochemie und Angewandte Physikalische Chemie	Germany
Zeitschrift für Physikalische Chemie	Germany
Journal of the Chemical Society	UK
Mathematics	
Journal für die reine und angewandte Mathematik	Germany
Mathematische Annalen	Germany
Mathematische Zeitschrift	Germany
Zeitschrift für angewandte Mathematik und Mechanik	Germany
Acta Mathematica	Sweden
Journal of the London Mathematical Society	UK
Proceedings of the London Mathematical Society	UK

Another major journal for physicists at the time was the "Zeitschrift für Physik". Unfortunately, the Web of Science does not include the articles in that journal after 1927. Therefore, I exclude the "Zeitschrift für Physik" from the analysis.

Table 5: Reduced Form (Department Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Physics				Chemistry				Mathematics			
Dependent Variable:	Publications	Publications	Citation Weighted Publ.	Citation Weighted Publ.	Publications	Publications	Citation Weighted Publ.	Citation Weighted Publ.	Publications	Publications	Citation Weighted Publ.	Citation Weighted Publ.
Number Dismissed	-0.009	-0.011	-0.036	-0.075	-0.009	-0.008	-0.100	-0.051	-0.012	-0.013	-0.034	-0.021
	(0.015)	(0.016)	(0.255)	(0.268)	(0.006)	(0.006)	(0.142)	(0.139)	(0.012)	(0.013)	(0.139)	(0.134)
Dismissal Induced	0.027	0.025	0.423	0.418	0.024	0.022	0.722	0.692	0.006	0.015	-0.664	-0.424
↓ in Peer Quality	(0.018)	(0.018)	(0.264)	(0.292)	(0.018)	(0.018)	(0.400)	(0.417)	(0.027)	(0.033)	(0.408)	(0.309)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE		✓		✓		✓		✓		✓		✓
Observations	2261	2261	2261	2261	3584	3584	3584	3584	1538	1538	1538	1538
# of researchers	258	258	258	258	413	413	413	413	183	183	183	183
R-squared	0.37	0.39	0.24	0.25	0.68	0.69	0.49	0.50	0.33	0.34	0.18	0.19

**significant at 1% level *significant at 5% level (All standard errors clustered at department level)

Publications is the sum of a scientist's publications in top journals in one year (normalized by the number of coauthors).

Citation Weighted Publications are defined as the sum of subsequent citations (in the first 50 years after publication in any journal included in the "Web of Science", including international journals) of all articles published in a given year (normalized by the number of coauthors).

Number dismissed is equal to the number of dismissed scientists in a researcher's department. The variable is 0 until 1933 for researchers in all departments. In 1934 it is equal to the number of dismissals in 1933 at a researcher's department. From 1935 onwards it is equal to the number of dismissals in 1933 and 1934 in a researcher's department.

Dismissal induced ↓ in Peer Quality is 0 for all researchers until 1933. In 1934 it is equal to (Avg. quality of total department before dismissal) - (Avg. quality of researchers not dismissed in 1933) if this number > 0. From 1935 onwards it will be equal to (Avg. quality of total department before dismissal) - (Avg. quality of researchers not dismissed in 1933 and 1934) if this number is > 0. Scientists in departments with above average quality dismissals will have a positive value of the quality dismissal variable after 1933 and a value of 0 until 1933. The variable will always be 0 for all other scientists. Average quality is measured as the department level average of citation weighted publications between 1925 and 1932 such that any changes after the dismissal do not affect the values of this average.

Table 6: Reduced Form (Specialization Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Physics				Chemistry				Mathematics			
Dependent Variable:	Publi-cations	Publi-cations	Citation Weighted Publ.	Citation Weighted Publ.	Publi-cations	Publi-cations	Citation Weighted Publ.	Citation Weighted Publ.	Publi-cations	Publi-cations	Citation Weighted Publ.	Citation Weighted Publ.
Number Dismissed	0.022	0.014	0.454	0.385	-0.003	-0.000	0.272	0.400	-0.026	-0.028	0.064	0.083
	(0.025)	(0.023)	(0.382)	(0.384)	(0.023)	(0.024)	(0.608)	(0.572)	(0.026)	(0.027)	(0.290)	(0.305)
Dismissal Induced	0.025	0.027	0.415	0.413	0.006	0.005	0.042	-0.003	0.018	0.033	-0.540	-0.401
↓ in Peer Quality	(0.021)	(0.021)	(0.322)	(0.322)	(0.009)	(0.009)	(0.132)	(0.124)	(0.030)	(0.036)	(0.322)	(0.327)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE		✓		✓		✓		✓		✓		✓
Observations	2257	2257	2257	2257	3567	3567	3567	3567	1538	1538	1538	1538
# of researchers	256	256	256	256	405	405	405	405	183	183	183	183
R-squared	0.37	0.39	0.25	0.26	0.68	0.69	0.49	0.50	0.33	0.34	0.18	0.19

**significant at 1% level *significant at 5% level (All standard errors are clustered at the department level)

Number dismissed is equal to the number of dismissed scientists within the same *specialization* as the researcher (e.g. it will be equal to the number of dismissed theoretical physicists at a researcher's department for a theoretical physicist). The variable is 0 until 1933 for all researchers. In 1934 it is equal to the number of dismissals in 1933 at a researcher's specialization. From 1935 onwards it is equal to the number of dismissals in 1933 and 1934 in a researcher's specialization.

Dismissal induced ↓ in Peer Quality is 0 for all researchers until 1933. In 1934 it is equal to (Avg. quality of *all* researchers within a specialization in the scientist's department before dismissal) - (Avg. quality of researchers within a specialization in a scientist's not dismissed in 1933) if this number is >0. From 1935 onwards it is equal to (Avg. quality of *all* researchers within a specialization in the scientist's department before dismissal) - (Avg. quality of researchers within a specialization in a scientist's not dismissed in 1933 or 1934) if this number is >0. Scientists in specializations with above average quality dismissals will have a positive value of the quality dismissal variable after 1933 and a value of 0 until 1933. The variable will always be 0 for all other scientists. Average quality is measured as the specialization level average of citation weighted publications between 1925 and 1932 such that any changes after the dismissal do not affect the values of this average.

Table 7: First Stages (Department Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)
	Physics		Chemistry		Mathematics	
Dependent Variable:	Department Size	Avg. Quality of Peers	Department Size	Avg. Quality of Peers	Department Size	Avg. Quality of Peers
Number Dismissed	-0.552	0.029	-0.962	0.016	-0.511	0.104
	(0.123)**	(0.136)	(0.105)**	(0.119)	(0.046)**	(0.041)*
Dismissal Induced	-0.082	-0.668	-0.019	-1.203	0.135	-1.531
↓ in Peer Quality	(0.177)	(0.198)**	(0.181)	(0.271)**	(0.175)	(0.123)**
Age Dummies	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓
Observations	2261	2261	3584	3584	1538	1538
# of researchers	258	258	413	413	183	183
R-squared	0.93	0.61	0.94	0.66	0.86	0.73
F - Test on Instruments	82.5	43.4	44.8	10.4	82.0	90.6

Table 8: Instrumental Variables (Department Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Physics				Chemistry				Mathematics			
Dependent Variable:	Publications		Cit. Weighted Pub.		Publications		Cit. Weighted Pub.		Publications		Cit. Weighted Pub.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Department Size	-0.001	0.017	-0.141	0.103	-0.006	0.008	0.013	0.043	0.006	0.025	0.055	0.098
	(0.004)	(0.034)	(0.081)	(0.559)	(0.004)	(0.006)	(0.147)	(0.129)	(0.012)	(0.024)	(0.072)	(0.281)
Peer Quality	0.001	-0.039	-0.081	-0.638	0.003	-0.018	0.056	-0.575	0.021	-0.008	0.541	0.285
	(0.004)	(0.036)	(0.086)	(0.609)	(0.003)	(0.016)	(0.045)	(0.289)	(0.014)	(0.021)	(0.174)**	(0.218)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	2261	2261	2261	2261	3584	3584	3584	3584	1538	1538	1538	1538
# of researchers	258	258	258	258	413	413	413	413	183	183	183	183
R-Squared	0.39		0.25		0.69		0.50		0.34		0.20	
Cragg-Donald EV Statistic		14.41		14.41		60.25		60.25		72.56		72.56

**significant at 1% level *significant at 5% level (All standard errors clustered at the department level)

Table 9: First Stages (Specialization Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)
	Physics		Chemistry		Mathematics	
Dependent Variable:	Department Size	Avg. Quality of Peers	Department Size	Avg. Quality of Peers	Department Size	Avg. Quality of Peers
Number Dismissed	-0.810	0.254	-1.011	0.625	-0.373	0.002
	(0.147)**	(0.201)	(0.105)**	(0.740)	(0.142)*	(0.152)
Dismissal Induced	0.060	-0.854	0.049	-0.972	-0.242	-0.613
↓ in Peer Quality	(0.041)	(0.314)*	(0.036)	(0.099)**	(0.139)	(0.552)
Age Dummies	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓
Observations	2257	2257	3567	3567	1538	1538
# of researchers	256	256	405	405	183	183
R-squared	0.92	0.57	0.92	0.67	0.88	0.65
F - Test on Instruments	15.5	4.9	46.4	72.4	49.1	0.9

Table 10: Instrumental Variables (Specialization Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Physics				Chemistry				Mathematics			
	Publications		Cit. Weighted Pub.		Publications		Cit. Weighted Pub.		Publications		Cit. Weighted Pub.	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Number of Peers in	-0.003	-0.027	-0.257	-0.641	-0.027	-0.003	-0.219	-0.407	-0.001	0.076	0.011	-0.220
Specialization	(0.012)	(0.031)	(0.187)	(0.550)	(0.014)	(0.024)	(0.224)	(0.565)	(0.016)	(0.095)	(0.127)	(0.733)
Average Peer Quality	0.003	-0.033	-0.062	-0.529	0.002	-0.006	0.022	-0.018	0.011	-0.084	0.377	0.740
	(0.004)	(0.035)	(0.052)	(0.555)	(0.001)	(0.009)	(0.024)	(0.130)	(0.016)	(0.153)	(0.152)*	(0.763)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	2257	2257	2257	2257	3567	3567	3567	3567	1538	1538	1538	1538
# of researchers	256	256	256	256	405	405	405	405	183	183	183	183
R-Squared	0.39		0.25		0.69		0.50		0.34		0.20	
Cragg-Donald EV Statistic		108.76		108.76		50.86		50.86		5.89		5.89

**significant at 1% level *significant at 5% level (All standard errors clustered at the department level)

Table 11: Robustness Checks Instrumental Variables Physics (Department Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Sample	omitting 33 & 34	omitting 33 & 34	younger than 50	younger than 50	50 or older	50 or older	≤ med. quality	≤ med. quality	> med. quality	> med. quality	Full Sample	Full Sample	Theor. Physics	Theor. Physics
Dep.Variable	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.
Department Size	-0.029	-0.106	0.077	1.618	-0.002	-0.993	0.020	0.346	0.352	5.007	0.056	0.171	-0.022	-0.728
	(0.035)	(0.679)	(0.050)	(1.280)	(0.070)	(0.783)	(0.015)	(0.340)	(1.929)	(25.722)	(0.059)	(0.556)	(0.061)	(1.196)
Peer Quality	0.010	-0.574	-0.069	-1.644	-0.006	0.785	0.017	-0.036	-0.527	-7.835	-0.067	-0.520	-0.086	-0.959
	(0.044)	(0.680)	(0.062)	(1.559)	(0.087)	(1.218)	(0.019)	(0.228)	(2.448)	(32.287)	(0.082)	(0.672)	(0.089)	(1.723)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uni specific. Time Trends											✓	✓		
Observations	1866	1866	1203	1203	1058	1058	1036	1036	1143	1143	2261	2261	464	464
# of researchers	256	256	181	181	147	147	128	128	112	112	258	258	50	50
EV Statistic	10.48	10.48	5.24	5.24	3.44	3.44	17.97	17.97	0.50	0.50	7.26	7.26	5.86	5.86

Table 12: Robustness Checks Instrumental Variables Chemistry (Department Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sample	omitting 33 & 34	omitting 33 & 34	younger than 50	younger than 50	50 or older	50 or older	≤ med. quality	≤ med. quality	> med. quality	> med. quality	Full Sample	Full Sample
Dep.Variable	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.
Department Size	0.012	0.157	0.002	-0.017	0.006	-0.067	0.006	-0.047	0.019	0.249	0.008	-0.121
	(0.009)	(0.105)	(0.013)	(0.344)	(0.011)	(0.136)	(0.007)	(0.082)	(0.018)	(0.254)	(0.013)	(0.279)
Peer Quality	-0.015	-0.349	-0.012	-0.681	-0.020	-0.277	-0.014	-0.208	-0.036	-1.221	0.015	-0.837
	(0.017)	(0.192)	(0.036)	(0.633)	(0.027)	(0.349)	(0.014)	(0.215)	(0.024)	(0.585)*	(0.056)	(0.748)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uni specific. Time Trends											✓	✓
Observations	2926	2926	1825	1825	1759	1759	1725	1725	1768	1768	3584	3584
# of researchers	411	411	265	265	241	241	204	204	187	187	413	413
EV Statistic	59.88	59.88	21.22	21.22	48.22	48.22	42.74	42.74	22.40	22.40	14.77	14.77

**significant at 1% level   *significant at 5% level   (All standard errors clustered at the department level)

Table 13: Robustness Checks Instrumental Variables Mathematics (Department Level Peers)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sample	omitting 33 & 34	omitting 33 & 34	younger than 50	younger than 50	50 or older	50 or older	≤ med. quality	≤ med. quality	> med. quality	> med. quality	Full Sample	Full Sample
Dep.Variable	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.
Department Size	0.033	0.242	0.049	-0.059	-0.012	-0.246	0.035	-0.289	-0.005	0.318	0.017	-0.107
	(0.042)	(0.508)	(0.028)	(0.315)	(0.039)	(0.470)	(0.029)	(0.320)	(0.031)	(0.454)	(0.016)	(0.240)
Peer Quality	-0.018	0.315	-0.020	0.375	0.028	0.081	-0.006	0.209	0.022	0.657	0.006	0.378
	(0.026)	(0.277)	(0.034)	(0.302)	(0.021)	(0.347)	(0.032)	(0.173)	(0.026)	(0.363)	(0.025)	(0.273)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uni specific. Time Trends											✓	✓
Observations	1256	1256	899	899	639	639	844	844	644	644	1538	1538
# of researchers	183	183	125	125	97	97	106	106	67	67	183	183
EV Statistic	19.18	19.18	41.16	41.16	20.82	20.82	30.51	30.51	34.71	34.71	68.30	68.30

**significant at 1% level *significant at 5% level (All standard errors clustered at the department level)

Table 14: Effect of Dismissal on Coauthors

	(1)	(2)	(3)	(4)
	Physics		Chemistry	
Dependent Variable	Publications	Citation Weighted Pub.	Publications	Citation Weighted Pub.
# of Dismissed Coauthors	0.363	8.449	0.419	-0.394
	(0.574)	(8.570)	(0.349)	(5.478)
Avg. Quality of Dism. Coauthors	-0.007	-0.128	-0.013	-0.165
	(0.003)*	(0.047)**	(0.003)**	(0.037)**
Age Dummies	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓
University FE	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓
Observations	2243	2243	3575	3575
# of researchers	258	258	413	413
R-squared	0.40	0.27	0.67	0.54

**significant at 1% level *significant at 5% level
(All standard errors are clustered at the individual level)

Table 15: Coauthors: Normalized Publications

	(1)	(2)	(3)	(4)
	Physics		Chemistry	
Dependent Variable	Publications	Citation Weighted Pub.	Publications	Citation Weighted Pub.
# of Dismissed Coauthors	0.684	10.503	0.279	-0.285
	(0.623)	(7.637)	(0.183)	(3.573)
Avg. Quality of Dism. Coauthors	-0.014	-0.244	-0.015	-0.161
	(0.008)	(0.094)*	(0.004)**	(0.068)*
Age Dummies	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓
University FE	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓
Observations	2243	2243	3575	3575
# of researchers	258	258	413	413
R-squared	0.39	0.26	0.68	0.49

**significant at 1% level *significant at 5% level
(All standard errors are clustered at the individual level)

Table 16: Coauthors: Timing of Coauthorship

	(1)	(2)	(3)	(4)
	Physics		Chemistry	
Dependent Variable	Publications	Citation Weighted Pub.	Publications	Citation Weighted Pub.
Coauthors 1930 - 1932				
# of Dismissed Coauthors	0.359	8.944	0.114	-6.177
	(0.636)	(8.516)	(0.556)	(10.365)
Avg. Quality of Dism. Coauthors	-0.007	-0.126	-0.013	-0.163
	(0.003)*	(0.040)**	(0.003)**	(0.047)**
Coauthors 1924 - 1929 (not later)				
# of Dismissed Coauthors	-0.030	-2.725	0.008	0.231
	(0.978)	(23.682)	(0.398)	(4.556)
Avg. Quality of Dism. Coauthors	0.007	0.118	0.004	0.069
	(0.019)	(0.440)	(0.004)	(0.068)
Age Dummies	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓
University FE	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓
Observations	2243	2243	3575	3575
# of researchers	258	258	413	413
R-squared	0.40	0.27	0.67	0.54

**significant at 1% level *significant at 5% level
(All standard errors are clustered at the individual level)

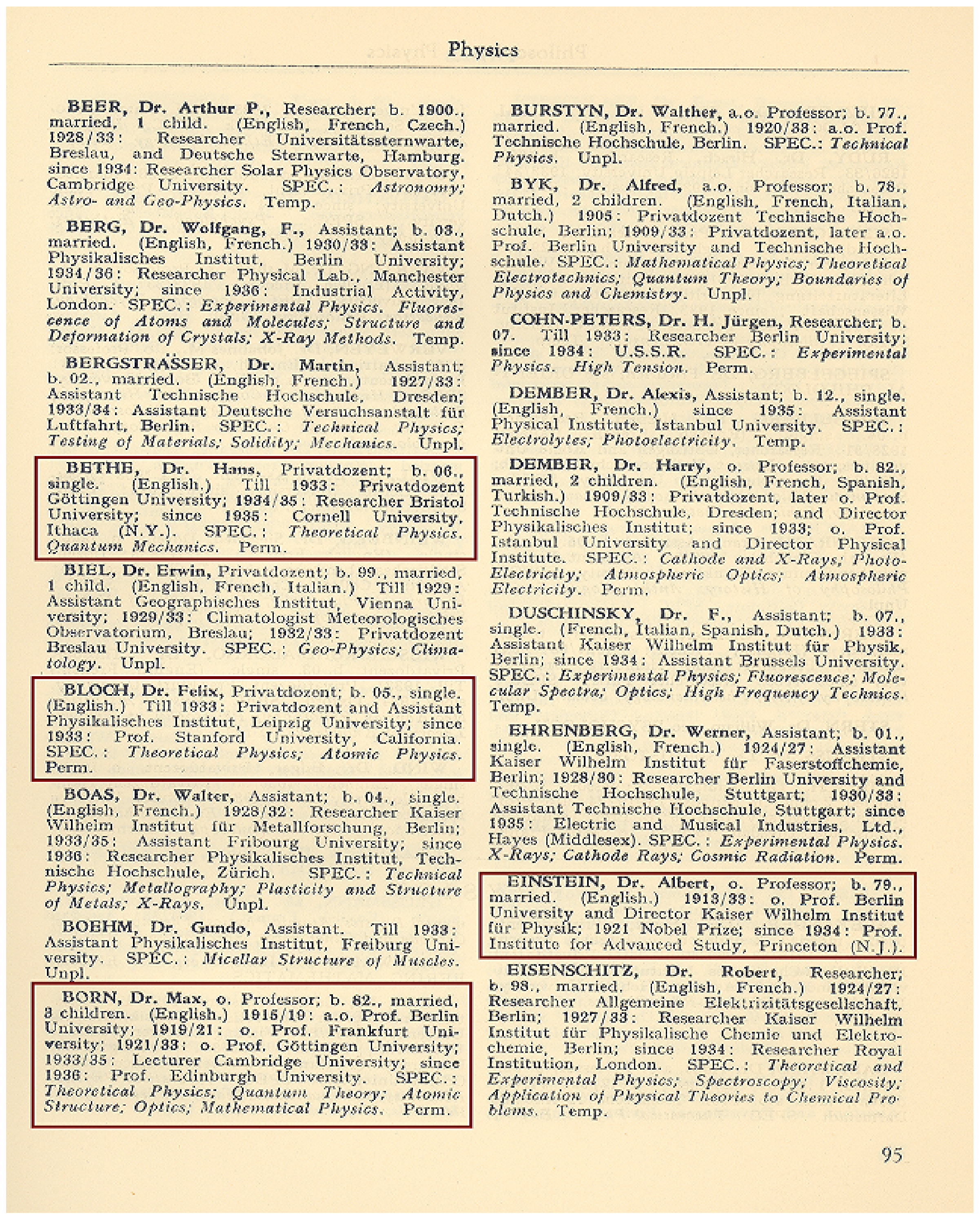
Table 17: Coauthors: Publications without dismissed Coauthors

	(1)	(2)	(3)	(4)
	Physics		Chemistry	
Dependent Variable	Publications	Citation Weighted Pub.	Publications	Citation Weighted Pub.
Coauthors 1930 - 1932				
# of Dismissed Coauthors	0.510	12.814	0.311	-6.859
	(0.662)	(10.669)	(0.546)	(14.775)
Avg. Quality of Dism. Coauthors	-0.007	-0.144	-0.012	-0.286
	(0.003)*	(0.050)**	(0.003)**	(0.068)**
Coauthors 1924 - 1929 (not later)				
# of Dismissed Coauthors	0.007	0.142	0.003	0.065
	(0.019)	(0.490)	(0.004)	(0.070)
Avg. Quality of Dism. Coauthors	0.028	-3.465	0.009	-1.128
	(0.970)	(26.113)	(0.394)	(5.287)
Age Dummies	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓
University FE	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓
Observations	2243	2243	3575	3575
# of researchers	258	258	413	413
R-squared	0.39	0.28	0.67	0.53

**significant at 1% level *significant at 5% level
(All standard errors are clustered at the individual level)

11 Appendix

Sample Page from List of Displaced German Scholars



Physics

BEER, Dr. Arthur P., Researcher; b. 1900., married, 1 child. (English, French, Czech.) 1928/33: Researcher Universitätssternwarte, Breslau, and Deutsche Sternwarte, Hamburg. since 1934: Researcher Solar Physics Observatory, Cambridge University. SPEC.: *Astronomy; Astro- and Geo-Physics.* Temp.

BERG, Dr. Wolfgang, F., Assistant; b. 03., married. (English, French.) 1930/33: Assistant Physikalisches Institut, Berlin University; 1934/36: Researcher Physical Lab., Manchester University; since 1936: Industrial Activity, London. SPEC.: *Experimental Physics. Fluorescence of Atoms and Molecules; Structure and Deformation of Crystals; X-Ray Methods.* Temp.

BERGSTRÄSSER, Dr. Martin, Assistant; b. 02., married. (English, French.) 1927/33: Assistant Technische Hochschule, Dresden; 1933/34: Assistant Deutsche Versuchsanstalt für Luftfahrt, Berlin. SPEC.: *Technical Physics; Testing of Materials; Solidity; Mechanics.* Unpl.

BETHE, Dr. Hans, Privatdozent; b. 06., single. (English.) Till 1933: Privatdozent Göttingen University; 1934/35: Researcher Bristol University; since 1935: Cornell University, Ithaca (N.Y.). SPEC.: *Theoretical Physics. Quantum Mechanics.* Perm.

BIEL, Dr. Erwin, Privatdozent; b. 99., married, 1 child. (English, French, Italian.) Till 1929: Assistant Geographisches Institut, Vienna University; 1929/33: Climatologist Meteorologisches Observatorium, Breslau; 1932/33: Privatdozent Breslau University. SPEC.: *Geo-Physics; Climatology.* Unpl.

BLOCH, Dr. Felix, Privatdozent; b. 05., single. (English.) Till 1933: Privatdozent and Assistant Physikalisches Institut, Leipzig University; since 1933: Prof. Stanford University, California. SPEC.: *Theoretical Physics; Atomic Physics.* Perm.

BOAS, Dr. Walter, Assistant; b. 04., single. (English, French.) 1928/32: Researcher Kaiser Wilhelm Institut für Metallforschung, Berlin; 1933/35: Assistant Fribourg University; since 1936: Researcher Physikalisches Institut, Technische Hochschule, Zürich. SPEC.: *Technical Physics; Metallography; Plasticity and Structure of Metals; X-Rays.* Unpl.

BOEHM, Dr. Gundo, Assistant. Till 1933: Assistant Physikalisches Institut, Freiburg University. SPEC.: *Micellar Structure of Muscles.* Unpl.

BORN, Dr. Max, o. Professor; b. 82., married, 3 children. (English.) 1915/19: a.o. Prof. Berlin University; 1919/21: o. Prof. Frankfurt University; 1921/33: o. Prof. Göttingen University; 1933/35: Lecturer Cambridge University; since 1936: Prof. Edinburgh University. SPEC.: *Theoretical Physics; Quantum Theory; Atomic Structure; Optics; Mathematical Physics.* Perm.

BURSTYN, Dr. Walther, a.o. Professor; b. 77., married. (English, French.) 1920/33: a.o. Prof. Technische Hochschule, Berlin. SPEC.: *Technical Physics.* Unpl.

BYK, Dr. Alfred, a.o. Professor; b. 78., married, 2 children. (English, French, Italian, Dutch.) 1905: Privatdozent Technische Hochschule, Berlin; 1909/33: Privatdozent, later a.o. Prof. Berlin University and Technische Hochschule. SPEC.: *Mathematical Physics; Theoretical Electrotechnics; Quantum Theory; Boundaries of Physics and Chemistry.* Unpl.

COHN-PETERS, Dr. H. Jürgen, Researcher; b. 07. Till 1933: Researcher Berlin University; since 1934: U.S.S.R. SPEC.: *Experimental Physics. High Tension.* Perm.

DEMBER, Dr. Alexis, Assistant; b. 12., single. (English, French.) since 1935: Assistant Physical Institute, Istanbul University. SPEC.: *Electrolytes; Photoelectricity.* Temp.

DEMBER, Dr. Harry, o. Professor; b. 82., married, 2 children. (English, French, Spanish, Turkish.) 1909/33: Privatdozent, later o. Prof. Technische Hochschule, Dresden; and Director Physikalisches Institut; since 1933; o. Prof. Istanbul University and Director Physical Institute. SPEC.: *Cathode and X-Rays; Photo-Electricity; Atmospheric Optics; Atmospheric Electricity.* Perm.

DUSCHINSKY, Dr. F., Assistant; b. 07., single. (French, Italian, Spanish, Dutch.) 1933: Assistant Kaiser Wilhelm Institut für Physik, Berlin; since 1934: Assistant Brussels University. SPEC.: *Experimental Physics; Fluorescence; Molecular Spectra; Optics; High Frequency Technics.* Temp.

EHRENBERG, Dr. Werner, Assistant; b. 01., single. (English, French.) 1924/27: Assistant Kaiser Wilhelm Institut für Faserstoffchemie, Berlin; 1928/30: Researcher Berlin University and Technische Hochschule, Stuttgart; 1930/33: Assistant Technische Hochschule, Stuttgart; since 1935: Electric and Musical Industries, Ltd., Hayes (Middlesex). SPEC.: *Experimental Physics. X-Rays; Cathode Rays; Cosmic Radiation.* Perm.

EINSTEIN, Dr. Albert, o. Professor; b. 79., married. (English.) 1913/33: o. Prof. Berlin University and Director Kaiser Wilhelm Institut für Physik; 1921 Nobel Prize; since 1934: Prof. Institute for Advanced Study, Princeton (N.J.).

EISENSCHITZ, Dr. Robert, Researcher; b. 98., married. (English, French.) 1924/27: Researcher Allgemeine Elektrizitätsgesellschaft, Berlin; 1927/33: Researcher Kaiser Wilhelm Institut für Physikalische Chemie und Elektrochemie, Berlin; since 1934: Researcher Royal Institution, London. SPEC.: *Theoretical and Experimental Physics; Spectroscopy; Viscosity; Application of Physical Theories to Chemical Problems.* Temp.

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Squares were added by the author to highlight the researchers who had already received the Noble prize or were to receive it after 1936.

Table A1: Specializations

Physics		Chemistry		Mathematics	
Specialization	% scientists in specialization	Specialization	% scientists in specialization	Specialization	% scientists in specialization
Experimental Physics	48.5	Organic Chemistry	26.6	Analysis	45.9
Theoretical Physics	22.3	Physical Chemistry	23.8	Applied Mathematics	36.2
Technical Physics	20.6	Technical Chemistry	19.4	Algebra	19.7
Astronomy	14.7	Anorganic Chemistry	18.6	Number Theory	13.5
		Pharmacology	10.2	Metha Mathematics	5.2
		Medical Chemistry	8.0	Topology	4.8
		Biochemistry	6.7	Foundations of Math.	4.4

Percentages add to more than 100 percent because some physicists and chemists have two specializations. Mathematicians have up to four specializations.

Table A2: Top Researchers 1925-1932 (Citation weighted Publications Measure)

Name	University beginning of 1933	First Special-ization	Second Special-ization	Third Special-ization	Avg. Cit weighted Publ.	Avg. Publ.	Nobel Prize	Dis-missed 33-34
Physics								
Fritz London	Berlin	Theo. Phy.			149.3	1.3		✓
Lother Nordheim	Göttingen	Theo. Phy.			110.0	0.7		✓
Gerhard Herzberg	Darmstadt TU	Exp. Phy.			78.0	2.0	✓	
Carl Ramsauer	Berlin TU	Exp. Phy.			75.6	3.0		
Max Born	Göttingen	Theo. Phy.			62.5	1.3	✓	✓
Hans Falkenhagen	Köln	Theo. Phy.			57.5	1.9		
Arnold Sommerfeld	München	Theo. Phy.			44.4	1.8		
Eugen Wigner	Berlin TU	Theo. Phy.			44.3	0.5	✓	✓
Heinrich Kuhn	Göttingen	Exp. Phy.	Theo. Phy.		42.0	4.0		✓
Harry Dember	Dresden TU	Exp. Phy.			40.8	1.0		✓
Karl Herzfeld		Theo. Phy.			33.7	1.3		
Richard Gans	Königsberg	Exp. Phy.			29.4	1.6		
Walter Gerlach	München	Exp. Phy.			29.1	3.1		
Wolfgang Pauli		Theo. Phy.			28.0	3.8	✓	
Max Wien	Jena	Exp. Phy.			25.4	2.0		
Werner Heisenberg	Leipzig	Theo. Phy.			25.3	1.0	✓	
Ludwig Prandtl	Göttingen	Tech. P.			23.3	1.1		
Fritz Kirchner	München	Exp. Phy.			22.5	2.5		
Johannes Malsch	Köln	Exp. Phy.			22.0	1.5		
Emil Rupp	Berlin TU	Exp. Phy.			21.4	5.2		✓
Chemistry								
Werner Kuhn	Karlsruhe TU	Physical C.			262.0	7.0		
Max Bergmann	Dresden TU	Organic C.	Biochem.		250.2	6.8		✓
Karl Lohmann	Heidelberg	Medical C.			224.0	6.0		
Ernst Bergmann	Berlin	Physical C.			223.3	17.0		✓
Carl Neuberg	Berlin	Biochem.			184.9	15.1		
Carl Wagner	Jena	Physical C.			177.5	5.0		
Otto Meyerhof	Heidelberg	Medical C.			176.3	5.8	✓	
Otto Ruff	Breslau TU	Anorganic C.			133.4	7.2		
Wolfgang Ostwald	Leipzig	Anorganic C.			127.0	8.6		
Hermann Staudinger	Freiburg	Organic C.			126.8	8.5	✓	
Gustav Tammann	Göttingen	Physical. C.			118.4	19.0		
Michael Polanyi	Berlin TU	Physical. C.			116.8	5.6		✓
Max Volmer	Berlin TU	Physical. C.			114.0	4.2		
Karl Freudenberg	Heidelberg	Organic C.			111.8	7.0		
Ulrich Hofmann	Berlin TU	Anorganic C.	Physical C.		109.0	6.0		
Richard Johann Kuhn	Heidelberg	Physical C.	Medical C.		92.1	8.0	✓	
Max Trautz	Heidelberg	Physical C.			91.9	5.3		
Wilhelm Klemm	Hannover TU	Anorganic. C.			91.4	5.2		
Mathematics								
Johann von Neumann	Berlin	Applied Math	Foundations	Analysis	36.3	1.5		✓
Richard Courant	Göttingen	Analysis	Applied Math		22.3	1.3		✓
Richard von Mises	Berlin	Applied Math	Analysis		15.6	0.9		✓
Heinz Hopf		Algebra	Topology	Geometry	13.3	1.3		
Paul Epstein	Frankfurt	Geometry	Number Th.	Algebra	11.5	0.6		
Oskar Perron	München	Algebra	Analysis		10.6	1.5		
Willy Prager	Göttingen	Applied Math			10.0	0.4		✓
Gabiel Szegö	Königsberg	Applied Math	Geometry		9.4	1.4		✓
Werner Rogosinski	Königsberg	Number Th.	Analysis		9.1	0.6		
Wolfgang Krull	Erlangen	Algebra			8.9	1.4		
Erich Rothe	Breslau TU	Analysis	Applied Math		8.0	1.0		✓
Hans Peterssonn	Hamburg	Number Th.	Analysis		8.0	2.0		
Adolf Hammerstein	Berlin	Number Th.	Analysis		8.0	0.5		
Alexander Weinstein	Breslau TU	Applied Math			6.3	0.7		✓
Erich Kamke	Tübingen	Number Th..	Foundations	Analysis	6.3	0.8		
Hellmuth Kneser	Greifswald	Applied Math	Analysis	Topology	6.3	0.6		
Bartel van der Waerden	Leipzig	Algebra	Geometry		5.8	1.8		
Max Müller	Heidelberg	Analysis			5.3	0.3		
Richard Brauer	Königsberg	Algebra			5.0	0.6		✓
Leon Lichtenstein	Leipzig	Analysis	Applied Math		4.9	1.5		✓

The university in 1933 is missing for researchers, who retire before before 1933.

Table A3: Probability of Being Ever Promoted

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:						
Promotion Dummy	Physics		Chemistry		Mathematics	
Peer Group:	Department Level	Specialization Level	Department Level	Specialization Level	Department Level	Specialization Level
Number Dismissed	0.012	-0.002	-0.002	-0.008	0.019	0.028
	(0.007)	(0.007)	(0.002)	(0.008)	(0.013)	(0.025)
Dismissal Induced	-0.012	0.001	0.000	0.001	-0.023	-0.019
↓ in Peer Quality	(0.008)	(0.003)	(0.004)	(0.002)	(0.022)	(0.038)
Age Dummies	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓
Observations	2261	2257	3584	3567	1538	1538
# of researchers	258	256	413	405	183	183
R-squared	0.76	0.75	0.79	0.79	0.82	0.82

Table A4: Signing Support List for Hitler

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:						
Signing Support List	Physics		Chemistry		Mathematics	
Peer Group	Department Level	Specialization Level	Department Level	Specialization Level	Department Level	Specialization Level
Number Dismissed	-0.019	-0.016	-0.000	-0.000	-0.027	-0.029
	(0.024)	(0.013)	(0.001)	(0.003)	(0.065)	(0.036)
Dismissal Induced	0.047	-0.004	0.000	0.000	0.047	-0.082
↓ in Peer Quality	(0.034)	(0.003)	(0.002)	(0.001)	(0.138)	(0.064)
Age Dummies	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓
Observations	202	202	332	329	144	144
# of researchers	202	202	332	329	144	144
R-squared	0.60	0.61	0.50	0.50	0.64	0.65

Table A5: Notgemeinschaft Funding

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:						
Received Funding	Physics		Chemistry		Mathematics	
Peer Group:	Department Level	Specialization Level	Department Level	Specialization Level	Department Level	Specialization Level
Number Dismissed	0.035	0.022	-0.006	-0.031	0.002	0.009
	(0.026)	(0.051)	(0.015)	(0.043)	(0.010)	(0.025)
Dismissal Induced	-0.082	-0.007	0.016	0.000	-0.004	-0.008
↓ in Peer Quality	(0.031)*	(0.015)	(0.021)	(0.012)	(0.017)	(0.022)
Age Dummies	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓
Observations	347	347	567	565	244	244
# of researchers	228	228	367	365	161	161
R-squared	0.79	0.77	0.71	0.71	0.60	0.60

**significant at 1% level *significant at 5% level (All standard errors clustered at the department level)

Table A6: Placebo Dismissal (Moving Dismissal to 1930)

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:						
Publications	Physics		Chemistry		Mathematics	
Peer Group:	Department Level	Specialization Level	Department Level	Specialization Level	Department Level	Specialization Level
Number Dismissed	0.025	0.006	-0.006	-0.061	-0.001	-0.029
	(0.033)	(0.024)	(0.013)	(0.084)	(0.023)	(0.047)
Dismissal Induced	-0.031	0.022	-0.000	0.013	0.028	0.034
↓ in Peer Quality	(0.042)	(0.017)	(0.022)	(0.007)	(0.055)	(0.050)
Age Dummies	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓
Observations	1314	1310	2051	2041	875	875
# of researchers	237	235	389	383	170	170
R-squared	0.48	0.48	0.75	0.75	0.39	0.39

Table A7: Robustness Checks Instrumental Variables Physics (Specialization Level)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Sample	omitting 33 & 34	omitting 33 & 34	younger than 50	younger than 50	50 or older	50 or older	≤ med. quality	≤ med. quality	> med. quality	> med. quality	Full Sample	Full Sample	Theor. Physics	Theor. Physics
Dep.Variable	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.
# of Peers in	-0.056	-1.010	0.021	0.611	-0.005	-0.494	0.003	0.277	-0.039	-1.482	-0.012	-0.431	0.097	-2.751
Specialization	(0.044)	(0.711)	(0.031)	(0.647)	(0.031)	(0.645)	(0.017)	(0.292)	(0.059)	(1.282)	(0.041)	(0.662)	(1.030)	(15.667)
Avg. Peer Quality	-0.050	-0.743	0.001	0.037	-0.078	-1.551	0.006	0.068	-0.095	-1.368	-0.034	-0.559	-0.065	-0.309
	(0.050)	(0.680)	(0.009)	(0.120)	(0.073)	(1.074)	(0.006)	(0.057)	(0.099)	(1.523)	(0.037)	(0.600)	(0.240)	(3.546)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uni specific. Time Trends											✓	✓		
Observations	1863	1863	1199	1199	1058	1058	1032	1032	1143	1143	2257	2257	464	464
# of researchers	254	254	179	179	147	147	126	126	112	112	256	256	50	50
EV Statistic	61.17	61.17	26.91	26.91	43.08	43.08	71.06	71.06	30.91	30.91	98.20	98.20	0.16	0.16

**significant at 1% level *significant at 5% level (All standard errors clustered at the department level)

Table A8: Robustness Checks Instrumental Variables Chemistry (Specialization Level)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sample	omitting 33 & 34	omitting 33 & 34	younger than 50	younger than 50	50 or older	50 or older	≤ med. quality	≤ med. quality	> med. quality	> med. quality	Full Sample	Full Sample
Dep.Variable	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.
# of Peers in	0.009	-0.144	-0.016	-0.683	0.016	-0.468	0.013	-0.374	-0.002	-0.302	-0.009	-0.889
Specialization	(0.029)	(0.379)	(0.046)	(1.487)	(0.022)	(0.345)	(0.031)	(0.445)	(0.086)	(0.958)	(0.041)	(0.747)
Avg. Peer Quality	-0.005	0.088	0.004	-0.071	-0.010	-0.078	-0.001	-0.027	-0.016	-0.154	-0.007	-0.031
	(0.009)	(0.144)	(0.013)	(0.261)	(0.009)	(0.084)	(0.006)	(0.118)	(0.010)	(0.142)	(0.006)	(0.164)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uni specific. Time Trends											✓	✓
Observations	2913	2913	1815	1815	1752	1752	1713	1713	1767	1767	3567	3567
# of researchers	404	404	261	261	236	236	199	199	186	186	405	405
EV Statistic	38.97	38.97	14.14	14.14	64.73	64.73	23.26	23.26	26.00	26.00	41.32	41.32

Table A9: Robustness Checks Instrumental Variables Mathematics (Specialization Level)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Sample	omitting 33 & 34	omitting 33 & 34	younger than 50	younger than 50	50 or older	50 or older	≤ med. quality	≤ med. quality	> med. quality	> med. quality	Full Sample	Full Sample
Dep.Variable	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.	Publications	Cit weig. Publ.
# of Peers in	-5.767	17.774	0.094	-0.178	-0.118	-1.935	0.054	-0.363	0.192	2.848	0.060	-1.288
Specialization	(342.329)	(1076.989)	(0.088)	(0.564)	(0.171)	(2.582)	(0.049)	(0.411)	(0.905)	(8.984)	(0.267)	(3.297)
Avg. Peer Quality	4.823	-14.321	-0.176	1.157	0.092	1.213	-0.031	0.197	-0.325	-3.036	-0.144	2.819
	(284.859)	(896.572)	(0.352)	(1.764)	(0.104)	(1.723)	(0.034)	(0.240)	(0.944)	(10.018)	(0.787)	(10.663)
Age Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year Dummies	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Individual FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
University FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Uni specific. Time Trends											✓	✓
Observations	1256	1256	899	899	639	639	844	844	644	644	1538	1538
# of researchers	183	183	125	125	97	97	106	106	67	67	183	183
EV Statistic	0.00	0.00	4.29	4.29	3.34	3.34	32.61	32.61	0.62	0.62	1.11	1.11

**significant at 1% level *significant at 5% level (All standard errors clustered at the department level)

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