MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

Effect of universities research groups' size and hierarchy on their performance: evidence from Austria and Germany

verfasst von / submitted by

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angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien, 2018 / Vienna 2018

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	A 066 914
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium Internationale Betriebswirtschaft
Betreut von / Supervisor:	Ass.-Prof. Steffen Keck, PhD

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CI   Citation Index

Et al.   "et alii", and others

Etc. "et cetera", and so forth

IF Impact Factor

SCI Science Citation Index

Chapter 1. Introduction

This chapter is devoted to the theoretical background aiming to illuminate the existing findings regarding the Universities research groups, examining the relationship between research group size and its performance and investigating the role of span of control or hierarchy in research group performance.

1.1. Background

An actual background of the notion of scientific work includes not only published works, but also research data and methods related to research. This is the case why governments around the world invest great amounts of money in the development of national information research infrastructures (Richardson et al. 2012, pp. 258-277). Universities, as centers of knowledge generation and innovation, are eager to prove that their research strategies and implemented projects are aligned with national imperatives.

The main indicators of the effectiveness of scientific research are bibliometric indicators (the number of publications in scientific journals, the frequency of citations of these publications, the impact factor of the scientific journal in which they are published, the number of highly cited papers, the Hirsch index, and various normalized citation indexes) and scientific review is powerful information tools for supporting the development of science. At the same time, nowadays worldwide bibliometric indicators are among the mandatory elements in the reporting of scientific institutions, universities, research groups, and individual scientists.

According to the professionals, the 21st century is the age of bibliometry. Half a century ago in 1964 on the basis of the bibliographic arrays analysis of the world's first edition of the Science Citation Index – SCI (index of references) created by Dr. E. Garfield a new scientific discipline appeared, called scientometrics (or as is now more often called bibliometrics) (Akoyev et al. 2014, pp. 14-48).

And already in 2011, Garfield underlined that we are witnessing the transformation of bibliometric research into a new industry: the evaluation of the effectiveness of scientific research carried out in universities and research teams (Akoyev et al. 2014, pp. 14-48).

Therefore, the major objective of this study is to investigate the productivity of scientific activities of the physic departments of Austrian and German Universities. Here will be examined the significance and impact of the research group size on the performance of research activities in Universities of Austria and Germany.

The purpose for assessing the performance of the scientific activities can be the formation of an effective system of research groups, the enlargement of Universities' contribution to the country's social and economic development and growth of managerial decisions effectiveness in the field of science.

Most studies in group size and its productivity have only focused on the groups in big companies and organizations, and only a few writers have been able to base their studies on the research groups in Universities.

Therefore, it seems relevant to choose the topic about the influence of the research group size on the performance of the University. The perspective of this direction and its lack of development and investigation has determined the topic of this research.

1.2. Framework of the universities' evaluation

This section contains the description of University performance patterns to understand better the main characteristics and determinants positively and negatively affecting the productivity of research groups. Moreover, various performance indicators used in measuring researcher's productivity are classified.

1.2.1. University Performance

The productivity of labour is determined by the volume of results produced by the employee work. The result of scientific employees' work is a new scientific knowledge, which is embodied mainly in the form of published scientific writings. Moreover, most publications are created by a small number of scientists, which is stated in several studies (Kwiek 2016, pp.379; Kyvik 1990, pp. 37-39).

In the 20th century appeared an interest in assessing the productivity of scientific employees and in the 1970s it has increased dramatically in connection with the massification of the higher education sector and awareness of the necessity of some standardized assessment of the productivity of academics (Abramo et al. 2009, pp.155-171). Up to the middle of the 20th century, the main tool for measuring the effectiveness of research staff was the procedure of peer review, that is the evaluation of work by colleagues-specialists in the field of knowledge to which the publication relates. The increase in the number of scientific journals and, consequently, the articles in them as well as computerization and automatization contributed to the development of various bibliometric methods for productivity evaluation. In the article published in the "Science" journal in 1954, Eugene Garfield came up with the idea of using scientific citation based on the mechanical control of scientific publications (Garfield 1964, pp.189-192). Centralized mechanisms for collecting and analysing scientific statistics and reprints of scientific publications have made it easier to find the necessary articles and information that they contain. This, in turn, served as a driver for the emergence and subsequent use of citation indexes.

By understanding under the academic productivity, the academic publication activities, productivity researches, and science administrators seek to develop scientifically based and most objective criteria for analysing productivity. Some tend to measure productivity only by the number of published scientific papers (Ivanov et al. 2016, pp.314-321, Abramo et al. 2011, pp.629-643). Another approach takes into account not only the quantity but also the quality of published works, for which evaluation exist many indicators (Lazarev 1996, pp.271-277, Pfeiffer et al. 2017).

Viktor Bolotov together with his colleagues notes that the analytical component of scientometrics is intended to the triad of objects investigated: author – publication – journal (publishing) (Bolotov et al. 2014, pp. 241-258). Harris distinguishes four components of the evaluation of scientific productivity: 1) importance/influence ("impact"- the number of citations); 2) quality (usually through peer reviews); 3) significance (it may not be clear until enough time has passed); 4) quantity (the number of published works or pages, as a rule, it strongly correlates with the influence) (Harris 1990, pp. 249-259). Talking about the productivity of university staff we can also divide between three types of performance indicators of scientific activity: gross data (we can also call them quantitative); qualitative data (based on the quality of the journal in which this work is published); and perceptual indicators (reflecting recognition among colleagues, can be calculated on the basis of citations). The indicators by which researches measure scientific productivity, the principle of their work and limitations are collected in Table 1 (Bolotov et al. 2014, pp. 241-258, Polyanin 2014, pp. 131-144, Wildgaard et al. 2014, pp. 125-158).

Table 1. Indicators used by researches in measuring the academic's productivity

Index		Principle	Limitations	Literature
Number of published works	• Throughout the whole career; • Before / after obtaining the degree; • Within 3 / 5 / 10 years after receiving the degree; • During the last 3 / 5 / 10 years	The total amount of the number of published scientific papers. Can be taken into account: the number of co-authors, the type of publication, as well as the publication standards within the discipline.	Does not reflect the quality of work and the importance of the results.	Prpić K., 1996, 2002 Kyvik S., Teigen M., 1996 Pfeiffer, M, 2016 Bentley P., 2012 Reskin B, 1978 Abramo G., 2011
Number of pages		Total estimation of the number of published pages	Does not reflect the quality of work and the importance of the results	Dubois P, 2014
Impact Factor (IF)	• Availability of publications in journals with high IF; • Citedness in such journals; • Speed and age of citedness in them; • Average IF for all publications of the author; • In comparison with the rest academic community.	The popularity and quality of journals in which the author is published, as well as the degree of recognition of the author's works in journals with different levels of quality.	Does not reflect the real quality of publications, only the fact of "success" of the publication in a journal with a high IF.	Rehn et al. 2007 Moed 2010 Waltman et al. 2012
Citation Index (CI)	• Total number of citations; • The average number of citations; • Adjusted for discipline; • Taking into account the complete bibliography of the author;	General / average / largest number of links on all works of the author for a certain period of time.	Does not reflect the real significance of the publications (self-citation, "counter-citations", citations by co-authors and colleagues). Different patterns of citation in different scientific disciplines.	Abramo G., 2011 Van Den Besselaar, P., Sandström U., 2016 HendrixD., 2008

	• Taking into account the age of works and citations.		Dependence on the journal where the article is published.	
Indices, taking into account both the number and quality of publications	Hirsch Index	A scientist has an h index, if h from his N_p articles is cited at least h times each, while the remaining (N_p-h) articles are cited no more than h times each.	Underestimation of highly cited works. Unreliable for comparing different disciplines. Dependence on the career duration.	Inanc O., Tuncer O., 2011
	Modified Hirsch Index: m, e, hmx, Hg, h^2, A, R, b, Q2, Hpd	Takes into account co-authorship, discipline, work that is rejected in calculations of h-index. Another approach for measuring citations.		Zhang 2009; Alonso et al. 2009; Kosmulski 2006 Jin, 2007
	Alternatives to the Hirsch Index: w, f, g, t, p	g – for a given set of articles, sorted in descending order of the number of citations that these articles received; g-index – is the largest number g of the most cited articles that have received (in total) not less than g^2 citations; w – best works; f,t – citation's weight; p – comparison with the best works in the field.		Egghe 2006 Wu 2008 Tol 2009 Vinkler 2009
Evaluation of the importance of the article over time	Takes into account: discipline; the author's entire bibliography.	Does the work continues to be cited over time due to the age of publication (based on citation indices, h, and g).		Costas et al. 2010a Costas et al. 2010a, b, 2011 Jin, 2007

1.2.2. Size and productivity

A lot of factors are described in the literature on which the publication productivity of researches depends. While studying the research performance of faculties, John Creswell proposed to divide all the factors that affect productivity into three groups: individual, organizational and institutional (Creswell 1985, pp. 92). Individual factors are a set of characteristics inherent in each individual scientific employee. These include psychological and socio-demographic factors, as well as skills and everything related to a person's first-hand experience. This group's factors should be taken into account when hiring employees for the university positions. The second group of factors, organizational ones, is the university characteristics or its subdivisions in which a research fellow is working. Understanding the working mechanisms of these factors helps to build the most effective administrative policy. Institutional factors (structural or conjunctural) reflect the national characteristics of countries. These factors discuss the impact of factors on the productivity of researches at all three levels.

The characteristics of universities with which research workers are affiliated also have different effects on the productivity of their employees (Fox and Mohapatra 2007, pp. 542-571). At the organizational level, the influence of organizational culture, the size of the working group and department, the prestige of the university, the system of incentives, access to resources and equipment, sources of financing are considered.

The problem of the relationship between the magnitude and success of the group has attracted many researches recently. Its popularity in the subject of research is due to the fact that the number of participants is relatively easy to manipulate, and if there are any regular links between the size and success of the group, they can be directly used to effectively regulate the effectiveness of group work. Studies of this problem fall into two relatively independent directions, following the traditions of the productivity and satisfaction allocation as the main criteria for the success of the group work: the study of the relationship between the size and productivity of the group, estimated either by the general results of group work or by the average individual contribution of participants to the results of joint work and analysis of the group size influence on the satisfaction of its members by various sides of group activities.

One of the earliest studies was the work directed by V. Moede (Moede 1927, pp. 193-207). There the author first described the phenomenon known as “Ringelmann effect”. The main point is a gradual and proportionate, expressible in a strict mathematical formula, a decrease in the average individual contribution of the participant to the results of group work with the increasing group size. O. Koehler, in general, confirmed the regularity described by Moede and at the same time showed that it has a curvilinear character (Koehler 1927, pp. 206-226). The data obtained in artificial laboratory groups indicate that Ringelmann effect appears almost always on random groups at least within a certain limited range of variations of group size.

In the next cycle of studies in the same direction the results of work of different group sizes, not only laboratory but also real ones, were directly compared to each other in the process of solving various problems. E. South found that for abstract problems bigger groups yield better results than relatively small ones (South 1927, pp 348-368). Ch. Hoffman and H. Hendrick also showed that in the laboratory conditions when solving creative problems there is a positive correlation between the size and productivity of the group (Hoffman and Hendrick 1971, pp. 489-500).

Many of the works turned out to be oriented towards findings of the so-called optimal group size. The idea that the optimal group size should not exceed 12 people was clearly formulated by A. Rice. According to Ralph C. Davis, the ideal group consists of 3-9 people (Davis 1951, pp. 273). Keith Davis who has devoted many years to the study of groups is inclined to agree with his opinion (Davis 1957, pp. 174-175). He believes that the preferred number of group members is 5 people.

According to some studies, it can be concluded that groups of 5 to 11 people usually make more precise decisions than those that go beyond this number. Studies have also shown that in groups of five people its members usually experience greater satisfaction than in larger or smaller groups. The explanation for this apparently is that in groups of 2 or 3 its members may be concerned about their personal responsibility for decisions to be too obvious. On the other hand, in groups of more than 5 people, its members may experience awkwardness in expressing their opinions in front of the others.

In general, as the size of the group increases, communication among its members becomes more complicated and it becomes more difficult to reach an agreement on issues related to the activities of the group and fulfillment of its tasks.

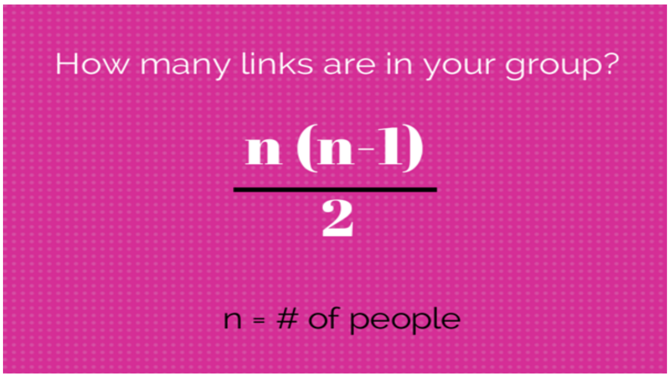
Most experts also agree that the number of team members ideally should be 7 ± 2 people. This confirmation was first made by Miller in 1956 in his famous article "The magical number seven, plus or minus two: some limits on our capacity for processing information" (Miller 1956, pp. 81-97). In this article, Miller argues that 7 is the most important number for describing the processing power of the human brain. The selected figure determines the maximum number of pieces of information for simultaneous processing by the mental center. The author comes to the conclusion that the frequency of number seven has an ambiguous interpretation. He asks to refrain from unambiguous judgments because he believes that something important is inside these numbers, but he also expect that it can simply appear to be a Pythagorean coincidence.

It is already 50 years passed since Miller's article was published, but it is widely viewed that the team's range of 5-9 people is satisfactory for making decisions. At the bottom end of the interval it is justified to perform tests and fulfill the requirements, but at the upper end of the interval, it is difficult to have full control. Therefore, the number of employees from 5 to 9 in the same group makes sense.

Thus, the number of members of an effective group should be sufficient to ensure constructive interaction and not so large to create obstacles during the discussion. Thus, when the group size increases, difficulties with which it has to cope also grow. Bostrom in 1970 wrote that if the group size rises by one member, the number of interactions between them increases exponentially. If the group consists of only two members: X and Y, then there are only two relationships that need to be managed, because they may not have the same feelings. But if the third person Z joins the group, then there are already 9 relationship types that need to be managed: X-Y; Y-X; X-Z; Z-X; Y-Z; Z-Y; X-YZ; Y-XZ; Z-XY (Rothwell 2015, pp. 60-61).

The same hypothesis made J. Richard Hackman, the author of 10 books on group dynamics. He wrote that the biggest problem comes to the number of interactions: the more we have, the higher is the probability of potential conflict and as a result the time loss for the decision-making (Hackman 1987, pp. 318-320). He made a formula which calculates a number of interactions between members (Figure 1).

Figure 1. Formula which calculates a number of interactions between members



Source: http://blog.idonethis.com/two-pizza-team/

Based on this formula, there will be 36 interrelationships in a team of 9 members. If the team consists of 4 participants, the number of interrelations will be 6. In such a way, with any more additional participant, we will face increasing organizational difficulties and as a result, the productivity of the team will fall.

In our work, we want to look more precisely at the influence of research group size and department on the productivity of the university.

Talking about the relationship between the size of the department and the productivity of its staff, researches find contrary answers in their articles: there is evidence as about positive connection, but also about a negative one and about lack of connection at all (Wallmark and Sellerberg 1966, pp. 137-142, Wallmark et al. 1973, pp. 80-86, Cohen 1981, pp. 467-487).

The dependence of the department productivity from its size was studied by S. Kyvik (Kyvik 1995, pp. 295-300). According to the results of his research, it cannot be concluded that large departments create more research opportunities than small ones. A small negative relationship between the size and productivity of the department is observed only in the natural sciences. Moreover, when considering only full-time employees, small departments are able to provide large resource opportunities for exploratory activities of their employees. Kyvik criticizes the following apparently logical judgements: the probability of creating a competitive research group is higher in large departments; the likelihood that two researches share common interests is bigger which means that there is a greater probability of cooperation (this, in turn, increases the probability of increasing productivity); in large departments it is easier to establish an incentive system. Against these statements, Kyvik plays off a different view on scientists: not as on co-workers of one department, but as on members of a global world. An actual intellectual community often does not coincide with the department in which the scientist works. He can have the closest cooperation with the colleagues from other countries or with employees from another department (Kyvik 1995, pp. 299-304). Thus, there is no precise answer to the question about the optimal size of the department, but this issue intersects with the problem of cooperation and can be considered also from this point of view.

1.2.3 Span of control and Hierarchy

In this subsection, the main issue is to give a brief overview on the importance of the hierarchy and span of control in the productivity because they exist in every society, organization or group of people. As Bob Sutton wrote in his article, despite the variety of forms that a hierarchy can take, it is impossible to find any organization without this structure. Regardless of the research object, people, dogs or baboons, existence of the exact structure (hierarchy) in their relations is obvious even after some minutes of observation (Sutton 2016). Accordingly, considering the fact that hierarchies are inevitable, it is very important to create good ones and to avoid those that are bad.

The necessity to determine the **span of control** is associated with the fact that the labor of a huge number of people is necessary for the creation of labor results. One person is not able to plan, organize and monitor their activities. Therefore, a leader is forced to form hierarchical levels of management which cause the following problems (Zajac O. V. 2004, pp. 62-63):

1. There is a need to increase management costs that go for the establishment of horizontal and vertical links and for the coordination of activities of different management levels;

2. Losses and distortions of information increase with the information transfer from one level to another;
3. Increases the time for taking decisions, organizing and controlling their performance.

Therefore, appears a cumulative problem of the management level costs which inevitably raises the question about the number of subordinates that the leader can effectively manage.

How many people or activities can be directly effectively integrated under one leadership? In the organization, each leader is limited in time, knowledge and skills as well as in the maximum number of decisions that can be taken with the sufficient efficiency level.

According to the theory proposed by the French management consultant Graicunas in 1933 (Graicunas 1937, pp. 183-187), if the number of subordinates increases in an arithmetic progression, then the number of potentially interpersonal relations between the leader and his subordinates increases exponentially. This happens for the reason that the manager deals with three types of interpersonal relations:

1. Direct single relationship. This means a direct communication of the leader with each of his subordinates separately. If the manager X has two subordinates Y and Z, then he has two direct relationships: X-Y and X-Z.
2. Direct group relationship. This exists between the leader and any possible combination of subordinates, i.e. the leader can work with one subordinate in the presence of the other or all together. If the leader X has two subordinates Y and Z, then he has the following possible relationships: X-Y in the presence of Z, X-Z in the presence of Y and X, Y and Z simultaneously.
3. Cross relationships. This happens when the subordinates work with each other under the supervision of the leader. One cross relationship Y-Z is possible: under the control of X.

The number of connections that a leader must control is determined by the formula:

$$k = n\left(\frac{2^n}{2} + n + 1\right)$$

where n is the number of subordinates, k is the number of relationships.

In accordance with this equation, having two subordinates, the number of relationships will be 6 units, having 3 subordinates – 18, having 4 – 44, having 10 – 5210. This analysis was used by many scientists to argue that the number of subordinates of one leader should not exceed six people.

The advantage of the Graicunas theory is that it allows you to determine the degree of management complexity with the increasing number of subordinates.

Currently, for determining the span of control is widely used a situational approach, based on the analysis of factors that influences the determination of the scale of control. The hierarchical level of the organization belongs to the factors considered.

Hierarchy is one of the basic cultural values. The two most famous and influential approaches to understand cultural values include the hierarchy as one of the main. Schwartz defines the hierarchy as a legitimacy emphasizing the unequal distribution of power, roles, and resources. Representatives of hierarchical cultures observe the rules and obligations regulated by the hierarchy of roles and demonstrate respect to the authorities (Schwartz 1999). Hofstede uses the concept of power distance as the degree to which community members accept inequality in the distribution of power (Hofstede 2001).

There are two views on the influence of the hierarchy on the group productivity. The first postulates that the hierarchy is good: clearly defined roles in the group, good coordination of team members, integration of information in one center, fewer conflicts. In accordance with the second view, the hierarchy is bad: it limits the ability to express an opinion for members with the lower status in the group, it reduces the feeling of psychological security and makes communication difficult. A group of researchers led by Adam Galinsky recently published an article in PNAS where they checked the validity of both positions (Anicich et al 2015, pp. 1338-1343).

The most remarkable thing about their research is the data with which they worked. Researchers analyzed data from 5.104 expeditions (30.625 alpinists altogether) from 56 countries who ascended the Himalayas from 1905 to 2012. The analysis included only monocultural expeditions, i.e. consisting only of representatives of the same culture. On average, in one expedition there were 7 people of which only 2-3 climbers reached the summit, 549 (about 1.8%) were dead. At least one death was in each of 12 expeditions (about 8%). Exactly these real indicators, the achievement of the summit and the number of dead climbers, were considered as real parameters for the expedition performance (Anicich et al 2015, pp. 1340-1341).

The results of the analysis showed that the expedition's climbers from the countries with the most valuable hierarchy values were more likely to reach the top, but they also died more often during ascending. Moreover, these effects are observable only in groups, but not in the single mountaineering. Effects remain significant after controlling environmental factors (Himalayan region, weather, year of an ascent), riskiness (type of the route, whether the expedition was pre-registered or not), characteristics of the expedition level (age, group size, leader experience, number of stops and number of women (because in the presence of women men can often take risky decisions)) and the characteristics of the alpinist's country of origin (inequality of income, GDP, population, average altitude above the sea) (Anicich et al 2015, pp. 1340-1343).

On the other hand, the presence of a significant hierarchy in the group can help climbers reach the top because it provides an exact chain of commands, a clear and rigid distribution of responsibility, which helps to avoid mistakes in the coordination of expedition members (for example, chokepoints). On the other hand, the hierarchy increases the mortality of expedition members during the ascent, because it creates the climate in which members in lower levels of hierarchy cannot express their apprehensions, this negatively affects psychological safety and information exchange which increases the risk for the whole group (Anicich et al 2015, pp. 1340-1343).

Therefore, the results of this study empirically confirm both views on the influence of the hierarchy on the group productivity. It actually increases group productivity, but for this results, the group pays a certain price which can be quite high (as in the case of alpinist groups) (Anicich et al 2015, pp. 1338-1343).

1.3. Significance of the study.

The relevance of this topic is supported by the fact that the scientific community participating in the competition on the world labor market is an important element of the social structure of a modern rapidly transforming society. And this is quite natural if we recall that in the last century the world survived the scientific, technical and information revolutions that significantly changed the conditions and character of the economic development of the progressive states. A post-industrial "new economy" began to form in these states where knowledge and information provided by science played the role of the main resource. The functioning of science is in interaction with the real market economy. Science becomes an integral part of the economy determining its progress. The economic system organically absorbs its achievements and regulates its development in accordance with internal needs. In such conditions, the development of science requires a considerably greater expenditure of human and material resources. Getting new knowledge becomes more expensive. Therefore, both developed and new industrial countries pay greater attention to the development of national science.

In order to have a good development in science, it is important to understand the connection between scientific productivity and research group size as well as between productivity and a hierarchy in the group.

1.3.1. Research Questions

Within the framework of this study, various scientific findings are analyzed related to this topic as well as summarized already abovementioned in order to formulate the questions and developed related hypotheses the answers which must be found for the assessment of scientific productivity:

1) **What is the optimal research group (department) size should be?**

There are a lot of discussions regarding this question: some researches tell us that bigger departments tend to have higher productivity because they have more qualified research employees with good international reputations that can change the department aims and standards in future and therefore they seem to be more prestigious and to have a higher ranking. Moreover, it is usually stated that more qualified researches try to get a job in bigger departments because they have more opportunities for research (Kyvik 1995, pp. 295-296). There are different hypotheses explaining the nature of this connection: on the one hand, the transfer to a bigger department can be a reward for a good job, on the other hand, bigger departments may not hire more research employees, but simply create conditions that can contribute to increase the productivity of the group (Kyvik 1995, pp. 300-303, Crane 1965, pp. 699-714). According to the results of Allison and Long, investigating the productivity of researches who changed their jobs, the impact of work in a bigger more prestigious department on the employee's productivity was more important than vice versa (Allison and Long, 1990, pp. 469-578). The controversy of the meritocratic hypothesis about the dependence of the organization's reputation on the research productivity of its employees and graduates is discussed in the article of K. Guba (Guba 2011, pp. 210-226). The author claims that the recognition of the scientist by the community doesn't have a decisive influence on his movements in terms of the working place status, but however the working place status is a significant forecasting factor for the quantity and quality of publications.

Moreover, there is a link between big departments and higher access to the resources. Resources, in turn, are necessary for the conduction and success of any research, although they cannot provide it. Broadly speaking, resources, or organizational capital, include not only the physical equipment needed for research but also libraries, access to databases and archives, financial and human capital (Schuelke-Leech B. A., 2013, pp. 1667-1678; Bland C.J., Ruffin M.T., 1991, pp. 385-397).

It is noteworthy that an increase in the resource base may lead to a decrease in productivity (Schuelke-Leech B. A., 2013, pp. 1667-1678). The availability of all necessary resources facilitates the research process and consequently allows researchers to be more productive in their work. At the same time, a lack of resources within the organization can stimulate the search for resources beyond its borders which, in turn, requires from researchers to be more productive (Schuelke-Leech B. A., 2013, pp. 1667-1678).

Additionally, it can be assumed that bigger Universities with bigger Departments have a better system of rewards. The administration of Universities can influence the professional behavior of researches by introducing a system of material incentives and rewards, redistributing all the resources of the Department (including financial ones) not evenly among all employees, but in favor of more productive ones. For example, researchers of one of the faculties in the California University indicate a significant increase in the productivity of employees as a result of increased financial motivation (Hales et al. 2005, pp. 244-248).

It is noteworthy that the number of incentives received correlates not only or not so much with the number of published articles, but with their quality (Cole and Cole 1967, pp. 377-390). Moreover, in addition to financial rewards, the incentive system may include an appointment to a position in a more prestigious department as it was discussed earlier in this section.

However, the results of various studies are sometimes contradictory, which is probably due to the different types of research groups, specificity, and conditions of their activities, etc. For example, after analyzing the answers of representatives of 128 organizations in the United States D. Devine with his colleagues concluded that the strongest link with a high level of efficiency has a small size team and lower level of conflicts while the weakest link has the composition of the team (Devine et al. 1999, pp. 291-310).

Although it seems that larger Departments can provide more intellectual synergy (Stankiewicz 1979) for the efficiency, in reality, it can turn out that not all the researchers make a significant contribution. As the group becomes larger, the possibility of productive participation of each employee dips down.

Furthermore, as the number of participants increases the level of trust and responsibility decreases. The more researchers there are in the group, the less responsibility for the implementation of projects they feel and the less they are ready to invest for the success of the group.

All things considered, we can tell that there a lot of different views and results when analyzing the correlation between size and performance of research groups. Some think that performance increases with the group size (Wallmark et al. 1966, 1973), while others think that there is no dependency between these two variables at all (Cohen 1984; Seglen and Aksnes 2000).

There are only a few studies which analyze exactly Department size or research group size influence on the performance and productivity. Isabelle Cook with her colleagues found that productivity rises with the group size increase, but the correlation is weak. Additionally, they pointed their attention that post-docs bring more productivity to the research groups as PhDs, so they concluded that Departments should have to hire more PIs in order to raise their performance (Isabelle Cook et al. 2015).

In 1980 Fritschi in his study analyzed two Swiss technical Universities and showed that there is no correlation between Department size and performance of researches (Fritschi et al. 1980). At the same time, Blackburn wrote that Department size variable cannot predict productivity of researchers (Blackburn et al. 1978).

All these reviews lead to the hypothesized relationships between Department size and productivity:

Hypothesis 1a: The larger the Department size, the larger the scientific productivity.

Hypothesis 1b: The larger the Department size, the smaller the scientific productivity.

Department size is not the only factor which can influence the productivity of researchers. On the one hand, having a lot of subordinates is good, because better results and achievements can be gained as well as better scope for different initiatives, etc., on the other hand, under a heavy workload a superior may not give enough time and attention to each subordinate and do not fully control them. It should be remembered that an overstated span of control usually leads to a loss of control over the productivity and efficiency of any organization. Thus, the question that has to be answered is:

2) **How many levels of hierarchy must be? How many subordinates can a superior have, so that his team remains manageable and can lead to a better performance?**

The larger the organization is, the more levels of hierarchy it has. Other things being equal, the more levels of hierarchy in the organization, the lower the efficiency. With a larger number of levels, the information transmitted through the communication channels may be distorted or incomplete, which affects the productivity. Distortions can go both through information moving from the bottom upwards (in this case, from MS Students to Professors) and from the top down (incorrect reporting of the directive meaning to subordinates).

In large modern organizations, the total number of levels usually doesn't exceed 12. Hattrup in his study wrote that a sufficient number for most organizations are 3-4 levels (Hattrup 1993) what coincides with the Graicunas statement that the optimum span is 4 (Graicunas 1937, pp. 185).

Following this line of reasoning, it can be hypothesized:

Hypothesis 2a: With the increasing number of hierarchy levels, the productivity of the research group increases.

Hypothesis 2b: With the increasing number of hierarchy levels, the productivity of the research group decreases.

Represented here goals, questions and hypotheses lead to the next stage, which includes the development of the possible research method, collection of data and planning of the optimal design.

1.3.2. Research structure

The overall structure of this paper is divided into four parts, including the introductory chapter. First of all, it starts by giving a brief overview of the literature about universities' evaluation system. This section examines the measurement of the universities' performance and productivity and provides some links between the size and productivity in the university research departments and also a comprehensive background of the span of control and hierarchy. Afterward, the research questions are developed and hypotheses proposed for the future research.

The second part contains a brief overview of the German and Austrian research sector in order to better understand the situation in these education sectors and have a closer comprehension of the hypotheses suggested earlier.

The third chapter is concerned with the research process. The observation groups information is collected from various databases and sources. Observation variables are determined and then statistic tests are performed. Afterward, the results of this research are presented.

The final part of this paper is based on the entire study by summarizing the theoretical and empirical parts of the work. All the research questions are answered, hypotheses are supported or not and then discussions about limitations and future research are identified.

Chapter 2. Specificity of Austrian and German research sector

This chapter is dedicated to the research sector of Austria and Germany, where scientific research is conducted both at the state and non-state levels. University studies differ in thematic and methodological breadth, while professional higher educational institutions conduct research activities oriented toward applied goals and also towards the training of the young specialists.

2.1. The Austrian research sector

Traditionally a great interest in science in Austria as a result of which the world received a pleiad of Nobel Prize winners in medicine, chemistry, physics, and economics has deep roots that go back to at least the year 1365, which is the year of the foundation of the University of Vienna. Nowadays research is being conducted in 22 higher education universities, 21 universities of applied sciences, numerous commissions, institutes and research centers of the Austrian Academy of Sciences, the Austrian Technological University, the Austrian University of Science and Technology, as well as private universities (especially in the field of social sciences).

A distinctive feature of the scientific field in Austria is the relative scarcity and heterogeneity of the research groups. The research is financed by the Austrian government, the Austrian Science Foundation (FWF - Fonds zur Förderung der wissenschaftlichen Forschung), the Austrian Research Support Agency (FFG - Österreichische Forschungsförderungsgesellschaft), private companies, the European Union and others.

In recent years, the cost of research in Austria has risen to 2,6% of GDP. Nowadays, Austria is considered one of the few European countries that are on their way to the stated political goal of European Union in the field of R&D clearly tries to outstrip its opponents and therefore has set itself a goal to raise the research GDP ratio till 3% by 2020.

Austria also defined even more ambitious goals for itself. The research strategy of the Austrian government is aimed to obtain the status of a European Innovation Leader in 2020. In 2010, total investments in the field of R&D amounted to 7,8 billion Euros (3,13 billion from government funding and 4,55 billion in the form of private investments of which 1,17 billion were foreign investments). According to European Innovation Scoreboard in 2010 Austria was ranked 7th among the countries participating in the rating and also headed a subgroup of countries called "innovative followers". In March 2011 the Austrian Federal Government implemented a strategy in the field of research and innovation called "Realizing Potential, Increasing Dynamics, Creating the Future: Becoming an Innovation Leader".

2.2. The German research sector

Science has always been of great importance in the culture of Germany and German science is in the world process of obtaining knowledge. German scientists have made a huge contribution to the development of principles of modern natural and technical sciences. Today Germany has a powerful scientific and research potential. The main research centers are universities as well as state and private non-commercial organizations and large enterprises.

Germany is a home country of more than 397 universities with a total number of students of about 2,8 million, including 360,000 international students (12,8%) offering a variety of education directions. Of these, 115 are universities, 217 are universities of applied sciences (in German 'Fachhochschulen'), 57 are colleges of art or music, 8 do not belong to one of these three categories, 691,000 staff in total, including 387,000 academic staff (HRK German Rectors' Conference 2018).

Academic education is characterized by a close relationship between teaching and research. The federal-state program "Exzellenzinitiative" is directed to the development of science and research at universities which supports both leading research and improvs the overall quality level of educational and scientific institutions in Germany.

Exzellenzinitiative (from German, best initiative) is the program created by the German Ministry of Education and German Research Society (Deutsche Forschungsgemeinschaft). Its goal is to facilitate the conduct of advanced research in universities. Within the framework of this program, the so-called elite universities (Eliteuniversitäten) are regularly chosen. The evaluation criteria are the quality and relevance of research conducted at the university as well as the participation of the university in international research projects.

In recent years, the share of budgetary expenditures for scientific work has been constantly increasing. Germany is among leading countries that invest more than 3% of their GDP in research and innovation (the goal is to increase the share to at least 3,5% by 2025). In the federal budget of Germany in 2017 for education and research is laid at 17.6 billion Euros. At the end of 2014, the "nature Index Global" was published in which the publications of research institutions and universities were evaluated: Germany received the highest ratings among European countries. On the global scale, it ranks third after the USA and China.

Chapter 3. Research process and results

In the following part of this study, the research process will be introduced in details by describing observation groups and their participants. Afterward, the indicators and sources for the measurement of the researchers' performance will be explained. With this in mind observation variables will be detected, an analysis will be conducted and, as a final step of the research, the results will be announced.

3.1. Observation groups

The research was based on the current data taken from Universities of Austria and Germany. The decision was to take Physics departments as it was assumed that there will be much more publications written on this topic as on some of the others. All the information was taken from departmental web-sites. All the Universities have different sizes, years of existing and different research orientation departments. I took researchers from the whole department regardless of the fact that some of them, especially in Germany, was divided into several different physics parts.

It was decided to take the full number of researchers from every research department for this analysis: professors, assistant professors, junior professors, senior scientists, post-docs, PhD students, and other employees working in their groups. Individuals that were working in the department part-time or were already gone into retirement, but still were listed in the group, were not counted, because it was very important that all the researches were from the same university due to the fact that only in such a way it was possible to define the number of publications issued by each researcher. As the composition of each group was also essential for the hierarchy and span of control analysis, all the researchers in the Department were classified according to their status.

During the data preparation, certain problems with the collection of the focus group appeared. The first one was that there are very few Universities in Austria and Germany with the physical science department, the second one is that even if there is a department that is needed, the website is made in such a way that it is closed or even no information about the researchers. In summary, this leaves us with only 14 departments from 14 different Universities of which only 5 are from Austria and the rest are from Germany.

Furthermore, all the departments vary greatly in size as well as in composition. The average number of researchers per group are 54,3 persons. The departments in Austria are much smaller than those in Germany, they have the least number of researchers in each University. Moreover, the organization of hierarchy and structure varies hugely. It was impossible to have a homogeneous sample. The title "Professors" was the only one which remained constant in all the groups. The mean number of professors each group contains is 22,4 while an average number of other staff is 15,5 employees per department. The hierarchy in most of the departments was flat: in 5 of them there were only 2 levels, in 6 groups were 3 levels and in others more.

In order to have a more observable dataset, I have made a simplified table excluding all the researches names and using only titles (Table 2).

3.2. Researchers' performance

The productivity of scientific activity can be assessed using both qualitative and quantitative indicators. Qualitative assessments are based on expert opinions. The subjectivity of such assessments reduces the reliability of the results obtained.

Quantitative estimations are based on the data published and information patented: the number of publications, the analysis of the frequency of their citations (citation index), the Hirsch index, the impact factor of the scientific journal in which this work is published, the number of domestic and international grants, scholarships, participation in international scientific cooperation, the composition of the editorial boards of scientific journals.

Of the above-listed indicators, as a measurement of researchers' performance of the greatest interest were chosen:

- Publication data of each scientist;
- Citation index of all publications per scientist.

Both indicators were obtained in the following way: the number of publications per each research group member was determined. Together with the citation index, it was collected by exploring two social networks: Google Scholar and ResearchGate.

These are platforms, online services and web-sites designed to build, reflect, and organize social relationships on the Internet. In recent years, specialized scientific social networks like ResearchGate and Google Scholar are gaining popularity, which represents a ready mechanism for the popularization of science and unlike the Web of Science and Scopus is also free. Each researcher can independently maintain his profile and upload his publications in such a network.

Having access to these databases it is possible to count the number of citations of scientific articles from any author. The indicator is the basis for assessing the author's scientific activity. The number of publications in scientific journals, the number of references to them and citations is an important factor in the scientific biography of any researcher. The citation index of the author is usually taken into account in competitions for the replacement of positions, allocation of grants. this is at the same time an evaluation of the organization in which the employee works: the higher the number of highly cited employees, the higher the prestige of an educational or scientific organization.

The citation index is the indicator of the significance of the scientist's work represented in the number of references to publications in refereed scientific periodicals accepted in the scientific world. First, the index characterizes the relevance and importance of ongoing research for those areas of knowledge in which specific scientists or research team work. Secondly, a high citation index to some extent serves as an official recognition of a particular scientist by a scientific community.

The biggest and world-famous scientific web-site nowadays is ResearchGate. Currently, the number of its users is more than 2 million scientists from different fields and countries.

ResearchGate contains a huge base of scientific articles and among them, there are also those that for some reason have never been published before. It's an important feature as the network creator Ijad Madisch noted: it is a unique opportunity to publish negative results of scientific research, such results are not accepted in scientific journals, but in reality, they can be very interesting. The creator of the network is looking for a great future and believes that it will change the whole science for us (Thomas Lin 2012).

In ResearchGate two ratings are formed both for the individual researcher and for the organization:

- Impact Point. The rating is formed on the basis of the journals' impact factors from the Web of Science and Scopus.

- RG Score calculates scores accruing to the researcher based on how other researchers interact with the content posted by them (download publications, participate in discussions, evaluate the reputation).

Another scientific social network that was used in this work is the Google Scholar. It allows users to search for a digital or physical copy of a scientific article if it is stored in a network or in a regular library. Search results are generated using links from a full-text journal articles, technical reports, preprints, dissertations, books and other documents, including selected web-pages that are considered scientific.

A freely available searching engine indexes the full text of scientific publications of all formats and disciplines and calculates the total number of citations and quoted publications as well as the Hirsch index.

Thus, using these searching engines for scientists, the productivity indicators were obtained by the means of scanning facility using the first and last name of the author, his initials in some cases, University and faculty names and fields of research. Consequently, the table created has several columns (Table 2):

1) With the country where University is located;

2) Name of the University observed;

3) The composition of the research group (professors, PhDs, etc.);

4) A title, name, and surname of each researcher (in the full version of the table);

5) Number of publications per person (in the full version of the table);

6) Number of citations per person (in the full version of the table);

7) Number of papers per group;

8) Number of citations per group;

9) Number of observations in the group.

Table 2. Observation groups and their performance.

Country	University	Composition (Title)	Number of person per title	Sum of resear-chers	Number of papers per group	Number of citations per group	Number of observations in the group
Austria	University of Vienna						
		Professors	6	26	920	25704	26
		Senior Scientists	1				
		Post-docs	6				
		Doctoral Students	13				
	Graz University of Technology						
		Associate Professors	3	23	639	10326	23
		Assistant Professors	3				
		Docent	1				
		Post-docs	3				
		PhD Students	13				
	University of Graz						
		Professors	5	14	795	16668	14
		PhD Students	6				
		Diploma Students	3				
	University of Innsbruck						
		Professors	7	72	705	87548	73
		University Docent	1				
		Research fellow	19				
		Bachelor of Education	45				
	University of Salzburg						
		Professors	3	13	493	5797	13
		Post-docs	4				
		PhD Students	6				
Germany	Ruprecht-Karls-University						
		Professors	24	112	2593	126152	112
		Research Associates	33				
		PhD Students	55				

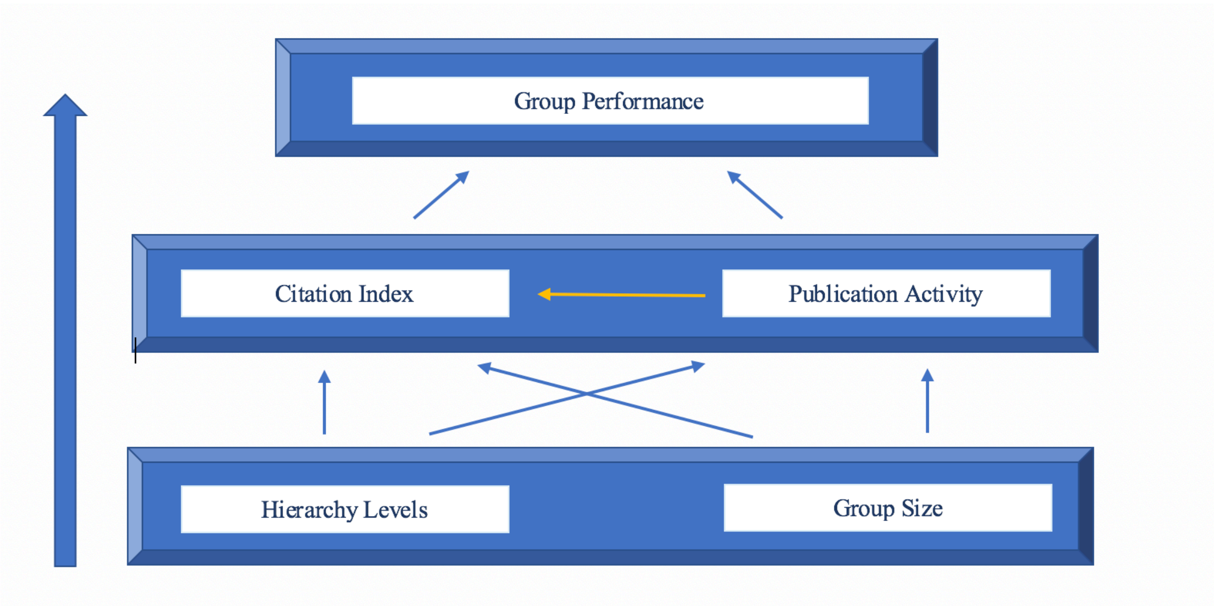
Country	University	Composition (Title)	Number of person per title	Sum of resear-chers	Number of papers per group	Number of citations per group	Number of observations in the group
Germany	University of Cologne						
		Professors	6	74	2284	30141	74
		Post-docs	31				
		PhD Students	37				
	Ludwig Maximilian University of Munich						
		Professors	59	84	11348	644933	84
		PhD Students	25				
	Technical University of Munich						
		Professors	45	51	8393	245962	51
		PhD Students	6				
	Heidelberg University						
		Professors	46	65	15202	710504	65
		Junior Professors	4				
		Post-docs	15				
	Albert-Ludwigs-University						
		Professors	23	40	9211	397555	40
		Assistant Professors	17				
	Georg-August-University						
		Professors	11	70	2479	93316	70
		Assistant Professors	20				
		PhD Students	39				
	Karlsruhe Institute of Technology						
		Professors	40	55	10688	404490	56
		Docents	15				
	WWU Munster University						
		Professors	35	61	5757	140188	61
		Research fellow	26				

3.3. Observation variables

Considering the above-discussed information, it can be concluded that the main variables of the group's performance are publication quantity and citation index that can be achieved by calculating each researcher of the group independently.

Therefore, it seems logical to define these variables and their dominance over each other before coming to the results. In this case, the group's performance and productivity depend on the citation index and publication activity, that is the number of publications each researcher has. At the same time, the citation index depends on the publication activity, because without publications we cannot calculate the number of quotations. Furthermore, the citation index, as well as publication activity, depends on the same variables: hierarchy levels and group size (Fig. 2).

Figure 2. Observable Variables.



3.4. Research results

This subchapter describes and discusses the methods used in this investigation as well as the results of it, which can validate or disprove the hypotheses introduced in this work.

To assess the degree of tightness and direction of the relationship between the size of the groups and the number of publications as well as between the group size and the number of citations was used Spearman's rank correlation coefficient, which was 0.442 and 0.508 respectively. This indicates a direct moderate relationship between the indices studied here. Thus, as the size of the groups increases both the number of publications and their citations will grow. This is demonstrated in Fig. 3 and Fig. 4. As seen on the graphs, the points of the correlation field are located chaotically. The evaluation of the significance of the calculated coefficients showed that they are insignificant. This is primarily due to the fact that the groups studied here are heterogeneous in composition.

Figure 3. The relationship between the group size and the number of publications.

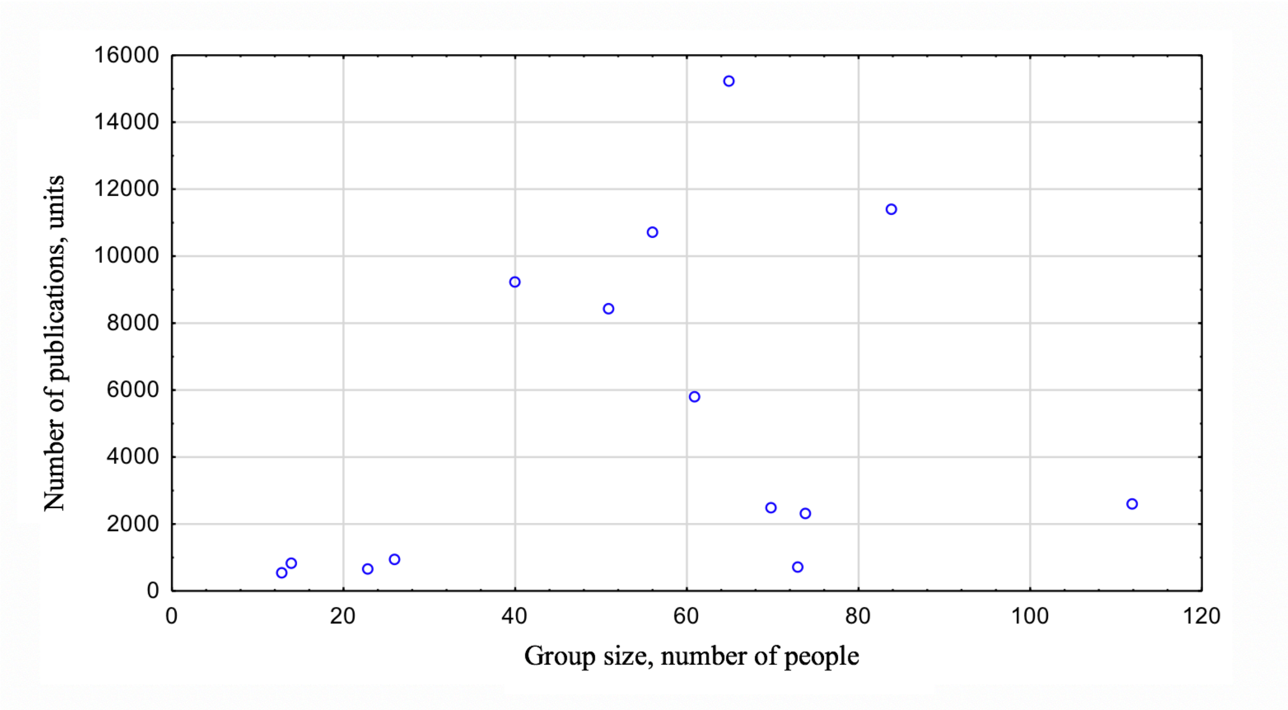
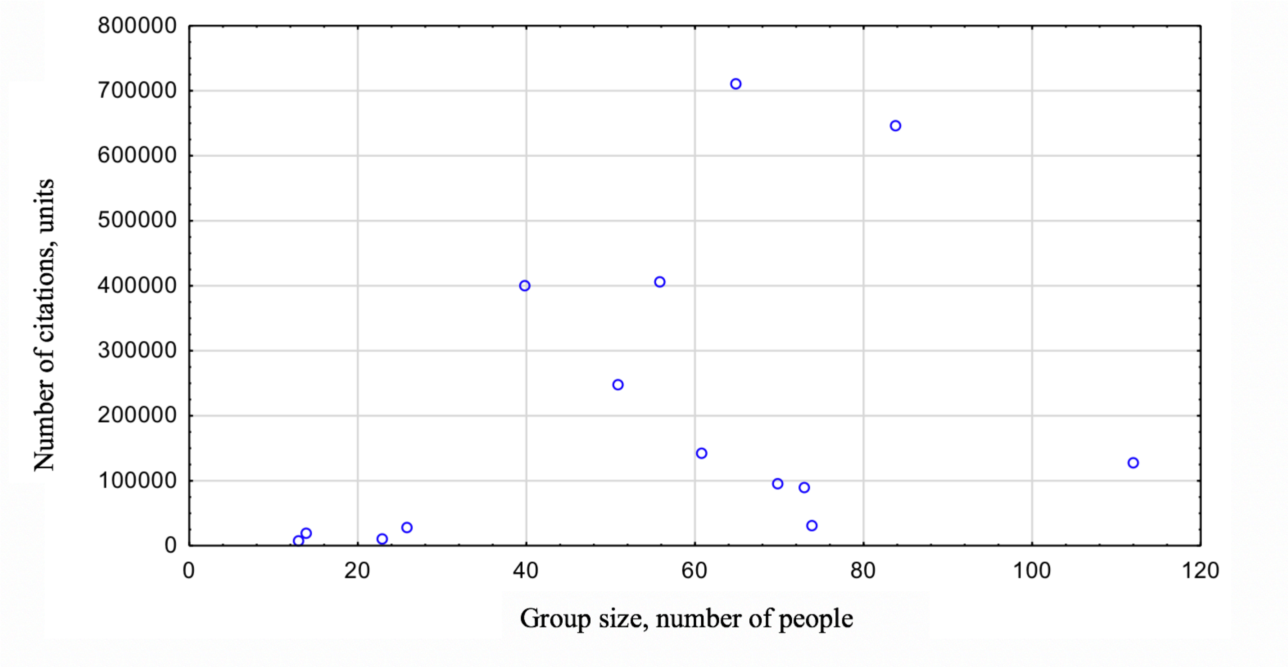


Figure 4. The relationship between the group size and the number of citations.



It is worth noting that the groups studied here include a different number of levels in the hierarchical structure. In this regard, it seems important to study the effect of this feature on the number of publications as well as on the number of citations.

In this way, the calculation of Spearman's rank correlation coefficient showed a strong inverse relationship between the indicators studied and is equal to -0.725 for the pair "number of levels – number of publications" and -0.689 for the pair "number of levels – number of citations". Thus, with an increase in the number of levels in the hierarchical structure, the number of publications and citations decreases (Fig. 5 and Fig. 6).

Figure 5. The relationship between the number of levels in the hierarchical structure of the group and the number of publications.

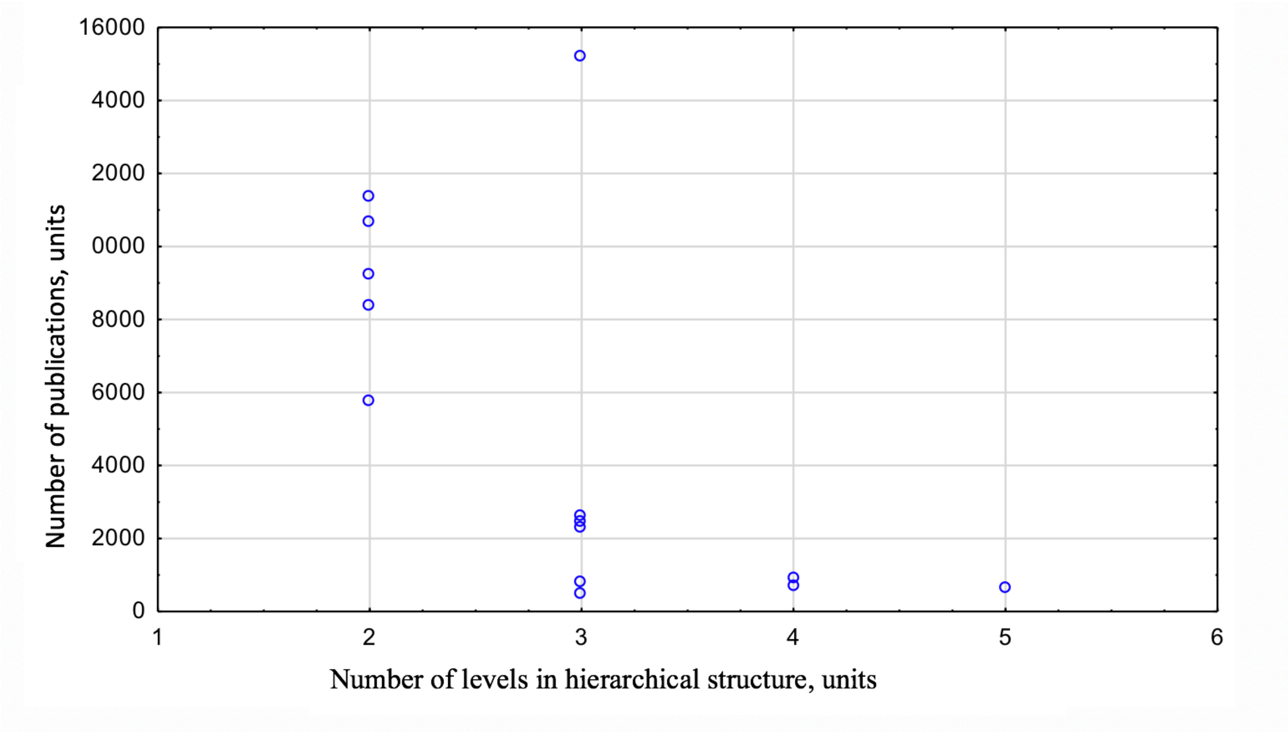
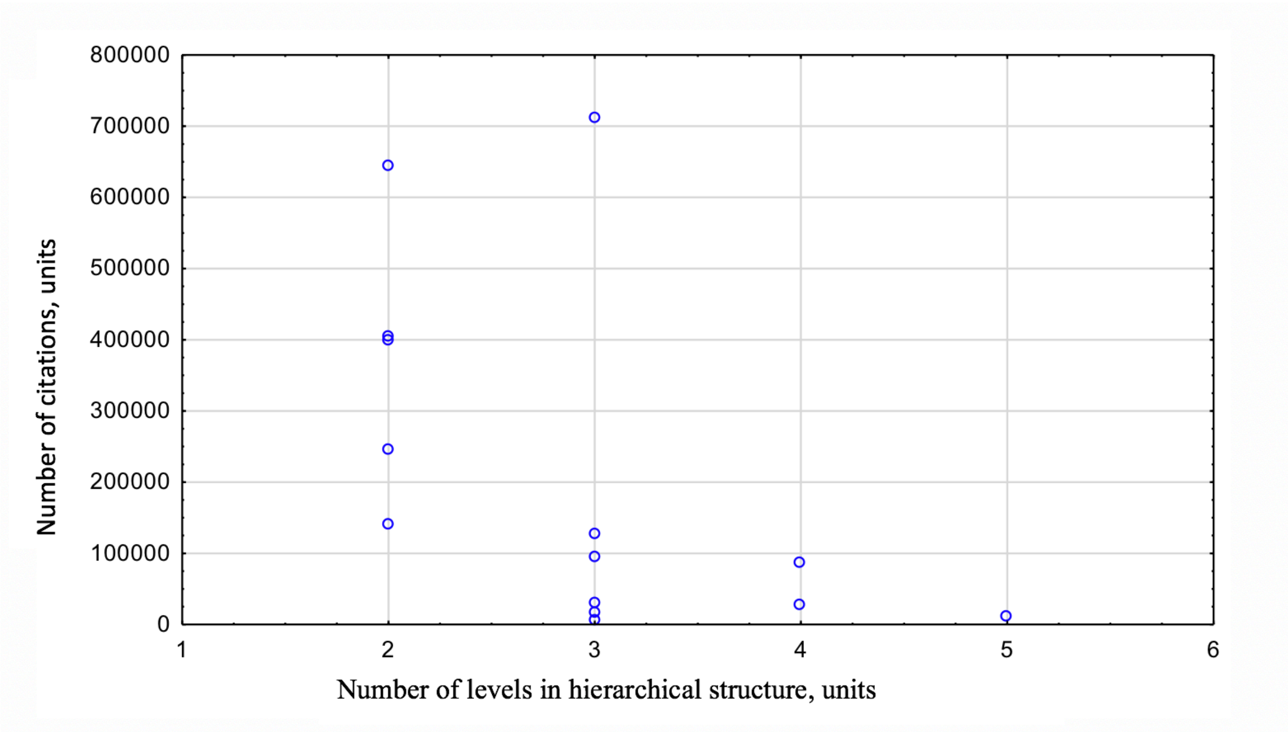


Figure 6. The relationship between the number of levels in the hierarchical structure of the group and the number of citations.



It can be assumed that the inverse relationship obtained is related to the fact that almost in each group there is a category “Professor” and an increase in the number of levels in the hierarchical structure of the groups occurs due to the addition of less qualified individuals with lower publication activity.

The confirmation of this thesis is shown in Table 3, which demonstrates the difference in the mean values of the number of publications and citations at the lower and upper levels of the hierarchical structure of the groups.

Table 3. Mean values of the publication and citation activity at the lower and upper levels in the hierarchical structure of the groups (in units).

Group number	Lower level		Upper level	
	Number of publications	**Number of citations**	**Number of publications**	**Number of citations**
1	8	2	89	3600
2	1	1	87	1268
3	0	0	155	3323
4	0	0	87	12137
5	27	172	76	1168
6	1	7	94	5066
7	3	10	172	2706
8	64	2548	165	9851
9	71	1836	177	5221
10	67	1778	306	14778
11	112	2639	318	15335
12	0	0	83	1554
13	63	1542	244	9534
14	65	1543	116	2859

Due to the fact that there are different profession categories in the groups, where professors have the greatest publication potential, it seems expedient to investigate the dependence of the proportion of professors in the group on the number of publications and citations.

Based on the calculation of Spearman’s rank correlation coefficient it can be concluded that there is a strong direct relationship between the proportion of professors in the group and the number of publications (0.759) and also between the proportion of professors and the number of citations (0.726). In other words, with an increase in the proportion of professors in the group, both publication and citation activity rise (Fig. 7 and Fig. 8).

Figure 7. The relationship between the proportion of professors in the group and the number of publications.

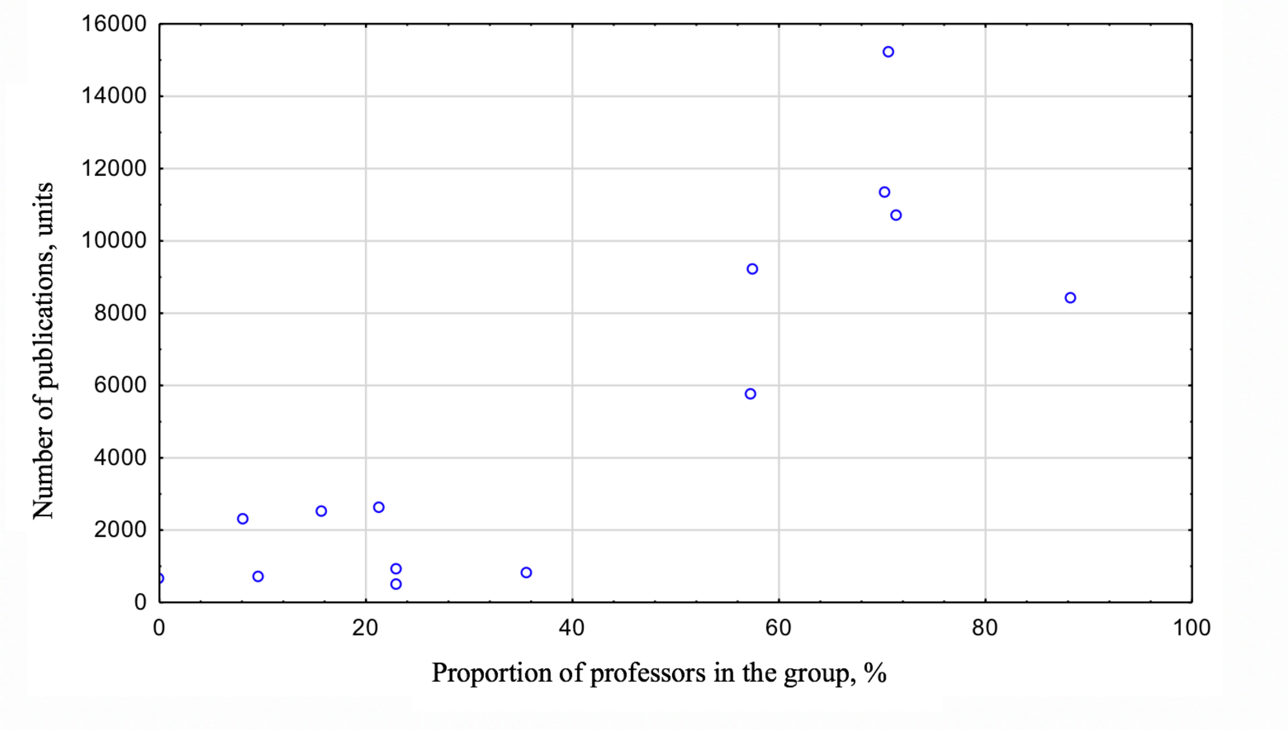
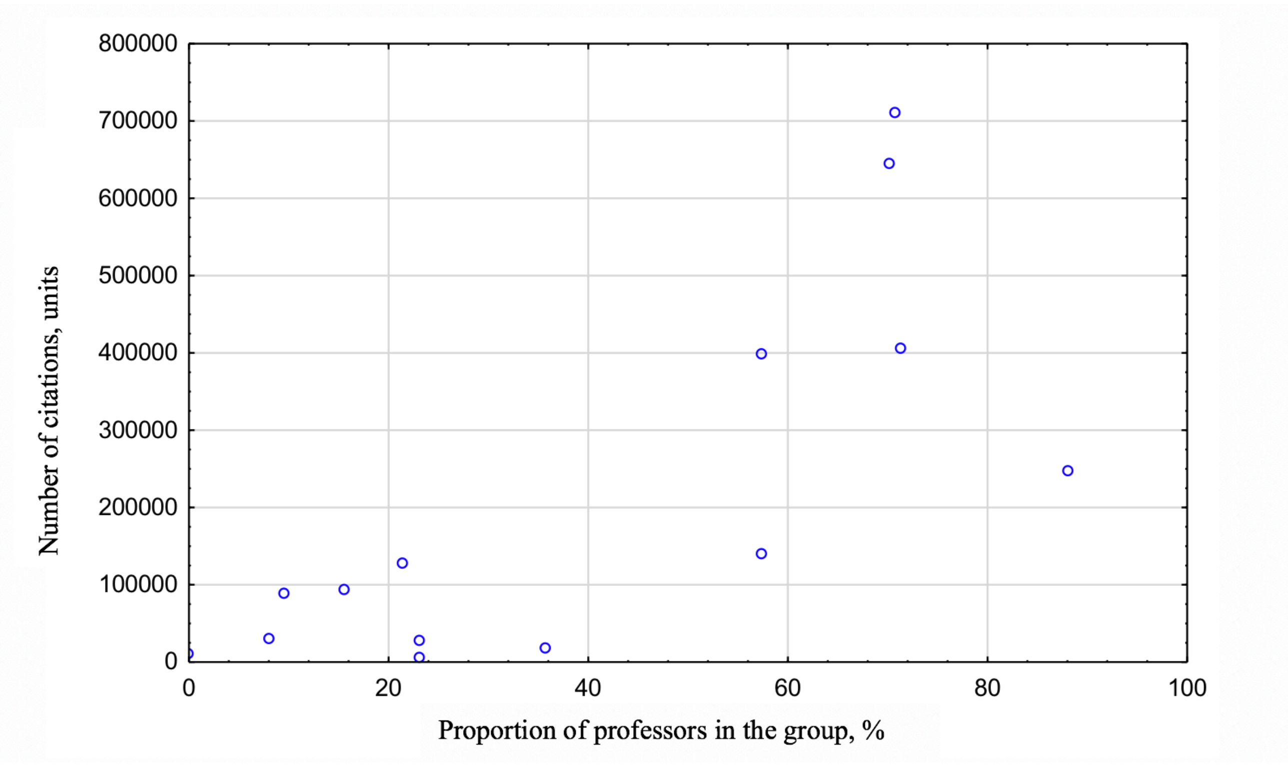


Figure 8. The relationship between the proportion of professors in the group and the number of citations.



Chapter 4. Conclusions

In this chapter, the following findings and conclusions from the analysis are presented, research questions are answered and hypotheses are assessed. Furthermore, certain limitations of this study are acknowledged as well as some recommendations for future research work are proposed.

4.1. Answers to research questions

This study was carried out in the scientific field of Austrian and German Universities. Researchers' productivity and performance were chosen as the main observation variable. The main purpose of this study was to develop an understanding of how research group size and its hierarchy can influence the productivity of the researchers. Previously, far too little attention has been paid to the research in exactly this field, so this indicates the importance of this process and its results.

Recently, increasing importance in the allocation of financial and technical resources is being given to improving the effectiveness of scientific activities, developing evaluation criteria and indicators that demonstrate how individual scientists, groups of scientists, institutions and universities work. The analysis in this study can be extremely useful and convenient tool for the planning and evaluating scientific activity both in the field of the strategic management in the scientific research and in relation to its implementation.

In this work, there were 2 main research questions and several hypotheses arisen from them. The first research question and hypotheses were:

What is the optimal research group (department) size should be?

Hypothesis 1a: The larger the Department size, the larger the scientific productivity.

Hypothesis 1b: The larger the Department size, the smaller the scientific productivity.

It was found that with the enlargement of the group (department) size, there will be also an increase in both publication and citation activity, which means that in larger groups scientific productivity is better. However, because of the heterogeneous groups, it cannot be told that these results are significant. These findings correlate with the previous studies in this field which has shown that there is a positive correlation between the group size and researchers' productivity (Wallmark et al., 1973).

Subsequently, it can be concluded that from two hypotheses presented as an answer to the first question, only one is supported, that is Hypothesis 1a. Unfortunately, there wasn't any strong relationship between 2 variables, so these results are not significant.

Moreover, it was presented the answer to the second research question, which was as follows:

How many levels of hierarchy must be? How many subordinates can a superior have, so that his team remains manageable and can lead to a better performance?

Hypothesis 2a: With the increasing number of hierarchy levels, the productivity of the research group increases.

Hypothesis 2b: With the increasing number of hierarchy levels, the productivity of the research group decreases.

After analyzing hierarchy in all the given groups, the inverse negative relationship was found, which means that with an increasing number of hierarchy levels, there will be a decreasing productivity and performance, which supports the Hypothesis 2b.

It was presumed that this negative correlation can be connected to the increasing number of less qualified research members to the group. After analyzing this fact, it was concluded that the presumption was correct and afterwards it was decided to make another analysis.

As it was above-mentioned, all the groups were heterogeneous and there was found only one category of researchers which was presented in all the groups. Therefore, it was decided to analyze the dependence of the proportion of "Professors" in the group on its productivity and performance.

This experiment detected a very strong relationship between these two variables, which fully supports the pre-estimation made during this analysis and once more prove the Hypothesis 2b.

4.2. Limitations of the results

This study highlights two key aspects of the scientific productivity assessment problem: the methodology of measuring productivity and factors that positively or negatively affect the productivity of research workers. Nowadays, there is a growing number of publications concerning the relationship between the productivity of researchers and the various characteristics of the staff and organizations in which they work. As a rule, quantitative indicators of productivity are used in such studies. More complex indicators that make it possible to evaluate the quality of publications are not included in studies about factors influencing scientific productivity. In addition, it is necessary to understand that employees striving to be more productive are guided by the indicators that department heads use to assess for the effectiveness of their work. In connection with this, the measurement of productivity in one simple way cannot show all those differences that actually exist. When working with the evaluation of productivity, it is also necessary to take into account that science cannot be assessed only on the basis of quantitative parameters.

The disadvantages of the quantitative analysis can be specified by:

- The physical impossibility of covering all the published journals in the world;
- The dominance in certain journals of certain scientific paradigms, often hampering the publications with non-traditional views;
- Insufficient representativeness of applied research;
- Lack of a qualitative assessment of applied research;
- Etc.

Moreover, the practice of citations taken from a purely quantitative point of view can rather complicate and make it difficult to obtain a real picture of the effectiveness of labor in a truly developing science.

In conclusion, it can be told that in spite of fully planned and well-organized research as well as statistical and quantitative analysis of all the variables and results, there are still some limitations and not completely answered questions that can be investigated in future studies.

Abstract (EN)

Nowadays the evaluation of the productivity of both scientists and scientific organizations with the help of scientometric indicators is one of the most urgent problems. Despite the significant progress in the development of science, it has not been able yet to find an optimal way of measuring the significance and quality of its own results.

This thesis includes the research related to the factors of scientific productivity and approaches of its evaluation. It examines the role of group size and hierarchy on group's performance and productivity. In this study research groups from Austrian and German Universities, in particular from the Physics Departments were investigated. In order to come to the results, all the relevant literature was analyzed. Afterwards, the data from the Universities was collected, groups were formed and two measures of productivity, such as the number of publications and number of citations, were found. Consequently, the collected data was evaluated using SPSS statistical methods. Finally, the results of this qualitative analysis are evaluated, all the research questions are answered and suggestions for future research are proposed.

Zusammenfassung (GER)

Heutzutage ist die Bewertung der Produktivität von Wissenschaftlern und wissenschaftlichen Organisationen mit Hilfe von szientometrischen Indikatoren eines der dringlichsten Probleme. Trotz der bedeutenden Fortschritte in der Entwicklung der Wissenschaft war es bisher nicht möglich, die Signifikanz und Qualität der eigenen Ergebnisse optimal zu messen.

Diese Arbeit beinhaltet die Forschung zu den Faktoren der wissenschaftlichen Produktivität und die Ansätze ihrer Bewertung. Sie untersucht die Rolle der Gruppengröße und -hierarchie für die Leistung und Produktivität von Gruppen. In dieser Studie wurden Forschungsgruppen von österreichischen und deutschen Universitäten, insbesondere aus den Physik-Abteilungen, untersucht. Um zu den Ergebnissen zu kommen, wurde die gesamte relevante Literatur analysiert. Anschließend wurden die Daten der Universitäten gesammelt, Gruppen gebildet und zwei Produktivitätsmaße, wie die Anzahl der Publikationen und die Anzahl der Zitate, gefunden. Folglich wurden die gesammelten Daten mit statistischen SPSS-Methoden ausgewertet. Abschließend werden die Ergebnisse dieser qualitativen Analyse ausgewertet, alle Forschungsfragen beantwortet und Vorschläge für zukünftige Forschung vorgeschlagen.

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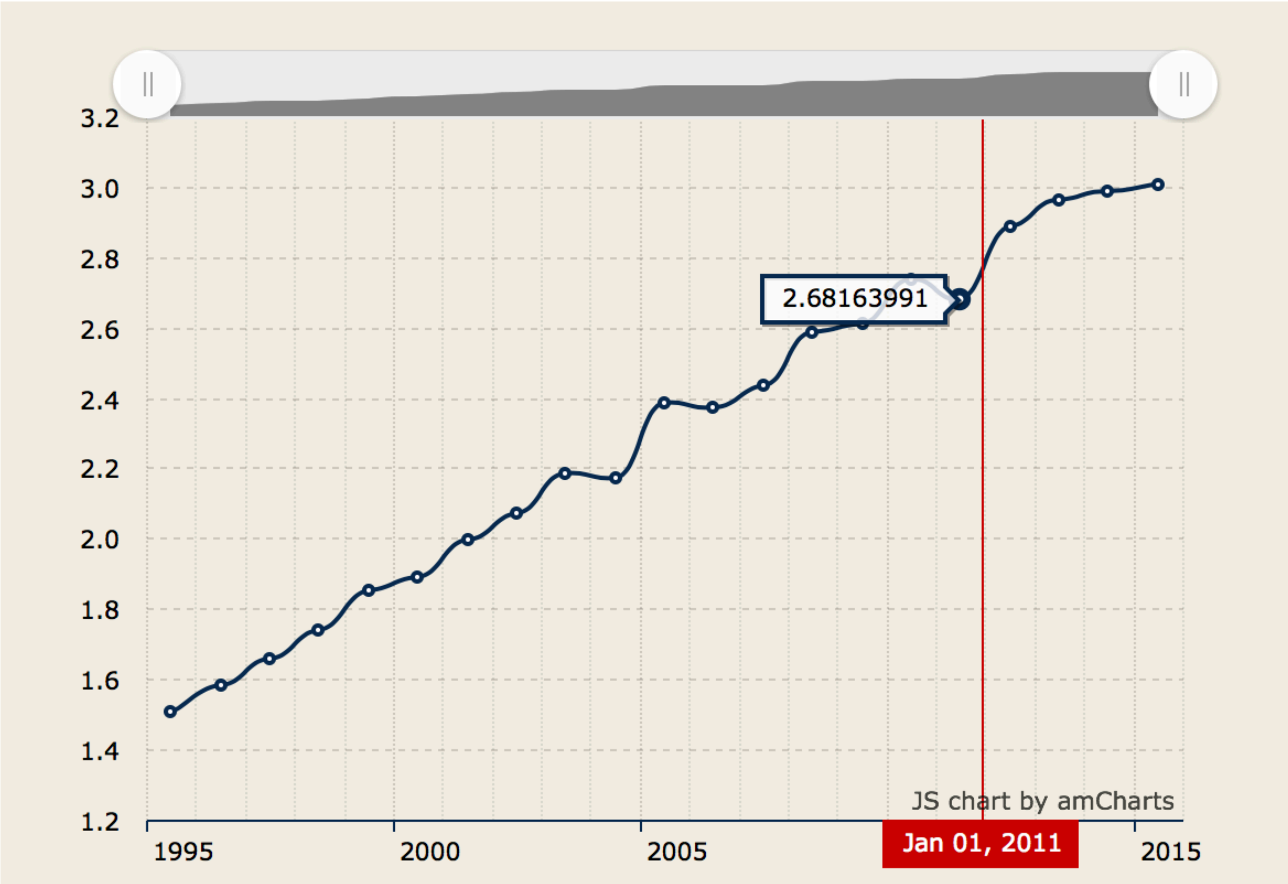
Appendix 1: The dynamics of change: Research and development expenditure in Austria

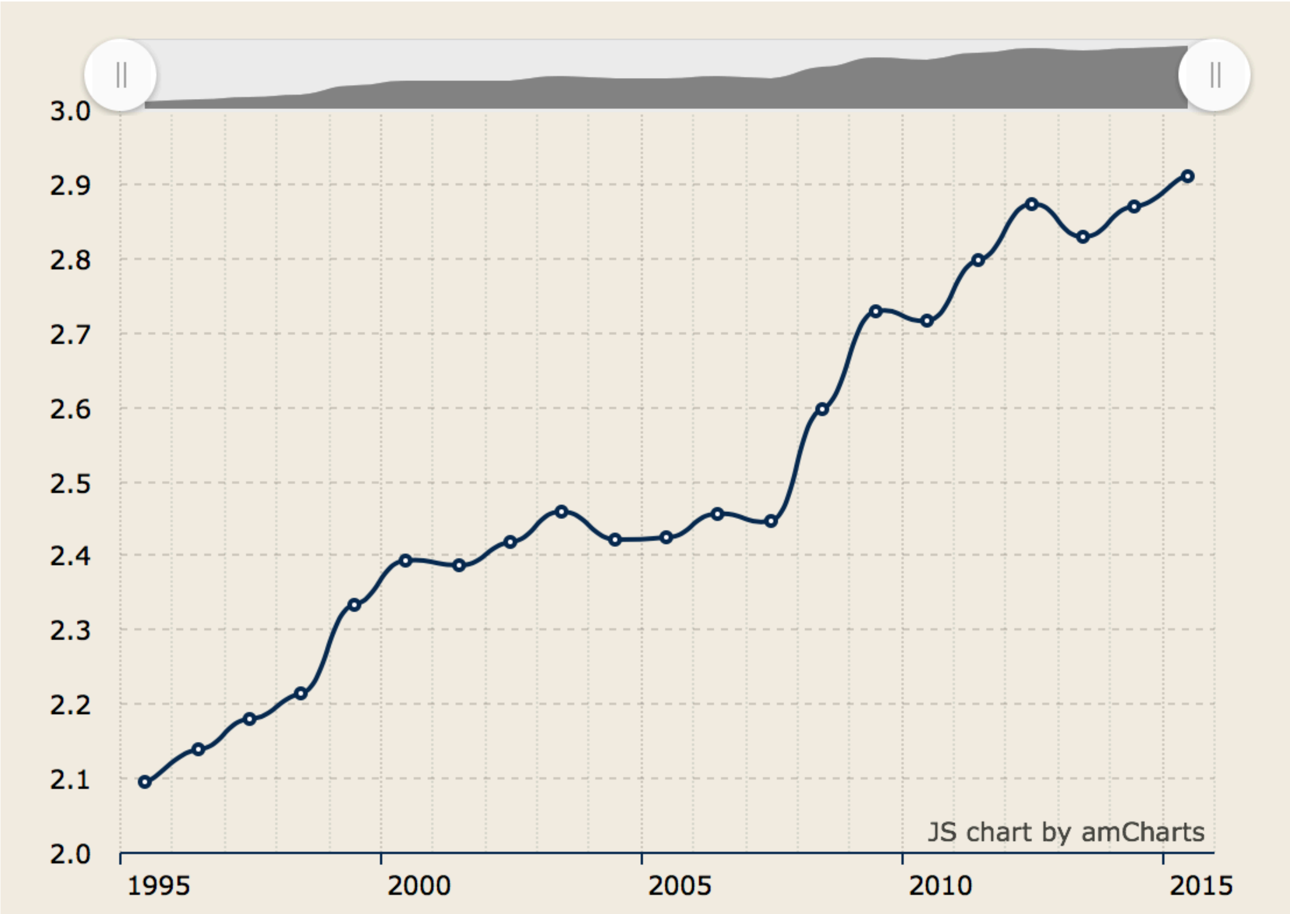
(% of GDP)



Source: https://countries.world/Austria/Research_and_development_expenditure-1217_129.html

Appendix 2. The dynamics of change: Research and development expenditure in Germany

(% of GDP)



Source: https://countries.world/Germany/Research_and_development_expenditure-1217_129.html

Appendix 3. Observation Data

Coun-try	Uni-versity	Compo-sition	No	Name	Number of papers per person	Number of citations
Austria	University of Vienna	Professors	1	Assoz. Prof. Dr. Jani Kotakoski	119	6045
			2	Univ.-Prof. Dipl.-Phys. Dr. Jannik C. Meyer	79	3485
			3	ao. Univ.-Prof. Mag. Dr. Christian Rentenberger	139	9800
			4	Ass.-Prof. Mag. Dr. Franz Sachslehner	18	147
			5	ao. Univ.-Prof. Mag. Dr. Erhard Schafler	94	1780
			6	ao. Univ.-Prof. Mag. Dr. Thomas Waitz	82	340
		Senior Scientists	7	Mag. Dr. Clemens Mangler	0	0
		PostDocs	8	Dr. Mohammad Reza Ahmad Pour Monazam	3	2
			9	Dr. Bernhard Bayer-Skoff	21	187
			10	Mag. Dr. Michael Kerber	31	24
			11	D.Sc. Kimmo Mustonen	22	273
			12	Ing. Viera Skakalova, PhD D.Sc.	123	3009
			13	Dr. Toma Susi	85	580
		Doctoral Students	14	Mag. Peter Cengeri	26	5
			15	Christian Ebner, MSc	26	7
			16	Kenan Elibol, MSc	5	2
			17	Mag. Christoph Hofer	6	2
			18	Heena Inani, M.Sc.	0	0
			19	Gregor Thomas Leuthner, BSc. MSc	3	0
			20	Ursula Ludacka, M.Sc.	1	0
			21	Andreas Mittelberger, M.Sc.	15	6
			22	Stefan Noisternig, BSc MSc	12	10
			23	Andrea Ojdanic, BSc MSc	1	0
			24	Mukesh Kumar Tripathi, MSc	3	0
			25	Semir Tulic, MSc	6	0
			26	Georg Zagler, M.Sc. BSc	0	0
				IN TOTAL:	920	25704
	Graz Technical University	Associate Professors	1	Ao.Univ.-Prof. Dipl.-Phys. Dr.rer.nat. Hans Gerd Evertz	103	1006
			2	Ao.Univ.-Prof.i.R. Dipl.-Ing. Dr.phil. Martin Heyn	16	54
			3	Ao.Univ.-Prof.i.R. Dipl.-Ing. Dr.techn. tit.Univ.-Prof. Ewald Schachinger	142	2744
		Assistant Professors	4	Assoc.Prof. Dipl.-Ing. Dr.techn. Markus Aichhorn	49	2100
			5	Dr. Lilia Boeri	85	2155
			6	Ass.Prof. Dipl.-Ing. Dr.techn. Winfried Kernbichler	54	530

		Emeritus Professors	7	Em.Univ.-Prof. Dr.phil. Bernhard Schnizer	115	304
		PostDocs	8	Dr. Viktor Eisler	31	920
			9	Dipl.-Ing. Dr.techn. BSc Andreas Frank Martitsch	8	52
			10	Dr.phil.nat. Irakli Titvinidze	26	445
		PhD Students	11	Dipl.-Ing. Dr.rer.nat. BSc Christopher Albert	0	0
			12	Dipl.-Ing. Dr.techn. BSc Daniel Bauernfeind	5	9
			13	Dipl.-Ing. BSc BSc Gerhard Dorn	0	0
			14	Dipl.-Ing. BSc Delia Maria Fugger	0	0
			15	Dipl.-Ing. Dr.techn. BSc Gernot Kapper	0	0
			16	Dipl.-Ing. BSc Christian Kokail	0	0
			17	Dipl.-Ing. Dr.techn. BSc Gernot Kraberger	5	7
			18	Dipl.-Ing. BSc Florian Maislinger	0	0
			19	Dipl.-Ing. BSc Michael Rumetshofer	0	0
			20	bak. mag. Andriy Smolyanyuk	0	0
			21	Dipl.-Ing. BSc MSc Max Erich Sorantin	0	0
			22	Dipl.-Ing. BSc Robert Triebl	0	0
			23	Dipl.-Ing. BSc Manuel Johannes Zingl	0	0
				IN TOTAL:	639	10326
	Karl-Franzens University of Graz	Professors	1	Sterrer, Martin, Univ.-Prof. Dipl.-Ing. Dr.techn.	102	3764
			2	Netzer, Falko, Em.o.Univ.-Prof. Dr.phil.	404	8945
			3	Ramsey, Michael, Ao.Univ.-Prof. Mag. Dr.rer.nat.	101	1646
			4	Surnev, Svetlozar, Ao.Univ.-Prof. Dr.rer.nat.	72	1554
			5	Koller, Georg, Assoz. Prof. Mag. Dr.rer.nat.	98	706
		PhD students	6	Blatnik, Matthias, Mag. rer. nat.	11	48
			7	Hollerer, Michael, DI	2	4
			8	Abdou, Jasmin, 1MSc.	1	0
			9	Egger, Larissa, MSc.	2	1
			10	Hurdax, Philipp, MSc.	2	0
			11	Mohammadi Bezanaj, Malihe	0	0
		Diploma students	12	Bone, Thomas, BSc.	0	0
			13	Radlinger, Thomas, BSc.	0	0
			14	Schwarz, Florian, BSc.	0	0
				IN TOTAL:	795	16668
	University of Innsbruck	Professors	1	Blatt Rainer, o. Univ.-Prof. Dr.	195	27294
			2	Ferlaino Francesca, Univ.-Prof. Dr.	47	5592
			3	Grimm Rudolf, Univ.-Prof. Dr.	159	26916
			4	Kirchmair Gerhard, Univ.-Prof. Dr.	15	4900
			5	Nägerl Hanns-Christoph, Univ.-Prof. Dipl.-Phys. Dr.	77	7717

			6	Northup Tracy Eleanor, Univ.-Prof. Dr.	24	438
			7	Weihs Gregor, Univ.-Prof. Mag. Dr.	95	12101
		Univ.-Doz.	8	Vass Erich, ao. Univ.-Prof. Dr.	67	2563
		Wiss. Mitarb.	10	Anich Gregor, BSc. MSc.	0	0
			11	Araneda Machuca Gabriel Andrés, MSc.	0	0
			12	Colombe Yves, Dr.	0	0
			13	Denoth Armin, ao. Univ.-Prof. Mag. Dr.	0	0
			14	Dittel Christoph, BSc MSc	0	0
			15	Fritsche Isabella, BSc MSc	0	0
			16	Ilzhöfer Philipp, MSc	1	0
			17	Karpov Denis, Dr.	0	0
			18	Kauten Thomas, Mag.	0	0
			19	Kirilov Emil, Dr.	8	10
			20	Lehmann Fabian Torben, BSc. MSc.	0	0
			21	Mark Manfred, Mag. Dr.	0	0
			22	Monz Thomas, Dr.	0	0
			23	Petter Daniel, BSc MSc	4	3
			24	Patscheider Alexander, MSc.	0	0
			25	Prilmüller Maximilian, BSc. MSc.	0	0
			26	Schlager Alexander, MSc.	0	0
			27	Schupp Josef Benjamin	0	0
			28	Shmakova Margarita	0	0
		Univ.-Bed.	29	Ames Benjamin, MSc	0	0
			30	Baier Simon, MSc.	0	0
			31	Bakhshinezhad Faraj	0	0
			32	Becher Jan Hendrick, MSc.	0	0
			33	Bykov Dmitry, Dr.	0	0
			34	Capecchi Deborah, Dott.ssa mag.	0	0
			35	Chomaz Lauriane, Dr.	5	8
			36	Czopak Ulrich, MSc.	0	0
			37	Dania Lorenzo, BSc.	0	0
			38	De Arinjoy	0	0
			39	Dobler Erich Martin, BSc. MSc.	0	0
			40	Durastante Gianmaria, Dott. mag.	1	0
			41	Erhard Alexander, BSc. MSc.	0	0
			42	Fan Hao	0	0
			43	Fioretto Dario Alessandro, Dott. mag.	0	0
			44	Friebe Konstantin, Dipl.-Phys.	0	0
			45	Gerster Lukas, MSc	0	0
			46	Horvath Milena Simone Julia	0	0
			47	Huan Chen	0	0
			48	Jobez Pierre, Dr.	0	0
			49	Keil Robert, Dr.	0	0
			50	Khaliulin Bulat	0	0
			51	Lakhmanskiy Kirill, MSc	0	0
			52	Lee Moonjoo, Dr.	0	0
			53	Martinez Esteban Adrian, MSc	0	0

			54	Mestres Junque Pau, MU	0	0
			55	Meth Michael Robert, BSc.	5	5
			56	Oleschko Stefan, BSc. MSc.	0	0
			57	Ong Florian, Dr.	0	0
			58	Postler Lukas, MSc.	0	0
			59	Pressl Benedikt Anton, MSc	0	0
			60	Sassermann Mathias, PhD.	0	0
			61	Schindewolf Andreas, Dipl.-Phys.	1	1
			62	Schindler Philipp, Mag. Dr.	1	0
			63	Schneider Christian, MSc	0	0
			64	Schüppert Klemens, MSc.	0	0
			65	Soave Elisa, Dott.ssa mag.	0	0
			66	Stricker Roman, BSc. MSc.	0	0
			67	Takekoshi Tetsu, Dr.	0	0
			68	Teller Markus, BSc. MSc.	0	0
			69	Unnikrishnan Govind	0	0
			70	Uryumtsev Yaroslav	0	0
			71	van Mourik Martin, MSc.	0	0
			72	Weinmann Philipp, Dipl.-Phys.	0	0
			73	Zanner Maximilian Friedrich, MSc.	0	0
				IN TOTAL:	705	87548
	University of Salzburg	Professors	1	BOCKSTEDTE Michel, Univ.-Prof. Dr.	83	2232
			2	DUNLOP John, Univ.-Prof. Dr.	62	128
			3	MUSSO Maurizio, Univ.-Prof. DI Dr.	82	1144
		Postdocs	4	LETTNER Herbert, Ao.Univ.-Prof. Ing. Dr.	59	757
			5	PRUNER Christian, Mag. Dr.	25	476
			6	REYER Andreas, Dr.	14	11
			7	SERENI Paolo, Dr.	6	17
		PhD Students	8	BERTOLDO-MENEZES Durval	10	10
			9	MADL Pierre, DI Mag. Dr.	53	238
			10	MALCIOGLU, Osman Baris, Dr.	53	300
			11	PICHELSTORFER Lukas, Dr.	12	28
			12	SCHAMBERGER, Barbara. MSc.	0	0
			13	WINKLER-HEIL Renate, Dr.	34	456
				IN TOTAL:	493	5797
Germany	Ruprecht-Karls-University Heidelberg	Professors	1	Luca Amendola	200	13166
			2	Jürgen Berges	105	6509
			3	Tilman Enss	43	1455
			4	Maurits W. Haverkort	73	4819
			5	Arthur Hebecker	96	8880
			6	Dieter W. Heermann	240	7020
			7	Joerg Jaeckel	68	3475
			8	Jan Martin Pawlowski	154	10576
			9	Tilman Plehn	114	18334
			10	Manfred Salmhofer	57	1637
			11	Ulrich Schwarz	114	9430
			12	Johannes Walcher	62	1890
			13	Timo Weigand	67	3989

			14	Susanne Westhoff	30	1293
			15	Christof Wetterich	342	16422
			16	Martin Bauer	30	1305
			17	Astrid Eichhorn	47	1305
			18	Carlo Ewerz (apl.Prof.)	54	1203
			19	Stefan Flörchinger (priv.Doz.)	46	959
			20	Martin Gärttner	43	625
			21	Philipp Hauke	57	3361
			22	Luminita Mihaila (priv.Doz.)	52	631
			23	Alexander Rothkopf	50	979
			24	Georg Wolschin (apl.Prof.)	100	2317
		Research Associates	25	Dario Bettoni	12	283
			26	Martin Bies	4	0
			27	Elmar Bittner	66	473
			28	Nadejda Bouldi	9	15
			29	Anton Konrad Cyrol	1	0
			30	Anil Dasanna	12	49
			31	Nicolo Defenu	15	42
			32	Guillem Domenech	20	113
			33	Richard Eager	1	0
			34	Eduardo Grossi	0	0
			35	Daniel Junghans	24	142
			36	Simon Kast	4	11
			37	Craig Lawrie	26	1027
			38	Stefan Lippoldt	10	200
			39	Yi Lu	28	591
			40	Aleksas Mazeliauskas	5	25
			41	Viraf Mehta	8	83
			42	Viviana Niro	25	881
			43	Pintu Patra	13	50
			44	Antonio Pereira	0	0
			45	Alessia Benedetta Platania	12	123
			46	Manuel Reichert	0	0
			47	Javier Rubio	0	0
			48	Michael Russell	0	0
			49	Nikolas Schnellbaecher	0	0
			50	Pablo Soler Gomis	0	0
			51	Eduard Thommes	4	63
			52	Jennifer Thompson	0	0
			53	Kambis Veschgini	1	3
			54	Sebastian Wetzel	0	0
			55	Masatoshi Yamada	0	0
			56	Savvas Zafeiropoulos	0	0
			57	Falko Ziebert	0	0
		PhD Students	58	Alefe Almeida	4	9
			59	Gonzalo Alonso Alvarez	3	7
			60	Alireza Beygi	4	8
			61	Anke Biekötter	4	105
			62	Martin Brass	0	0
			63	Aleksandr Chatrchyan	0	0

		64	Min Chu	0	0
		65	Lukas Corell	1	1
		66	Ricardo Costa de Almeida	0	0
		67	Tobias Denz	1	32
		68	Moritz Drescher	0	0
		69	Bruno Faigle-Cedzich	0	0
		70	Anastasiia Filimonova	0	0
		71	Patrick Foldenauer	2	10
		72	Felix Frey	0	0
		73	Oscar Garcia Montero	4	17
		74	Kevin Geier	1	7
		75	Justin Grewe	1	0
		76	Johannes Hölck	0	0
		77	Simon Heinze	0	0
		78	Aaron Held	0	0
		79	Markus Heller	0	0
		80	Philipp Henkenjohann	2	25
		81	Andreas Hofmann	0	0
		82	Julia Jäger	1	5
		83	Jiying Jia	0	0
		84	Frank Könnig	0	0
		85	Lukas Kades	0	0
		86	Fabian Klos	0	0
		87	Sascha Leonhardt	0	0
		88	Kunhe Li	0	0
		89	Johannes Lumma	1	8
		90	Niklas Müller	0	0
		91	Marc Merstorf	0	0
		92	Henrik Nersisyan	7	76
		93	Michele Pastena	0	0
		94	Martin Pauly	0	0
		95	Ana Marta Pinho	0	0
		96	Dimitri Probst	0	0
		97	Christian Reichelt	0	0
		98	Peter Reimitz	2	36
		99	Sebastian Schenk	1	2
		100	Manuel Scherzer	0	0
		101	Marc Schiffer	0	0
		102	Philipp Schulz	0	0
		103	Alessio Spurio Mancini	2	9
		104	Fleur Versteegen	3	28
		105	Nicolas Wink	3	7
		106	Ramon Winterhalder	0	0
		107	Paul Wittmer	0	0
		108	Manuel Wittner	1	2
		109	Wei Xiong	0	0
		110	Fengjun Xu	1	4
		111	Torsten Zache	0	0
		112	Felix Ziegler	0	0
			IN TOTAL:	2593	126152

	University of Cologne	Professors	1	Prof. Dr. Andreas Eckart	14	81
			2	Prof. Dr. Lucas Labadie	107	645
			3	Prof. Dr. Peter Schilke	421	7619
			4	Prof. Dr. Stephan Schlemmer	311	4151
			5	Prof. Dr. Jürgen Stutzki	92	1264
			6	Prof. Dr. Stefanie Karoline Walch-Gassner	86	2475
		Postdocs	7	Dr. Gerold Busch	31	146
			8	Dr. Matthew Horrobin	68	1124
			9	Dr. Marzieh Parsa	1	0
			10	Dr. Steffen Rost	2	0
			11	Dr. Nadeen Sabha	43	241
			12	Dr. Mónica Valencia-S.	71	215
			13	Dr. Rebekka Grellmann	0	0
			14	Dr. Nicola Baccichet	19	19
			15	Dr. Jan Tepper	12	71
			16	Dr. Thomas Moeller	15	65
			17	Dr. Alvaro Sanchez-Monge	56	340
			18	Dr. Esteban Morales	45	267
			19	Dr. Holger S. P. Müller	78	578
			20	Dr. Frank Lewen	125	1534
			21	Dr. Sven Thorwirth	100	2904
			22	Dr. Leonid Surin	55	1140
			23	Dr. Oskar Asvany	70	997
			24	Dr. Philipp Schmid	63	265
			25	Dr. Nadine Wehres	34	136
			26	Dr. Elena Zakharenko	12	15
			27	Dr Isabel Peña	24	78
			28	Dr. Stefan Glenz	3	6
			29	Dr. Holger Müller	5	8
			30	Dr. Markus Röllig	100	1935
			31	Dr. Robert Simon	17	295
			32	Dr. Matthias Justen	34	594
			33	Dr. Daniel Seifried	36	502
			34	Dr. Johanna Malinen	3	8
			35	Dr. Juan Ibanez-Mejia	11	49
			36	Dr. Frantisek Dinnbier	6	13
			37	Dr. Seamus Clarke	0	0
		PhD Students	38	Nastaran Fazeli	7	1
			39	Elaheh Hosseini	0	0
			40	Florian Peißker	0	0
			41	Matthias Subroweit	1	0
			42	Madeleine Yttergren	0	0
			43	Michal Zajaček	30	48
			44	Andres Cahuasqui	0	0
			45	Fabio Eupen	0	0
			46	Balaji Muthusubramanian	11	13
			47	Sabine Graf	0	0
			48	Fanyi Meng	9	35
			49	Liem Ngo Thanh	2	13

			50	Mahya Sadaghiani	1	0
			51	Yasemin Poyraz	5	4
			52	Andreas Schwörer	3	5
			53	Sümeyye Suri	0	0
			54	Nassim Tanha	1	0
			55	Kai Yang	2	2
			56	Roya Hamedani Golshan	1	0
			57	Shreyak Banhatti	1	1
			58	Kirill Borisov	1	0
			59	Stefan Brackertz	1	0
			60	Marius Hermanns	4	52
			61	Thomas Salomon	4	70
			62	Philip Schreier	0	0
			63	Matthias Töpfer	2	12
			64	Oliver Zingsheim	2	0
			65	Markus Cubick	0	0
			66	Martin Klinkmann	0	0
			67	Michael Masur	0	0
			68	Pedro Pablo Munoz-Pradas	2	4
			69	Kefeng Sun	1	0
			70	Annika Franeck	3	3
			71	Sebastian Haid	6	28
			72	Dominik Derigs	10	40
			73	Prabesh Raj Joshi	4	30
			74	Nassim Tanha	0	0
				IN TOTAL:	2284	30141
	LMU Munich	Professors	1	Prof. Dr. Ralf Bender	100	40624
			2	Prof. Dr. Otmar Biebel	26	749
			3	Prof. Dr. Thomas Birner	100	2370
			4	Prof. Dr. Til Birnstiel	61	3599
			5	Prof. Dr. Immanuel Bloch	100	40864
			6	Prof. Dr. Dieter Braun	12	543
			7	Prof. Dr. Chase Broedersz	19	786
			8	Prof. Dr. Ilka Brunner	48	3956
			9	Prof. Dr. Gerhard Buchalla	53	4367
			10	Prof. Dr. Andreas Burkert	177	9283
			11	Prof. Dr. George Craig	97	3426
			12	Prof. Dr. Georgi Dvali	8	483
			13	Prof. Dr. Barbara Ercolano	17	648
			14	Prof. Dr. Jochen Feldmann	100	28829
			15	Prof. Dr. Livia Ferro	0	0
			16	Prof. Dr. Erwin Frey	353	11974
			17	Prof. Dr. Hella Garny	74	1143
			18	Prof. Dr. Hermann Gaub	300	34436
			19	Prof. Dr. Raimund Girwidz	19	754
			20	Prof. Dr. Theodor W. Hänsch	509	34515
			21	Prof. Dr. Stefan Hofmann	49	2673
			22	Prof. Dr. Alexander Högele	47	2034
			23	Prof. Dr. Ralf Jungmann	78	2577
			24	Prof. Dr. Stefan Karsch	22	442

			25	Prof. Dr. Roland Kersting	67	279
			26	Prof. Dr. Ulf Kleineberg	200	10514
			27	Prof. Dr. Matthias Kling	319	8905
			28	Prof. Dr. Ferenc Krausz	400	56137
			29	Prof. Dr. Thomas Kuhr	776	38800
			30	Prof. Dr. Harald Lesch	22	65
			31	Prof. Dr. Tim Liedl	104	10468
			32	Prof. Dr. Jan Lipfert	121	3233
			33	Prof. Dr. Dieter Lüst	266	12965
			34	Prof. Dr. Stefan Maier	527	37730
			35	Prof. Dr. Bernhard Mayer	271	6088
			36	Prof. Dr. Peter Mayr	32	2563
			37	Prof. Dr. Ximena Mazzalay	18	232
			38	Prof. Dr. Joseph Mohr	44	1985
			39	Prof. Dr. Viatcheslav Mukhanov	125	16785
			40	Prof. Dr. Belén Paredes	56	465
			41	Prof. Dr. Katia Parodi	436	5356
			42	Prof. Dr. Lode Pollet	157	5670
			43	Prof. Dr. Thomas Preibisch	233	5745
			44	Prof. Dr. Matthias Punk	42	1102
			45	Prof. Dr. Joachim Rädler	63	1312
			46	Prof. Dr. Markus Rapp	351	4420
			47	Prof. Dr. Marco Riboldi	257	1546
			48	Prof. Dr. Eberhard Riedle	279	8344
			49	Prof. Dr. H. Ruhl	202	5565
			50	Prof. Dr. Dorothee Schaile	675	10549
			51	Prof. Dr. Ulrich Schollwöck	220	13070
			52	Prof. Dr. Jörg Schreiber	136	7375
			53	Prof. Dr. Armin Scrinzi	57	1307
			54	Prof. Dr. Jan von Delft	183	5463
			55	Prof. Dr. Harald Weinfurter	401	39396
			56	Prof. Dr. Thomas Weitz	90	5174
			57	Prof. Dr. Jochen Weller	149	20310
			58	Prof. Dr. Mark Wenig	59	698
			59	Prof. Dr. Wolfgang Zinth	45	539
		PhD Students	60	Dr. Ralph Blumenhagen	153	7710
			61	Dr. Keith Butler	90	3005
			62	Dr. Klaus Dolag	108	4013
			63	Dr. Torsten Enßlin	122	4326
			64	Dr. Andreas Glindemann	2	13
			65	Dr. Alexei V. Ivlev	2	5
			66	Dr. Tijana Janjic-Pfander	92	547
			67	Dr. Markus Kissler-Patig	68	2423
			68	Dr. Martin Krause	1	2
			69	Dr. Theobald Lohmüller	58	1458
			70	Dr. Bert Nickel	100	4332
			71	Dr. Richard Nisius	5	10
			72	Dr. Madeleine Opitz	0	0
			73	Prof. Dr. Gerhard Ortwin	100	3250
			74	Dr. Joachim Puls	20	820

		75	Dr. Thomas Pütterich	1	0
		76	Dr. Georg G. Raffelt	401	23077
		77	Dr. Christoph Räth	179	2463
		78	Dr. Roberto Philip Saglia	4	310
		79	Dr. Martin Schultze	76	5863
		80	Dr. Jörg Stober	0	0
		81	Dr. Peter Thirolf	11	75
		82	Dr. Jeannine Wagner-Kuhr	0	0
		83	Dr. Andreas Weichselbaum	3	1
		84	Dr. Vladislav Yakovlev	0	0
			IN TOTAL:	11348	644933
Technical University of Munchen	Professors	1	Prof. Dr. Wilhelm Auwärter	2	1
		2	Prof. Dr. Christian Back	57	2576
		3	Prof. Dr. Aliaksandr Bandarenka	115	4717
		4	Prof. Dr. Johannes Barth	168	1787
		5	Prof. Dr. Andreas Bausch	215	12657
		6	Prof. Dr. Martin Beneke	63	900
		7	Prof. Dr. Shawn Bishop	10	30
		8	Prof. Dr. Peter Böni	51	5476
		9	Prof. Dr. Nora Brambilla	217	9411
		10	Prof. Dr. Hendrik Dietz	86	6158
		11	Prof. Dr. Kar Duderstadt	23	603
		12	Prof. Dr. Laura Fabbietti	439	6544
		13	Prof. Dr. Peter Fierlinger	8	14
		14	Prof. Dr. Johnathan Finley	346	8680
		15	Prof. Dr. Björn Garbrecht	71	476
		16	Prof. Dr. Ulrich Gerland	100	4009
		17	Prof. Dr. Rudolf Gross	500	14800
		18	Prof. Dr. Elena Hassinger	46	1264
		19	Prof. Dr. Julia Herzen	226	1862
		20	Prof. Dr. Alexander Holleitner	167	3401
		21	Prof. Dr. Alejandro Ibarra	56	1320
		22	Prof. Dr. Reinhard Kienberger	96	8539
		23	Prof. Dr. Michael Knap	54	1874
		24	Prof. Dr. Katharina Krischer	75	1373
		25	Prof. Dr. Bastian Märkisch	22	560
		26	Prof. Dr. Susanne Mertens	14	1128
		27	Prof. Dr. Peter Müller-Buschbaum	689	11833
		28	Prof. Dr. Lothar Oberauer	31	271
		29	Prof. Dr. Christine Papadakis	21	86
		30	Prof. Dr. Stephan Paul	770	12106
		31	Prof. Dr. Franz Pfeiffer	550	14947
		32	Prof. Dr. Christian Pfleiderer	320	11938
		33	Prof. Dr. Frank Pollmann	105	3608
		34	Prof. Dr. Menno Poot	60	3620
		35	Prof. Dr. Elia Resconi	59	2657
		36	Prof. Dr. Matthias Rief	1	0
		37	Prof. Dr. Stefan Schönert	434	11627
		38	Prof. Dr. Ian Sharp	178	4315
		39	Prof. Dr. Friedrich Simmel	169	9526

			40	Prof. Dr. Ulrich Stroth	2	205
			41	Prof. Dr. Martin Stutzmann	911	34211
			42	Prof. Dr. Sherry Suyu	30	88
			43	Prof. Dr. Andreas Weiler	100	5408
			44	Prof. Dr. Martin Zacharias	301	7648
			45	Prof. Dr. Wilhelm Zwerger	8	692
		PhD	46	Dr. Ante Bilandzic	209	4200
			47	Dr. Gregor Birkenmeier	73	611
			48	Dr. Rikkert Frederix	43	2384
			49	Dr. Zeynep Ökten	8	65
			50	Dr. Friedemann Reinhard	45	2583
			51	Dr. Danny van Dyk	49	1173
				IN TOTAL:	8393	245962
		Professors	1	Prof. Dr. rer. nat. Werner Aeschbach	11	4
			2	Prof. Dr. Luca Amendola	262	13212
			3	Prof. Dr. rer. nat. Matthias Bartelmann	322	17871
			4	Prof. Dr. rer. nat. Jürgen Berges	174	4356
			5	Prof. Dr. rer. nat. André Butz	235	3186
			6	Prof. Dr. rer. nat. Norbert Christlieb	260	10107
			7	Prof. Dr. rer. nat. Cornelis Dullemond	320	13898
			8	Prof. Dr. rer. nat. Christian Enss	188	3260
			9	Prof. Peter Fischer	246	2717
			10	Prof. Dr. rer. nat. Norbert Frank	192	3030
			11	Prof. Dr. rer. nat. Eva Grebel	901	47236
			12	Prof. Dr. rer. nat. Fred A. Hamprecht	232	6458
			13	Prof. Dr. Stephanie Hansmann-Menzemer	577	16671
			14	Prof. Dr. rer. nat. Maurits Haverkort	173	4841
			15	Prof. Dr. rer. nat. Arthur Hebecker	111	8989
			16	Prof. Dr. rer. nat. Dieter W. Heermann	240	6952
			17	Prof. Dr. rer. nat. Norbert Herrmann	76	3876
			18	Prof. Dr. rer. nat. Joerg Jaeckel	123	5051
			19	Prof. Dr. rer. nat. Bernd Jähne	380	14398
			20	Prof. Dr. rer. nat. Selim Jochim	31	7480
			21	Prof. Dr. rer. nat. Ralf S. Klessen	453	16397
			22	Prof. Dr. rer. nat. Rüdiger Klingeler	358	6923
			23	Prof. Dr. rer. nat. Thomas Leisner	158	2893
			24	Prof. Dr. rer. nat. Silvia Masciocchi	261	16530
			25	Prof. Dr. rer. nat. Karlheinz Meier	2656	156923
			26	Prof. Dr. rer. nat. Laura Na Liu	1	15
			27	Prof. Dr. rer. nat. Markus Oberthaler	153	7574
			28	Prof. Dr. rer. nat. Tilman Plehn	194	12225
			29	Prof. Dr. rer. nat. habil. Annemarie Pucci	50	442
			30	Prof. Dr. rer. nat. Andreas Quirrenbach	679	16654
			31	Prof. Dr. rer. nat. Friedrich Röpke	128	5281
			32	Prof. Dr. sc. nat. Kurt Roth	57	2439
			33	Prof. Dr. Carsten Rother	200	22936
			34	Prof. Dr. rer. nat. Manfred Salmhofer	65	2012

			35	Björn Malte Schäfer	45	1976
			36	Prof. Dr. André Schöning	184	7854
			37	Prof. Dr. rer. nat. Hans-Christian Schultz-Coulon	985	50862
			38	Prof. Dr. rer. nat. Ulrich Schwarz	145	9848
			39	Prof. Dr. Joao Seco	242	2379
			40	Prof. Dr. rer. nat. Volker Springel	544	68917
			41	Prof. Dr. rer. nat. Johanna Stachel	612	42813
			42	Prof. Dr. rer. nat. Robert Strzodka	1	0
			43	Prof. Dr. rer. nat. Ulrich Uwer	3	13
			44	Prof. Dr. rer. nat. Joachim Wambsganß	245	5372
			45	Prof. Dr. rer. nat. Matthias Weidemüller	247	10566
			46	Prof. Dr. rer. nat. Christof Wetterich	339	16344
		Junior Professors	47	Dr. Loredana Gastaldo	7	49
			48	Dr. rer. nat. Fred Jendrzejewski	18	810
			49	Yana Vaynzof	80	2259
			50	Dr. rer. nat. Susanne Westhoff	26	939
		Postdocs	51	Dr. rer. nat. Maria Bergemann	24	200
			52	Dr. rer. nat. Frank Bigiel	18	118
			53	Dr. Bertram Bitsch	13	687
			54	Astrid Eichhorn	58	1308
			55	Florian Goertz	37	1752
			56	Dr. Joseph Hennawi	176	5078
			57	Dr. rer. nat. Knud Jahnke	74	4609
			58	Dr. rer. nat. Tobias Kluge	34	354
			59	Dr. rer nat. Holger Kreckel	143	1541
			60	Dr. Diederik Kruijssen	112	1246
			61	Dr. Karin Lind	36	455
			62	Dr. Sebastian Neubert	9	26
			63	Dr. rer. nat. Nadine Neumayer	34	488
			64	Dr. rer. nat. Werner Rodejohann	136	4420
			65	Dr. Glenn Van de Ven	108	4384
				IN TOTAL:	15202	710504
	Albert-Ludwigs-University	Professors	1	Prof. Dr. Svetlana Bergyugina	269	3460
			2	Prof. Dr. Andreas Buchleitner	224	4683
			3	Prof. Dr. Stefan Dittmaier	228	13746
			4	Prof. Dr. Joachim Dzubiella	105	1526
			5	Prof. Dr. Beate Heinemann	16	70
			6	Prof. Dr. Gregor Herten	1933	151701
			7	Prof. Dr. Harald Ita	80	2465
			8	Prof. Dr. Karl Jakobs	1561	35748
			9	Prof. Dr. Tobias Lau	154	15689
			10	Prof. Dr. Michael Moseler	212	7543
			11	Prof. Dr. Günter Reiter	288	10960
			12	Prof. Dr. Giuseppe Sansone	148	7483
			13	Prof. Dr. Tobias Schätz	3	46
			14	Prof. Dr. Tanja Schilling	164	11846
			15	Prof. Dr. Markus Schumacher	456	34578

			16	Prof. Dr. Marc Schumann	94	7125
			17	Prof. Dr. Frank Stienkemeier	176	4007
			18	Prof. Dr. Gerhard Stock	168	8266
			19	Prof. Dr. Michael Thoss	160	5925
			20	Prof. Dr. Jens Timmer	595	17785
			21	Prof. Dr. Jochum Johan van der Bij	96	6758
			22	Prof. Dr. Oskar von der Lühe	116	556
			23	Prof. Dr. Oliver Waldmann	63	731
		Assistant Professor	24	apl. Prof. Dr. Heinz-Peter Breuer	454	12193
			25	Dr. Stefan Buhmann	78	1309
			26	apl. Prof. Dr. Christian Elsässer	557	17422
			27	apl. Prof. Dr. Thomas Filk	39	506
			28	apl. Prof. Dr. Horst Fischer	109	3364
			29	PD Dr. Frank Kühnemann	69	1546
			30	apl. Prof. Dr. Ulrich Landgraf	32	478
			31	apl. Prof. Dr. Oliver Mülken	50	1374
			32	PD Dr. Alberto Rodriguez	67	497
			33	apl. Prof. Dr. Markus Roth	88	1714
			34	apl. Prof. Dr. Wolfgang Schmidt	1	11
			35	PD Dr. Harald Schneider	92	937
			36	apl. Prof. Dr. Bernd v. Issendorff	23	498
			37	apl. Prof. Dr. Joachim Wagner	56	606
			38	PD Dr. Michael Walter	78	895
			39	PD Dr. Markus Walther	43	667
			40	PD Dr. Thomas Wellens	66	841
				IN TOTAL:	9211	397555
	Georg-August-University Goettingen	Professors	1	Prof. Dr. Stefan Mathias	86	1908
			2	Prof. Dr. Vasily Moshnyaga	186	855
			3	Prof. Dr. Gustav Beuermann	34	345
			4	Prof. Dr. Wolfgang Felsch	79	1440
			5	Prof. Dr. Konrad Samwer	255	7177
			6	Prof. Dr. Klaus Winzer	13	44
			7	Prof. Dr. Baida Achkar	9	613
			8	Prof. Dr. Ariane Frey	12	1077
			9	Prof. Dr. Hans Christian Hofsäss	162	3010
			10	Prof. Dr. Stan Lai	68	567
			11	Prof. Dr. Arnulf Quadt	11	62
		Assistant professors	12	Dr. Bernd Damaschke	33	618
			13	Dr. Yuansu Luo	12	45
			14	Dr. Daniel Steil	27	922
			15	Dr. Sabine Steil	32	345
			16	Dr. Henning Ulrichs	41	1020
			17	Dr. Zheng Wang	16	380
			18	PD. Dr. Ralf Bernhard	9	243
			19	PD Dr. Jörn Große-Knetter	807	46009
			20	PD Dr. Markus Keil	546	25874
			21	Dr. Marcello Bindi	1	0
			22	Dr. Michel Janus	1	0
			23	Dr. Gen Kawamura	0	0
			24	Dr. Jörn Lange	0	0

			25	Dr. Matthias Nagl	3	347
			26	Dr. Clara Nellist	7	278
			27	Dr. Thomas Peiffer	3	78
			28	Dr. Benjamin Schwenker	7	52
			29	Dr. Ali Skaf	0	0
			30	Dr. Royer Edson Ticse Torres	0	0
			31	Dr. Dimitar Yordanov	3	0
		PhD	32	M. Sc. Vitaly Bruchmann-Bamberg	1	0
			33	Dipl.-Phys. Matthias Büchsenschütz-Göbeler	4	4
			34	M. Sc. Marten Düvel	0	0
			35	M. Sc. Marius Keunecke	0	0
			36	M. Sc. Philipp Ksoll	0	0
			37	M. Sc. Martin Lüttich	0	0
			38	M. Sc. Christoph Meyer	0	0
			39	M. Sc. Sebastian Merten	0	0
			40	M. Sc. Dennis Meyer	0	0
			41	Dipl.-Phys. Markus Michelmann	0	0
			42	M. Sc. Christina Nolte	0	0
			43	Dipl.-Phys. Melanie Schneider	0	0
			44	M. Sc. Cinja Seick	0	0
			45	MSc Kira Abeling	0	0
			46	MSc Manuel Auge	1	0
			47	MSc Helge Christoph Beck	0	0
			48	MSc Tobias Bisanz	4	3
			49	Dipl.-Phys. Omar Bobes	0	0
			50	MSc Petar Bokan	0	0
			51	MSc Eric Buschmann	0	0
			52	MSc Tomas Dado	0	0
			53	MSc Antonio de Maria	1	0
			54	MSc Timo Dreyer	1	0
			55	MSc Uwe Gebauer	4	0
			56	MSc Jannik Geisen	0	0
			57	MSc Lino Gerlach	0	0
			58	MSc Tristan Koppe	0	0
			59	MSc Gvantsa Mchedlidze	0	0
			60	MSc Johannes Mellenthin	0	0
			61	MSc Ishan Pokharel	0	0
			62	MSc Serhat Ördek	0	0
			63	MSc Paolo Sabatini	0	0
			64	MSc Harrison Schreek	0	0
			65	MSc Joshua Wyatt Smith	0	0
			66	MSc Fabian Sohns	0	0
			67	MSc Alrik Stegmaier	0	0
			68	MSc Ulf Stolzenberg	0	0
			69	MSc Philipp Wieduwilt	0	0
			70	MSc Knut Zoch	0	0
				IN TOTAL:	2479	93316
	Karlsruher Institut	Professors	1	Baumbach, Tilo	231	1612
			2	Bernlochner, Florian	720	31899

			3	Bohlen, Thomas	157	1929
			4	Bräsicke, Peter	167	2316
			5	Drexlin, Guido	78	1568
			6	Feindt, Michael	693	61209
			7	Gerthsen, Dagmar	282	2730
			8	Hoose, Corinna	125	2657
			9	Hunger, David	37	1854
			10	Husemann, Ulrich	920	55611
			11	Kalt, Heinz	323	2985
			12	Klinkhamer, Frans R.	169	3277
			13	Knippertz, Peter	208	2886
			14	Kottmeier, Christoph	104	1500
			15	Le Tacon, Matthieu	104	4295
			16	Leisner, Thomas	156	1783
			17	Melnikov, Kirill	186	11004
			18	Mirlin, Alexander	235	8364
			19	Mühlleitner, Margarete	117	10083
			20	Müller, Anke-Susanne	93	44
			21	Müller, Thomas	51	479
			22	Nienhaus, Gerd Ulrich	526	20556
			23	Nierste, Ulrich	105	5537
			24	Orphal, Johannes	250	7538
			25	Pinto, Joaquim	447	5459
			26	Quast, Günter	831	48866
			27	Rietbrock, Andreas	230	1647
			28	Rockstuhl, Carsten	299	5077
			29	Schimmel, Thomas	33	720
			30	Schmalian, Jörg	281	8096
			31	Schwetz-Mangold, Thomas	170	11235
			32	Shnirman, Alexander	159	6230
			33	Steinhauser, Matthias	246	11036
			34	Ustinov, Alexey	99	543
			35	Weber, Marc	3	3
			36	Wegener, Martin	331	16358
			37	Weiß, Georg	2	48
			38	Wernsdorfer, Wolfgang	229	8349
			39	Wulfhekel, Wulf	136	2425
			40	Zeppenfeld, Dieter	214	11558
		Dozenten	42	Gieseke, Stefan	75	4110
			43	Gornyi, Igor	128	2810
			44	Heidbach, Oliver	85	631
			45	Hetterich, Michael	121	1081
			46	Hoffmann-Vogel, Regina	16	39
			47	Höpfner, Michael	170	3422
			48	Mozer, Matthias	4	0
			49	Naber, Andreas	28	1395
			50	Narozhny, Boris	68	1378
			51	Rabbertz, Klaus	11	79
			52	Rauch, Michael	141	7680
			53	Schröder, Frank	69	452

		54	Weber, Frank	18	46
		55	Wolf, Roger	5	1
		56	Zakeri Lori, Khalil	2	0
			IN TOTAL:	10688	404490
WWU Munster University	Professors	1	Prof. Dr. Sergej O. Demokritov	219	7021
		2	Prof.´in Dr. Cornelia Denz	287	2949
		3	Prof. Dr. Carsten Fallnich	167	3321
		4	Prof.'in Dr. Susanne Heinicke	4	7
		5	Prof. Dr. Stefan Heusler	40	755
		6	Prof'in Dr. Anna Windt	21	9
		7	Prof'in Dr. Nicola Meschede	7	23
		8	Sen.-Prof.´in Dr. Kornelia Möller	46	311
		9	Prof. Dr. Nikos Doltsinis	118	2542
		10	Jun.-Prof'in Dr. Doris Reiter	76	495
		11	Prof. Dr. Michael Rohlfing	121	7700
		12	Prof. Dr. Tilmann Kuhn	298	5052
		13	Prof. Dr. Michael Becken	61	599
		14	Prof. Dr. Ulrich Hansen	49	1342
		15	Prof.´in Dr. Christine Thomas	13	118
		16	Prof. Dr. Anton Andronic	326	19857
		17	Sen.-Prof. Dr. Dieter Frekers	6	118
		18	Prof. Dr. Alexander Kappes	10	200
		19	Prof. Dr. Christian Weinheimer	30	217
		20	Prof. Dr. Johannes P. Wessels	5	6
		21	Prof. Dr. Gerhard Wilde	341	5170
		22	Prof. Dr. Heinrich F. Arlinghaus	70	1425
		23	Prof. Dr. Rudolf Bratschitsch	186	3968
		24	Prof. Dr. Markus Donath	142	2663
		25	Prof. Dr. Harald Fuchs	565	14825
		26	Prof. Dr. Helmut Kohl	3	6
		27	Prof. Dr. Wolfram Pernice	102	2434
		28	Jun.-Prof. Dr. Carsten Schuck	49	1036
		29	Prof. Dr. Helmut Zacharias	216	3091
		30	Prof. Dr. Michael Klasen	188	5392
		31	Prof.'in Dr. Anna Kulesza	11	120
		32	Prof. Dr. Stefan Linz	44	438
		33	Prof. Dr. Gernot Münster	119	4265
		34	Prof. Dr. Uwe Thiele	90	1271
		35	Jun.-Prof. Dr. Raphael Wittkowski	37	1336
	Wiss. Mitarbeiter	36	Dr. Jürgen Berkemeier	4	6
		37	Dr. Vladislav Demidov	21	53
		38	Dr. Jörg Imbrock	36	316
		39	Dr. Alexander Pusch	14	5
		40	Dr. Christin Robisch	0	0
		41	Dr. Martina Schramm	0	0
		42	Apl. Prof. Dr. Peter Krüger	7	19
		43	Dr. Volkmar Schmidt	21	174
		44	Dr. Jörg Schmalzl	30	515
		45	Dr. Stephan Stellmach	19	294
		46	Dr. Volker Hannen	70	782

			47	Priv.-Doz. Dr. Christian Klein-Bösing	388	18644
			48	Apl. Prof. Dr. Alfons Khoukaz	238	3915
			49	Apl. Prof. Dr. Hartmut Bracht	108	2072
			50	Priv. Doz. Dr. Sergiy Divinski	42	274
			51	Dr. Martin Peterlechner	12	43
			52	Dr. Harald Rösner	8	94
			53	Dr. Manfred Bartsch	45	367
			54	Apl. Prof.´in Dr. Lifeng Chi	420	9544
			55	Dr. Andreas Gorschlüter	7	127
			56	Dr. Dieter Lipinsky	4	0
			57	Dr. Anke B. Schmidt	37	375
			58	Dr. A. Christian Strassert	5	1
			59	Priv.-Doz. Dr. Jochen Heitger	101	1687
			60	Dr. Svetlana Gurevich	16	48
			61	Dr. Pietro Giudice	37	751
				IN TOTAL:	5757	140188