

ACTA UNIVERSITATIS UPSALIENSIS
Uppsala Studies in Economic History, 122

Carl Björvang

Cracks in the Ivory Tower

Antibiotics Research and the Changes in Academia
1980-2015



UPPSALA
UNIVERSITET

Dissertation presented at Uppsala University to be publicly examined in Hörsal 2, Ekonomikum, Kyrkogårdsgatan 10, Uppsala, Friday, 2 September 2022 at 11:03 for the degree of Doctor of Philosophy. The examination will be conducted in English. Faculty examiner: Senior Researcher Oili-Helena Ylijoki (Tampere University).

Abstract

Björvang, C. 2022. Cracks in the Ivory Tower. Antibiotics Research and the Changes in Academia 1980-2015. *Uppsala Studies in Economic History* 122. 192 pp. Uppsala: Acta Universitatis Upsaliensis. ISBN 978-91-513-1531-7.

At the same time as resistance to antibiotics became an increasingly problematic health care concern around the world, major changes occurred in the condition scientists faced when conducting university-based research. This thesis aims to study these changes as they applied to antibacterial and bacteriological research, and how they influenced the researchers' ability to make new scientific discoveries. Especially such discoveries that could be of critical importance for addressing the resistance problems of the era.

Using interviews with researchers, funding data and political documents, this thesis has been able to confirm that findings regarding the global trend of changes in academic research from previous research also applied to the bacteriological research in Sweden in the late 20th and early 21st century. These changes included increased performance pressure, administrative burden, and concentration of funding to a few large research groups as well as decreased employment security and less time for senior researchers to be directly active in the scientific work. While there were many intertwined underlying factors for these developments, most of them could be traced back to the changes in funding model for academic science. Most crucially, research funding turned from being based on employment to being based on recurring applications to funding agencies.

In conclusion, the changes in academic research conditions had major impacts on the ability of researchers to make new scientific discoveries. They incentivised doing safe, low-risk research with predictable outcomes, and producing many small, insubstantial publications. There were also some positive effects, such as a decrease in the impunity of senior researchers and a limitation on their ability to rest on their laurels. However, overall, this move away from taking chances and daring to research the truly unknown is likely to have decreased the ability of researchers to utilise their talents and follow-up on chance findings, decreasing their potential for discovery-making. Instead, it is likely that these changes within academia indirectly contributed to the antibacterial resistance problem by slowing down the rate of major breakthroughs in antibacterial treatments.

Keywords: antibiotic research, academic capitalism, scientific discoveries, research policy, Swedish research, antibiotic resistance, antibacterial treatment

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ISSN 0346-6493

ISBN 978-91-513-1531-7

URN urn:nbn:se:uu:diva-474261 (<http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-474261>)

To Richelle, Mamma and Pappa

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Abbreviations

ALF: Avtal om Läkarutbildning och Forskning
BMA: Biomedicinsk Analytiker
BMC: Biomedicinskt Centrum
CB: Carl Björvang
CEO: Chief Executive Officer
CFO: Chief Financial Officer
CUDOS: Communism, Universalism, Disinterestedness and Organised
Scepticism
CV: Curriculum Vitae
DNA: Deoxyribonucleic Acid
ENABLE: European Gram-negative Antibacterial Engine
EU: European Union
ERC: European Research Council
FTI: Fast Track to Innovation
GSK: GlaxoSmithKline
HIV: Human Immunodeficiency Virus
HR: Human Relations
IG Farben AG: Interessengemeinschaft Farbenindustrie Aktiengesellschaft
IMI: Innovative Medicine Initiatives
IT: Information Technology
KK: Kunskaps- och Kompetensutveckling
KPI: Konsumentprisindex
MD: Medical Doctor
MFR: Medicinska Forskningsrådet
NFR: Naturvetenskapliga Forskningsrådet
NIH: National Institute of Health
OR: Older Researcher
PhD: Doctor of Philosophy
PI: Principal Investigator
RAE: Research Assessment Exercise
SEK: Swedish Krona
SLU: Sveriges Lantbruksuniversitet
SME: Small- and Medium-sized Enterprise
SRB: Swedish Research Bill
TFR: Tekniska Forskningsrådet
TQA: Teacher Quality Assessment

UK: United Kingdom
US: United States
VR: Vetenskapsrådet
WHO: World Health Organisation
YR: Younger Researcher

Acknowledgements

In this thesis, I highlight collaborations as one of the most important aspects of research. Though this might be more apparent in the medical sciences, with research groups and sometimes dozens of contributors to the same journal article, it is as relevant in the social sciences. Below, I would like to highlight some of the people who have meant the most on the road towards the publication of my thesis.

Before I mention anyone by name though, I want to thank a group that was instrumental to the completion of this thesis, my interviewees. Though I can't write your names here, you know who you are and you should know that your contribution was essential to making this thesis what it is. Without you, this would have been a dry document of bills and statistics, lacking the human, lived experience that provide meaning to policies and numbers.

My sincere gratitude goes to my supervisor Alexandra Waluszewski. Without your ability to navigate the traitorous waters of research grant applications it would, in a very real sense, not have been possible to conduct the research that led to this thesis. You have been an ever-present cheerleader, listening to my worries and doubts, guiding my efforts and urging me onwards even when things were not going according to plan. Your engagement in the public debate has also been an inspiration and a reminder that our research has value even outside our immediate sphere.

I'm also highly grateful to have had Lars 'Tokfan' Fälting as my co-supervisor. As the thesis has evolved over the years, you have been a steadfast pillar, reminding me to anchor it in the methods and traditions of economic history. Your dedication and passion for the art of teaching have been a great encouragement and will be with me wherever my future path takes me.

Just as it is said that it takes a village to raise a child, it takes a department to raise a PhD student. As such, I want to thank the Department of Economic History at Uppsala University for raising me, broadening my understanding of our common subject matter while sharpening my research skills. Everyone who partook in Högre Seminariet contributed to creating a nurturing and educational environment where we could all reflect on the theories and methods upon which our subject is based, as well as keep up to date with developments in various field. The STS-seminar also helped me greatly, by familiarising me with the research fields most pertinent to my thesis.

Some special mentions are called for here. To Ann-Kristin Bergquist who read and commented on my half-time manuscript, and Per Lundin, who did

the same for my final seminar manuscript. Your input was crucial at steering my efforts in the right direction. To Daniel Normark, who provided vital input on empirical source material. To Ylva Hasselberg, who read the manuscript before and after the final seminar. Her keen eye and deep subject knowledge helped bring the thesis to a distinctively higher level. To Maths Isacson who read the manuscript after the final seminar and whose comments helped improve the final quality of the thesis.

Many others have helped me navigate life as a PhD student. I want to thank especially Mats Morell, Kristina Lilja and Nikolas Glover for their substantial support they've provided through the years. Petra Millbert, Jenny Björkegård, Maria Bengtsson and Pamela Tipmanoworn have also been of great help in making various tasks run smoothly and deserve deep gratitude. Likewise does Fredrik Sandgren, who has been of great help in some of the most pressing situations of my PhD studies.

However, the life of the PhD student is far more than the purely academic endeavours. In order to get through these years with some semblance of hope and sanity remaining, my fellow PhD students and younger researchers at the department have played a crucial role. Maja, my music friend and general confidant; Simon, my room-mate and master of the deep philosophic discussion; Cissi, our bastion of push and forward thinking, you have all been with me from the start. Sarah, Hedvig, Pär, Viktor, David and Jonas, you've all been role-models and sources of insight and encouragements. Arvand, Diego, Elisabeth, Ellen, Erik, Jonatan, Kasper and William, you have brought much needed drive and initiative to the department and it is good to see that the future is bright for our subject.

In addition, I have benefitted from belonging to Uppsala Antibiotic Center. Having the opportunity to learn about vastly different topics relating to antibiotics - from the inner workings of bacteria and ways to rapidly detect and determine bacterial infections to local and global efforts to prevent the spread of antibiotics resistance - has been a great boost. It has allowed me a much better understanding of how the issues are related, from biochemical interactions to World Health Organisation guidelines. A special thanks to Eva Garmendia for running the day-to-day operations of the centre, coordinating dozens of people from different departments, faculties and even universities.

Beyond the university, there are also numerous people who have aided in the process of creating this thesis. Not least among these are Pauliina Damdimopoulou and her lab. Having been an auxiliary member to the lab, I have gained valuable insights in the everyday routines, practices and requirements of medical research. The friendship of Tianyi, Nerges, Jasmin, Leni, Valentina, Laura and everyone else in and around the lab also helped retain my mental well-being, especially when Covid severed the physical connection with Uppsala.

Some connections from my earlier studies have also remained of great value to my academic pursuits, even to this day. I want to thank John and

Alwina for your continued moral support and providing me a home away from home. Thanks also Lazare for being a trusted friend and someone I can always trust. I also want to thank Julia for being my academic sounding board and discussion partner. Many thanks also go to Jay and Robin for introducing me to the life of a PhD student and making me realise that it could be something for me.

Another group that deserves thanks is Chorus Virorum, which has been my choir for the last decade. It is always a great joy and a soothing touch for the soul to sing with you, my friends. Many other friends have also given me that spark of joy necessary to persevere through trials of life as a PhD student. Simon and Erla, Diana and Alex, Alta and Fredrik, Andrea and Abdullah, Tita Malu, Tita Bert, Karolina, Sam and Jonas, Lydia and Sebastian, John and Xenia, Max and Sebastian, Lani and Chayan, Johan and Angelica, your friendships, insights and hospitalities have helped me remain human throughout this process.

Many a teacher have taught me the skills and knowledge that has enabled me to reach this point. One that deserves a special mention is Stephan, who was the first to indicate to me that an academic career might be a suitable path for me. Another is Liselotte, who encouraged my passion for writing. A third is Pauline, who elevated my interest in history from the popular to the academic.

I wish to thank my parents, Kent and Lotta. Without you, I would not be here, both in a literal and figurative sense. You have encouraged me when I needed encouragement and challenged me when I needed challenging, making me who I am today. Knowing that I have your constant support has given me a peace that has made this endeavour bearable. Carro and Victor, thank you for always being there and supplying me with new games, be they on a board or a computer. Mormor, morfar, farmor och farfar, tack för allt ni gjort genom åren, särskilt hur ni visat mig att den ofta abstrakta samhällshistorien har en mycket påtaglig återkoppling på det personliga planet.

I also want to thank my new family for all their encouragement and support. Daddy Bobby and mommy Fresy, you welcomed me as your own and provided me with a home in the Philippines. Kuya Richard, Kuya Momon and Angelica, you have helped me in numerous ways, be it with computer specs or pokémon hunting.

That antibiotics resistance could become a very personal threat is something that all who have had to be treated with them ought to realise. In 2016 I had my own struggle with a bacterial infection and I want to thank everyone that helped me and showed their support at that precarious moment. These include Dr Mary Ann Lansang, Trinah and Jopet, Edward, Issa and Alvin, Jo-Ann and Tim, Koodei, Mike Mo, Bib, Lolo Edwin, Jap, Kara and Mon.

Thanks also to all of the Filipino friends I've made over the last few years, who have been there to help and share more joyous moments, such as Trix and

Joseph, Ja and James, Mia, Mike Tu and Aimee, Anna and Dong, Lal, Esther, Falqi and RJ, Dappy and Daryl, Ninang Bevs, Dianne and Pol, Carol and Archie. An additional thanks to our friends spread around Europe, including Tita Badette, Tita Tessa and Tito Ben, Ate Jo-Ann and Thea, Robert and Alvira, Nany and Marcos, Ate Xiao and Adam. Like the travelling scholars of old, you have made us feel at home wherever we go.

Last, but definitely not least, I want to thank Richelle, my wife, my rock, my *baboy*. Not only have you been with me through all the emotional ups and downs of my thesis, but you have also been of great academic help. You were my proof-reader, my walking knowledge hub on infectious diseases, my statistics guru and general aid. Thank you for your constant help, encouragement and belief in me. I am utterly grateful that you've been, are and want to continue to be in my life!

1. Introduction

Scientific discoveries, the result of curiosity about the world around us and a dedicated search for truth about it, hold a value of their own. They are the bedrock upon which further truth inquiries can be made, one discovery opening the door for even more discoveries to come. However, throughout the centuries, many scientific discoveries have also proven to change societies and the lives of those within them in profound ways. One of the most important of these discoveries was that of antibiotics. In the mid-20th century, the progress in antibiotics fundamentally changed the treatment of bacterial infections, saving millions of lives, while also enabling new treatments for other medical conditions, such as advanced surgery. Unfortunately, in recent decades, the further development of antibiotics has largely stalled, while the bacteria have continuously developed increased resistance to existing antibiotics. This decrease in new antibiotics in the face of an ever-increasing need for them makes antibiotics research a fascinating case study of how the situations that researchers find themselves in may influence their ability to come up with scientific discoveries.

When antibiotics were first discovered, they were a game-changer in the treatment of infectious diseases and for the advent of modern medical practices. With these substances, old, endemic diseases that had previously been viewed as chronic or fatal, such as tuberculosis and syphilis, could be treated and cured. In addition, minor cuts and skin abrasions were no longer potentially lethal incidents.¹ Antibiotics also enabled the advent of modern surgical practises, including advanced procedures such as neural and cardiac surgeries, by dramatically reducing the risk of post-operative infections. Without antibiotics, that risk would be too high for many modern surgical procedures to be considered safe enough to conduct.²

Unfortunately, all of these advances are being threatened by the emerging resistance to these antibiotics within many of the most clinically relevant species of bacteria. They are living, multiplying organisms with the evolutionary ability to mutate over generations. Those bacteria that have mutations allowing them to survive being treated with a certain antibiotic will be more successful than those without such traits and will go on to reproduce. The future bacteria that trace their origins from these survivors will be more

¹ Aldridge, Parascandola, & Sturchio 1999, p. 3.

² Teillant, Gandra, Barter, Morgan, & Laxminarayan 2015.

likely to survive future treatments by the same or similar antibiotics, and hence more likely to be able to multiply. Over the generations, this eventually spreads the resistant mutations until they become dominant in the bacterial population.

The speed of this resistance spreading and the effect it will have on the future of medicine is determined by a range of factors, including how well current antibiotics are managed and the discovery of new anti-bacterial treatments, antibiotic or otherwise. While noticeable progress is being made across the world in implementing stewardship programs and other efforts to limit unnecessary use of antibiotics, the search for new antibiotic substances has proven less fruitful.³ The decline in antibiotic research outcomes has been a trend for several decades. While the period 1941 to 1960 saw nine new antibiotics classes (0.45 per year), 1961 to 1980 saw only two (0.1 per year).⁴ In recent years, several major initiatives have been launched to boost this research, yet results are so far sparse. As an example, the 6-year-old, €100 million EU project ENABLE count it as a substantial success to have helped bring one substance into clinical trials.^{5, 6}

At the same time as antibiotic research suffered from a lack of significant new discoveries, academic life went through extensive changes in the late 20th and early 21st century. Many authors have been critical of these changes, arguing that they challenge the core norms of science and make life more difficult for university researchers.⁷ This thesis studies if these changes may have contributed to the seeming inability of antibiotic research to come up with new breakthrough discoveries despite the increasing need for new antibacterial treatments.

This thesis will use several terms relating to the treatment of bacterial infection. To understand how these terms will be used, they will be defined below. In this thesis, antibiotics refers to chemical compounds used to treat bacterial infection, whether these are derived from biological or synthetic processes.⁸ Antibacterial treatments refers to a broader category of treatments for bacterial infections. These include, but are not limited to, phage, nano-, probiotic and chemical treatments. Antimicrobial treatments refers to treatments that are not necessarily directed at bacterial infections but may also

³ However, the development of unnecessary use is still far from under control and significant challenges remain in how to construct and implement stewardship programmes, as discussed by e.g. Bassetti, Giacobbe, Vena, & Brink 2019.

⁴ Conly & Johnston 2005, p. 159.

⁵ Innovative Medicines Initiative 2021a; 2021b.

⁶ EU: European Union; ENABLE: European Gram-negative Antibacterial Engine

⁷ See e.g. Hackett 1990; Hasselberg 2012; Mirowski 2011; Slaughter & Leslie 1997.

⁸ Historically, compounds derived from synthetic processes, such as arsphenamine, were treated as a different category from those derived from biological processes, such as penicillin. The former were labelled as chemotherapeutics, while the latter were known as antibiotics. However, as chemotherapy became associated with cancer treatments and antibiotics with the treatment of bacterial infections, it would be confusing for a modern audience to use the earlier distinction. Hence, these two categories have been grouped together under the term antibiotics.

be used to treat infections by other forms of microbes, such as fungi and parasites.⁹

Following on from this, the research of any of these areas refers to scientific activities that aim to discover new treatments within the related group of treatments. Antibacterial research, for example, refers to research that aim to discover new antibacterial treatment. Bacteriological research, on the other hand, refers to any research pertaining to bacteria, whether or not it is focused on discovering new treatments. This could, for example, include understanding the internal processes in bacteria, bacteria-host interactions or how bacteria communicate with each other. Furthermore, a term that will be used throughout this thesis is antibacterial-related research. In the context of this thesis, this means both antibacterial and bacteriological research, but excludes antimicrobial research that does not pertain to the treatment of bacterial infections.

When studying how scientific research conditions have changed over time, there's a need to acknowledge the particular circumstances facing any given field of study. For example, all research relating to bacteria must account for their biological properties, especially their ability to develop resistance to various treatments. It is also important to understand the economic models that made the antibacterial research field relatively unappealing for the pharmaceutical industry in the late 20th and early 21st century.¹⁰ In order to understand the particularities of antibacterial-related research and also provide an insight into how the early antibiotic substances were discovered, the following section will provide a brief outline of the history of antibiotics research.

The History of Antibiotics Research

Our current understanding of bacterial pathogens and ways to combat them is unparalleled in history. For much of human history, the understanding of infectious diseases was rudimentary and often extensively inaccurate, with treatments either inefficient or outright poisonous.¹¹ A major step in gaining a more correct understanding of these diseases was taken when Pasteur provided proof of the existence of bacteria, simultaneously disproving many of the

⁹ There exists a debate as to if viruses should be included under the umbrella term microbes, as they are not alive. Hence, they do not belong among the microscopic organisms from which the word microbes derive. As such, this thesis will only count treatments for viral infections as antimicrobial if they can also be used to address infections by proper microbes.

¹⁰ Plackett 2020.

¹¹ Frith 2012, pp. 52–53; Karamanou, Panayiotakopoulos, Tsoucalas, Kousoulis, & Androustos 2012.

inaccurate theories.¹² Once Pasteur had proven their existence, bacterial research started to take off, providing an academic field dedicated to the study of these microscopic pathogens.

In the latter half of the 19th century, the subject of bacteriology, as part of the wider field of microbiology, blossomed. Year after year, the library of bacteria and their associated diseases was expanded. Physicians like Semmelweis and Lister also studied the positive effects of hygiene, especially within clinical settings.¹³ While cures were still out of reach, preventive treatments were successively expanding. Before 1900, vaccines against both typhoid fever and cholera had been discovered.¹⁴ Meanwhile, pioneers like Robert Koch discovered new bacterial pathogens to human diseases and improved laboratory techniques.¹⁵

These advances in bacteriology would eventually lead to our current library of antibacterial substances. However, this process was initially neither straight nor fast. The first antibacterial substances to be used in medicine were limited in the infections they could treat and associated with major side-effects. Nevertheless, antibacterial substances existed, and before the advent of the widely known penicillin, arsphenamine and sulfonamide had been used for treatments for many years.

Arsphenamine, more commonly known as its trade name Salvarsan, was the first antibacterial compound to come out of a bacteriology lab. For several years, Paul Ehrlich's laboratory had been screening various chemicals for one that was effective against bacteria but non-toxic to humans - which he referred to as a 'magic bullet'.¹⁶ However, it was only when Sahachiro Hata, a Japanese exchange student, re-ran a number of earlier tests that he discovered the antibacterial properties of arsphenamine, then named compound 606 in accordance with its trial number. Though Hata had only been given the task of re-running tests in order for him to learn the method of chemical testing practised at the lab, he made a momentous discovery.¹⁷ Despite being active against only a narrow range of bacteria, inducing mild to severe side effects, having to be delivered intravenously and being logistically hard to handle due to its tendency to oxidise, arsphenamine became the standard treatment for syphilis.¹⁸ While not an optimal treatment, it showed that chemically derived compounds could be used against bacterial infections.

¹² However, the research that led Pasteur towards his discoveries was not focused on human diseases but rather about solving problems that affected the French wine industry.

¹³ Newsom 1993; 2003; 2006.

¹⁴ Plotkin 2014, p. 12284.

¹⁵ Blevins & Bronze 2010.

¹⁶ Parascandola 2001, p. 1.

¹⁷ Collard 1976, pp. 57–58.

¹⁸ Collard 1976, pp. 58–60; Yarnell 2005.

The next antibacterial substance to become widely used was the sulfonamides. These compounds were discovered in the early 1930's by Domagk, working for a laboratory associated with IG Farben AG¹⁹, a chemical company that focused on creating colours.²⁰ Compared to arsphenamine, this new substance was active against a comparatively large spectrum of bacteria. On top of this, it was also far less toxic to humans as well as easily manufactured in pill format, making it superior in almost all aspects.²¹ If penicillin had not come by relatively soon after its launch, sulfonamides would likely have been remembered as the first wide-spread, functional antibacterial substance.

When the sulphonamides were first sold for medical purposes, Alexander Fleming had already discovered penicillin. Still, it would take more than a decade from the discovery of this substance to its mass production as an antibacterial agent. Fleming discovered penicillin in 1928 through a set of rather unorthodox experiments involving contamination of bacterial plates. However, the long and chequered development process behind the drug shows that he did not carry the sole responsibility for the medical revolution caused by penicillin.

What Fleming was able to produce was a diluted liquid product filled with contaminants. As Payne would show, this 'mould juice' was only functional when an infection could be flushed with the substance, essentially limiting its use to eye infections.²² It would take until 1940 when Chain, working for Florey, was able to purify it into a concentrated product.²³ However, not even this was enough to transform the substance into a useful medical treatment, as the original production capabilities for the purified substance were so limited that only a handful of patients could be treated. Even then, a number of these patients died because they were not able to receive sufficient quantities of the substance. It was only with the help of the US Department of Agriculture²⁴ and their wartime industrial research branch that methods capable of sufficiently sized production were found.²⁵ Even so, it then required wartime cooperation with industry to scale up production to the point that the substance could be widely distributed.²⁶

Penicillin was superior to the previous antibacterial substances in several ways. Its effect was stronger and more reliable than the previous substances. As such, it for example replaced arsphenamine as the standard treatment for syphilis. It could also address new diseases, such as gonorrhoea, caused by

¹⁹ IG Farben AG: Interessengemeinschaft Farbenindustrie Aktiengesellschaft

²⁰ Grundmann 2004, pp. 41–50.

²¹ Marshall 1964, pp. 4–6; Zaffiri, Gardner, Toledo-Pereyra, & Toledo 2012, pp. 68–69.

²² Wainwright 1990, pp. 38–47.

²³ Wainwright 1990, pp. 50–59.

²⁴ US: United States

²⁵ Wainwright 1990, pp. 61–64.

²⁶ Ginsberg 2008; Wainwright 1990, pp. 60–73.

various gram-positive bacteria.^{27, 28} Even so, the effect of the discovery of penicillin was greatest on the methodology in antibacterial research. The previous compounds had been chemotherapeutic, meaning that they were made from synthetic, man-made chemicals. Penicillin was different as it was an antibiotic sourced from an existing organism, who had developed the substance in order to ward off bacteria from its territory. Proving that naturally occurring organisms could be explored for highly potent, non-toxic antibacterial substances, penicillin set off a boom era in the fight against bacterial infection. In the decades that followed, researchers from both academia and industry discovered a host of new classes of antibacterial agents through this method.

The first compound that followed penicillin was streptomycin, discovered by Waksman and Schatz. Waksman had been working on antagonistic organisms even before Fleming discovered penicillin, but intensified and systematised this research in the wake of hearing about the successes of the British researchers.²⁹ While penicillin deserves its reputation as initiator of the antibiotic research boom, streptomycin was, in both a medical and scientific sense, almost as important. Medically, it complemented penicillin in significant ways, both by addressing gram-negative bacteria, on which penicillin was largely useless, and by combatting tuberculosis, one of the most widespread and lethal bacterial infections of the time. Scientifically, it proved not only that penicillin wasn't a fluke and that organism antagonism was a reliable source of antibiotics, but also that fungi were not alone in producing useful antibacterial substances, as streptomycin was discovered from a bacterium.³⁰

After the war, the field of available antibacterial treatments expanded vastly. According to Conly and Johnston,³¹ ten new classes of antibiotics were introduced between 1949 and 1968.³² Gradually, the combined coverage of these substances against various bacterial infections increased. Some were found to be more efficient than others against certain pathogens and hence the specificity of treatments increased. The existence of several alternatives against a given bacterial infection enabled doctors to adapt treatments more to case-specific circumstances, such as severity of infection and allergic

²⁷ Marshall 1964, pp. 5–6.

²⁸ Gram-positive refers to the possibility to stain these bacteria with a specific chemical compound. Their counter-parts, gram-negative bacteria, possess an outer membrane that inhibits them from being stained by the compound.

²⁹ Wainwright 1990, p. 121.

³⁰ Wainwright 1990, pp. 121–122.

³¹ Conly & Johnston 2005, p. 159.

³² Unfortunately, introduction dates are often problematic, as they tend to conflate first instance of discovery, first synthesis of purified substance, regulatory approval for medical use and availability for use in medical treatments. As such, they are problematic when looking at individual substances. However, when observing trends among a group of substances they can be indicative.

reactions. Combination treatments could even be used to address the most persistent infections, such as severe cases of tuberculosis.³³ In addition, with different classes utilising different modes of action, the early cases of bacterial resistance against antibiotics could be treated by switching the substance used for one that worked in a different way.

During the boom years of antibiotics, there were many who argued that it was only a matter of time until bacterial infections, at least severe and life-threatening ones, would be a thing of the past.³⁴ However, towards the end of the 20th century, it had become clear that such a positive outlook was unwarranted. Instead, resistance against existing antibacterial substances was on the rise. At the same time, there was a decline in both the emergence of new compounds, especially those with novel mechanisms of action, and the research necessary to find these. This led to a fear that humanity was approaching a ‘post-antibiotics’ era.³⁵

The decline of antibiotics research started to be seen in the 1970’s. While industrial engagement in antibacterial research continued to increase during this decade, the dividend this research received in terms of new antibacterial compounds declined sharply. While the previous three decades had seen several new classes of antibacterial substances each, the rest of the 20th century saw none.³⁶ The first two decades of the 21st century saw some new antibiotics released, yet few were new classes of clinical significance, while the others were mainly derivatives of older compounds seeking to counter the growing resistance against these classes.³⁷ This led organisations such as WHO³⁸ to closely monitor the so-called antibiotics pipeline, seeing which substances were under development and what bacteria they were supposed to address.³⁹ This was often combined with projections of resistance development, in order to forewarn about upcoming shortages and show researchers where the most urgent need for new compounds could be found.⁴⁰

However, a look at the antibacterial research scene post 1970 would have shown that simply increasing the amount of research carried out was not a sure way to increase number of novel antibiotics. Rather, as noted above, while antibacterial research yielded fewer and fewer new substances, research efforts were initially increased. The number of major pharmaceutical companies engaged in antibacterial research only began to decline past the late 1980’s. However, after this, the decline was extensive. From 1997 to 2013, the number of experienced pharmaceutical companies engaged in antibacterial

³³ Wainwright 1990, pp. 137–139.

³⁴ Pier 2008.

³⁵ See. e.g. Alanis 2005; Kährström 2013.

³⁶ Conly & Johnston 2005, p. 156.

³⁷ Butler, Blaskovich, & Cooper 2017.

³⁸ WHO: World Health Organization

³⁹ Such as World Health Organization 2017.

⁴⁰ See e.g. Anderson et al. 2019; Folkhälsomyndigheten 2018; O’Niell 2014; OECD 2019.

research went down from 31 to 9.⁴¹ While some of this collapse could be attributed to mergers between companies, projected profitability was still the driver in determining which diseases pharmaceutical companies chose to engage in.⁴² Even though the period saw a rise in the number of small- and medium-sized companies, or SMEs, involved in antibacterial research, the potential for these SMEs to bring a compound from discovery to availability was highly limited.⁴³

At the same time as research into new antibiotics decreased, the bacterial fauna grew increasingly resistant to the available ones. Although the possibility of resistance development had been known to the early antibacterial researchers, including both Domagk⁴⁴ and Fleming⁴⁵, it was only towards the end of the 20th century that the issue of antibacterial resistance became widely acknowledged. In the beginning, it was mainly noticed as an increase in hard-to-treat hospital acquired infections, where hospitalised, often immunocompromised patients would be infected by resistant bacteria rare outside of healthcare settings.⁴⁶ However, within a few decades, the problem had spread into communities around the world and evaluations were made of the contemporary and future burden of resistant bacteria. One such study, the O'Neil Report, argued that, if the issue was not addressed successfully, the burden of resistant bacteria would come to dwarf any other single health care issue, in terms of both mortalities and costs, by 2050.⁴⁷ Unfortunately, while some scientists were driven to take up the pursuit of new antibacterial substances in order to help prevent the consequences of resistance development, the overall impact of resistance on antibacterial research, at least in the early 21st century, was negative. Since novel antibiotics needed to be saved for critical cases to limit resistance development towards them, pharmaceutical companies were likely to receive significantly less profit, if any, from developing these substances. This ensured their disinterest in such projects.⁴⁸

It is in the light of these developments that this thesis should be read. While the changes that universities went through in the late 20th and early 21st century influenced the whole range of academic subjects, it is in the effects on antibiotic development, and other major challenges of the current era such as climate change, that the consequences of these developments become most critical. It is the need for discoveries that can help deal with these challenges

⁴¹ Kinch, Patridge, Plummer, & Hoyer 2014, p. 1286.

⁴² Trouiller et al. 2002.

⁴³ Baraldi, Lindahl, Savic, Findlay, & Årdal 2018, p. 28.

⁴⁴ Domagk 1947.

⁴⁵ Fleming 1945.

⁴⁶ In many settings these resistant infections became synonymous hospital-acquired-infections. For example, in Sweden, these infections became known colloquially as 'Sjukhussjukan' (The Hospital Sickness)

⁴⁷ O'Niell 2014, p. 5.

⁴⁸ Outterson, Powers, Daniel, & McClellan 2015, pp. 278–279.

that most urgently calls us to understand how these changes in academia impacted researchers' ability to make new scientific discoveries.

Aims and Research Questions

This thesis aims to study how the changes in academia in the late 20th and early 21st century impacted university researchers' ability to make new scientific discoveries. In doing so, it is intent on adding to the literature that has studied these changes, contributing especially to the discussion on how these changes influenced research practises. In studying these practises, it also provides insights valuable for the broader study of Sociology of Science.

In choosing to study antibacterial-related research in particular, this thesis also aims to contribute to the understanding of an ongoing medical challenge. This is in recognition of how full comprehension of current trends require knowledge of their historical origins. Antibiotics as a case study also positions this thesis within the larger field of Science and Technology Studies, which studies the interaction between scientific and technological developments and societal processes.

The following research questions will be answered in pursuit of these aims:

RQ1) *How did the situation for Swedish academic researchers in the antibacterial field change during the period 1980-2015?*

RQ2) *How did these changes, or lack thereof, impact the ability of these researchers to make new scientific discoveries?*

Disposition

In order to provide the background, approach and sources used to analyse and answer the above research questions, this thesis is divided into nine chapters, including this introduction. Chapter 2 provides the theoretical underpinnings of the thesis, discussing how scientific discoveries are made and providing an analytical framework to study the situation for academic researchers. In Chapter 3, the methods used in the thesis are presented and discussed, including the particularities of Sweden as the case country.

Chapters 4, 5 and 6 contain the empirical material used to address the research questions. In Chapter 4, a study of the periodical Swedish research bills provides insights into the political context within which the changes to Swedish academia occurred. Chapter 5 then presents data on the funding of antibacterial-related research from the largest Swedish external grant provider. Following this, in Chapter 6, an interview study with researchers about their experiences of changes within academia provides an understanding

of these changes from the actors who are tasked with making scientific discoveries.

The final chapters 7, 8 and 9 are used to analyse, discuss and summarise the findings of the thesis. In Chapter 7, the empirical data is analysed in accordance with the analytical framework presented in Chapter 3. Chapter 8 discusses the findings of the study in relation to the aims of the study. Finally, Chapter 9 summarises the findings of the study and uses these findings to answer the research questions.

2. Theory

The decrease in the discovery of new classes of antibiotics coincided historically with significant changes in the conditions of academic researchers. From this follows the question if the discoveries made by academic researchers are dependent on the conditions they work under, and if so, how. To study this, there will first be a discussion of how discoveries are made. This discussion will focus on the concept of serendipity and how it highlights the debate on whether discoveries are made due to luck or due to the exceptional talent of the discoverers. Arguing that neither luck nor talent can fully explain discoveries, situation will be presented as a third explanatory factor, the one that this thesis will focus on.

Based on this, an analytical framework is presented in order to enable the situation of researchers to be studied. This framework is made up of six aspects, namely information, time, materials, labour, collaboration and freedom. Each aspect will be discussed in terms of their importance in research and how they will be operationalised in this thesis.

How are discoveries made?

The idea that scientific discoveries are something to be strived for is one that is almost universally accepted in current culture. However, there is far less agreement on how these discoveries are actually made. The following section will attempt to outline the current debate over this question and how it relates to the aims of this thesis. To do this, it will first provide a definition of scientific discoveries and discuss the implications of this definition.

There are many ways of, and some debates over, how to properly define a scientific discovery.⁴⁹ For the purpose of this thesis, four elements are important for something to be called a scientific discovery. First, for it to be a discovery, it must be previously unknown. In this context, it should be unknown not only to the discoverer but to the wider scientific community. Second, it needs to be true, at least as far as it can be verified. For it to be in a scientific context means that it can be supported by use of scientific methodology. Third, it needs to be pertaining to an area of knowledge that is relevant to scientific enquiries. Fourth, it needs to be communicated to the

⁴⁹ Schickore 2018.

scientific community in such a way that the knowledge can be spread throughout this community.

All of these four points are important. However, for this thesis, it is especially important to discuss the first point in further detail - that the discovery has to be unknown to the scientific community. Not everything that is unknown is equally unknown. A finding that, all by itself, gives rise to a new understanding of a subject - a paradigm shift in Kuhn's terms - is arguably highly unknown.⁵⁰ Correspondently, a finding that was fully predicted by an existing theory and where many similar findings have already been made is substantially less unknown. Hence, we ought to treat known and unknown not as a dichotomy, but as a spectrum.

The recognition that all scientific discoveries are, by necessity, unknown to some degree implies that there is also a degree of uncertainty as to the method by which to make these discoveries. For a more expected discovery, the theory which predicts them is likely to provide insights on how such a prediction can be tested. There might even be previous experiments or observations carried out on similar predictions. On the other end of the spectrum, a discovery that is completely unexpected given current theories is likely impossible to plan. This progression of difficulty with which a given discovery can be predicted indicates that the element of luck is increasingly important the more unknown the discovery is.

To understand this element of luck, and why some scientists might seem to have more of it than others, the term serendipity might be useful. It denotes specifically the luck of discovering something unexpected and stems from an 18th century novel about three princes who repeatedly discover things that they were not in search of while travelling the world.⁵¹ As outlined by Merton and Barber, in debates over how scientific discoveries are made, serendipity has become a central topic of discussion, especially if it is an attribute connected to certain individuals, or a marker of the unpredictable, of luck.⁵²

On one end of the serendipity debate are those who argue that serendipity is essentially an illusion. In this view, it is the talent of the discoverer that ought to be credited for the discovery, which only looks serendipitous to the outsider who is not privy to the full process that led to the discovery.⁵³ On the other end of the debate are those who argue that most discoveries, especially the most important ones, are mainly down to luck. In this view, scientists ought to give more emphasis to the unexpected and the element of chance when they retell the story of their discoveries.⁵⁴

The debate on serendipity and its place in scientific discovery has continued in the late 20th and early 21st century. Proponents of the two

⁵⁰ For an understanding of Kuhnian paradigm shifts see Kuhn 1962, pp. 66–91.

⁵¹ Merton & Barber 2004, p. 22.

⁵² Merton & Barber 2004, pp. 157–159.

⁵³ Merton & Barber 2004, pp. 164–171.

⁵⁴ Merton & Barber 2004, p. 161.

extremes still exist. Some, such as Ippoliti, maintain that serendipity is essentially an illusion or false narrative. Others, such as Kantorovich, holds that science is an inherently non-systematic endeavour that require serendipity to advance.⁵⁵ Others, such as Copeland, follow more moderate lines of thinking, understanding serendipity as both unexpected and, at the same time, dependent on the skills of the given researcher and the state of the scientific community in which they operate to gain its scientific relevance.⁵⁶

Still, whether tied to the extremes or searching for a middle ground, much of the serendipity debate continues to be centred around the great minds versus luck camps. What this thesis will do is rather to look at a third element, that of the situation of the discovery. Indeed, neither greatness of mind nor luck will matter much if the situation does not permit serendipity to occur. Locked in a barren prison cell, the chances of stumbling upon anything, let alone a scientific discovery, would be minimal, even for the greatest of minds.

Situation might be the key that bridges the gap between the attributes of the discoverer and the element of luck in scientific discovery. There are works on why certain environments, be they whole civilizations or individual institutions, have seen greater scientific progress than other environments. However, there is no unified framework for understanding which situations favour scientific discoveries for a given scientist or research group. Hence, in order to study the effect of the situation of researchers on their ability to make scientific discoveries, the following section will construct such an analytical framework.

Analytical Framework

Scientific research is not carried out within a vacuum. As discussed above, every discovery is made within a given situation by scientists who have access to given resources and who find themselves in particular circumstances. This section will outline the aspects this thesis will use to study the situation of university researchers working on antibacterial-related research in Sweden during 1980-2015.

However, before outlining these aspects, it is important to realise that the pursuit of new scientific knowledge is a rather recent development in the history of universities. For most of their existence, universities were semi-religious institutions focused on teaching the arts, theology and vocational knowledge.⁵⁷ It was only in the early 19th century that the science and humanities faculties at German universities started to demand contributions towards research within a given subject in order to view a person as fit for

⁵⁵ Ippoliti 2017; Kantorovich 2014.

⁵⁶ Copeland 2019.

⁵⁷ See Aszталos 1991; García Y García 1991; Leff 1991; North 1991; Siraisi 1991.

university employment.⁵⁸ This requirement for attested research achievements spread over the world, especially Europe and North America, in the following century. Gradually, academic employment came to be increasingly associated with research rather than teaching.⁵⁹ Hence, although many modern universities often view academic research as the main purpose of their existence, this emphasis on research over teaching is a recent development.⁶⁰

There has long existed debates about the appropriate conditions for academics active at universities.⁶¹ In recent decades, scholars have pointed out the importance of, for example, merit systems, job security, funding availability, mobility and relations between colleagues, as well as how these aspects interact in the academic environment.⁶² Based on findings from the previous research, the analytical framework for this study will be composed of six aspects. These aspects are information, time, materials, labour, collaboration and freedom.⁶³ The first four are resources that enable researchers to practise their craft while the latter two are circumstances that are important in shaping research practises. These aspects have been chosen because they are highly relevant for the ability of researchers to make discoveries. As such, in the discussion and operationalisation of them below, the focus will be on their relation to the ability to make scientific discoveries.

Information

In order to make progress in science, a researcher has to base their efforts on that which is already known. The sharing of information is integral to the values of the modern scientific community. Scientists are called upon to share their findings with the rest of the scientific community, no matter what those findings are. While a scientist might earn recognition for having made a discovery, they have no ownership of it in the sense that they can limit who gets access to the information or how it is utilised.⁶⁴ For whatever reason, be it profit, modesty or other concerns, secrecy about one's results or how one achieved them obstructs the proper functions of science.⁶⁵ In return for this willingness to share their research, the scientific community should validate,

⁵⁸ Turner 1971, pp. 137–139. Previously, having completed a given education was generally considered sufficient to be allowed to teach said course. If a member of faculty chose to research, they did so in accordance with their own proclivities, not because they had to do so.

⁵⁹ Axtell 2016, pp. 221–241.

⁶⁰ Especially those that style themselves research universities, rather than teaching universities.

⁶¹ Verger 1991, pp. 151–159.

⁶² Aboal & Tacsir 2017; Falavigna & Manello 2014; Hackett 1990; 2014; Hasselberg 2012, pp. 155–156, 182–183, 219–226; Horodnic & Zaiț 2015; Morichika & Shibayama 2015.

⁶³ It is important to understand that this is not an exhaustive list of possible aspects influencing the situation in which scientific discoveries are made. Instead, the reasons for including each of the six aspects are presented under the subheading of each aspect, and together they provide an extensive insight into the situation facing researchers.

⁶⁴ Merton 1973a, p. 273.

⁶⁵ Merton 1973a, p. 274.

or question, these findings without prejudice and based on structured principles.⁶⁶

Similarly, most theories of scientific advancement are based on the accumulation and improvement of scientific information. For example, Kuhn's theory of paradigm shifts is built around the idea that certain paradigms become dominant during given time periods in the history of science based on the information available to scientists at that time. It is only by the accumulation of scientific information that contradicts or is otherwise incompatible with the current paradigm that major shifts in understanding, so called paradigm shifts, can happen.⁶⁷

When discussing the impact of information on the scientific endeavour and the ability to make new discoveries, what must be realised is that it is not only a question about access to information but also about the quality of that information. It has been evident through history such as the problems of cross-block communication during the Cold War that limitations in access to information can impact the scientific endeavour.⁶⁸ Without access to up-to-date research from other researchers, the collective accumulation of knowledge is impeded and the researcher might conduct research on issue that have already been settled, or not get the inspiration necessary for taking their research in the most promising directions.

Low quality of information can also be an obstacle to the progression of science. Many have studied the effects of the mass publication trends that emerged during the 20th century and exacerbated by the digital publishing abilities of the 21st century. Not only have they found that the sheer number of articles make it hard for researchers to find the right information, but much of the information in those articles is faulty or outright false.⁶⁹ Trends such as a proliferation of low-quality journals and pay-to-publish further called the integrity of scientific publications into question.⁷⁰ This means that researchers have to spend increasing amounts of time collecting and processing information. Even so, they face an increasing risk of conducting research based on incorrect premises. This might in turn lead some researchers down flawed pathways, or make researchers hesitant to follow any research direction that is not already well-established within their fields for fear that they might be derived from faulty studies.

Since information has both access and quality concerns, it has to be operationalised in ways that can capture both of these. Access can largely be

⁶⁶ Merton 1973a, pp. 270–273, 277–278.

⁶⁷ Kuhn 1962, pp. 66–91.

⁶⁸ See e.g. Hollings 2016, pp. 55–68.

⁶⁹ For discussions on the need for reproducibility in science and examples of the situations in different disciplines, see Gilbert et al. 2012; Ioannidis 2005; Ioannidis, Stanley, & Doucouliagos 2017; Nosek et al. 2015.

⁷⁰ Bartholomew 2014; Nielsen & Davidson 2020; Sorokowski, Kulczycki, Sorokowska, & Pisanski 2017.

studied through the university libraries and the coverage of their collections. However, we must also see if there are other ways in which access might be restricted from scientists, a knowledge that could most accurately be gained by the scientists themselves. When it comes to the quality of information, there are, as stated, a number of previous studies on this but to put these studies into context requires information from scientists on both the issues facing them in their particular field and the extent to which it influences their research.

Time

At a fundamental level, the need for time is obvious. Various research activities take time, and the more that is available, the more research can be conducted. However, previous research has shown that there are two features of time that determine how it impacts academic researchers.

The first important feature of time for academic researchers is that significant parts of their time is spent on other tasks than research. A major part of these tasks revolves around students in the form of either teaching or supervising. However, there are also many other types of tasks that take up scientists' time - from administrative work to funding applications.⁷¹

The other important aspect of time is longevity, specifically employment longevity or job security. In recent decades, longevity in research has declined. There is a proliferation of short-term jobs and other forms of insecure employment terms and a corresponding relative decline in secure, tenured positions.⁷² Research can only be planned for as long as the researcher is reasonably sure of their employment, forcing scientists to limit their research if they face low job security. This issue is further compounded if their future employment is depending on their current research performance. In this case, the research does not only have to fit the time frame of current employment but also produce results that can be used as merits for future employment.⁷³

While both of these aspects of time are important, longevity is likely to be more influential on the ability to make worthwhile scientific discoveries. As stated, research must be fitted within the time that the researcher can reasonably expect to be able to conduct it. So, if one research direction favours shorter studies while another longer ones, the former is more likely to be the chosen path even if the latter would be held by the researcher as more likely to lead to new discoveries.⁷⁴ Longevity would also be the major factor in determining how deep the researcher can go in their pursuits. Thinner, easier

⁷¹ See e.g. Gross & Bergstrom 2019.

⁷² See e.g. Ivancheva 2015; Morgan & Wood 2017.

⁷³ See the differentiation between timeless time and contracted time in Ylijoki & Mäntylä 2003, pp. 62–67.

⁷⁴ Also, shorted timeframes lend themselves towards the projectification of science, of dividing scientific pursuit into short, modular and clearly demarked projects rather than long, with consequences that are elaborated more in Ylijoki 2016.

studies would be quicker and hence more feasible than more substantial ones.⁷⁵ However, available time for research might be compensated with increased labour resources. At the same time, such a solution would limit any potential effect of the talent argued for by some in the serendipity debate, as will be discussed further below.

Within this thesis, time is primarily dealt with through the lens of the individual scientists. This means that, rather than estimating the total time available for researchers within academic antibacterial-related research, the availability and longevity of time will be estimated on the level of the individual. The proportions of research time within an employment, contract lengths and job security will be important factors to study.

Materials

In order to conduct research, a scientist needs a place to do it, some equipment to do it with and some supplies to use for it. For antibiotics research, most of these material requirements centre around laboratories, reagents and equipment. From the rudimentary beginnings of bacterial research laboratories in the 19th century, these laboratories have become increasingly sophisticated and hence increasingly costly to set up and maintain.⁷⁶

It is almost inevitable that material circumstances will have an influence on what scientific discoveries can, and can not, be made. In order to be able to conduct any research, the researcher needs adequate equipment to run experiments, conduct observations and/or analyse the data gathered. Hence, if the material circumstances permit one line of research and not another, the researcher can only pursue the former. Even the relative ease with which materials for various research paths can be obtained will influence the choices of researchers.

Similarly, researchers can only delve as deep into a topic as their equipment permits. If the equipment needed to go deeper into a subject is not accessible, either via purchases or collaborations, any discovery that would have depended on this increased depth will not be made. Neither luck nor intellectual ability can act on data that isn't available.

Material resources must always be seen in relation to the requirements of the particular research. Hence, the average levels of material resources available to a given researcher does not necessarily reflect how well the resources align with the need of the scientists. Instead, a better way to study the availability of material resources is to investigate if scientists face difficulties in conducting their research based on material limitations.

⁷⁵ 'Thin' in this context means small and insubstantial.

⁷⁶ See e.g. Hasselberg 2012, pp. 223, 250; Miller et al. 2019; Schmidgen 2011; Stephan 2012, pp. 82–87.

Labour

Scientific research requires human effort, often a significant amount of it. Apart from the data gathering, there are planning, analysis and communication tasks necessary to conduct scientific research. In line with the traditions and demands of university employment, teaching is also part of the tasks required of many academic researchers, as well as other 'services to the profession' such as reviewing the works of others and organising departmental life. Researchers are also often burdened by non-academic administrative duties as part of their employments.

When discussing labour in research, it is important to note that not all labour is equal in terms of that which it can produce, as explored for example in the literature on human capital. Hence, labour should not be discussed solely in terms of how much of it is available. As the proponents of scientific serendipity being talent-driven point towards, it is just as important, if not more so, who it is that conducts the research. For example, on average, any part of the research carried out by a senior, more experienced researcher is likely to be of a higher level than parts carried out by junior scientists, who are still learning the fundamentals of research. Additionally, instead of being distracted by multiple projects or other tasks, the degree to which researchers can focus on a given research project is likely to influence their ability and willingness to explore that research in depth.

At the same time, it would be neglectful not to recognise that the ability to make scientific discoveries is also dependent on the amount of labour available and their specialisations. Research fields differ substantially in both the amount of labour needed to gain results and in their need for various specialisations in that labour force. Hence, the ease of employing staff and the specialisations available in the pool of potential employees will impact the possibilities of conducting research in a given field, and thus how likely it is for new discoveries to be made.

This thesis will look briefly at the overall number of researchers in the antibacterial-related fields. However, the main focus will be to see how much attention the academic employees can direct towards research, as well as who performs the actual research.⁷⁷ It will also inquire if research careers are indeed open to anyone with the right competency or if there are direct or indirect barriers to academic employment.⁷⁸

⁷⁷ In relation to attention and the performance of research, the labour and time aspects partially overlap as time constraints influences both of these factors. However, labour deals with the overall division of labour within a research group, where tasks can be divided between members according to their availability. Time focuses on the individual researcher.

⁷⁸ See for example Merton 1973a, p. 272.

Collaboration

As noted earlier in this chapter, science is a collaborative endeavour. Scientists are dependent on one another for a range of functions. These include collaborations in specific research endeavours, sharing of various resources as well as critical scrutiny and reflections.

The ability to form and utilise collaborations are hugely important in many research endeavours and hence for the ability to make new discoveries within them. On the smaller scale, the availability of people to collaborate within a given field or a specific topic can make or break the possibilities to pursue a given research project in that field or on that topic. This is especially true if you as a researcher lack a particular equipment or expertise needed to carry out a particular line of research. On the larger scale, the overall structure of academic science, with departments, journals, grants and so on, divided into certain fields, make it easier to pursue research that aligns with those fields, where established infrastructures already exist to facilitate research.

However, collaborations are not only there to provide resources necessary for making scientific discoveries. Academic researchers are also there to uphold each other's standards and challenge each other to improve scientific practises. Even if we would allow that the serendipity of discovery is largely up to the talent of the researcher in question, as some would argue, the discoverer still needs other scientists to confirm the accuracy of the discoveries and to verify its value as a discovery. Indeed, many of the functions of academic collaboration, such as critical review and reflections, are specifically designed to ensure proper methodological procedures and careful reflections on the implications of new results. Therefore, they are often seen as the fundamental safeguards of scientific progress.

For the thesis, collaboration will be seen from the view of the scientists. Since different fields have different collaborative traditions, it is impossible to impose a fixed standard for collaboration. Instead, it is best understood from the opportunities for, and limitations to, collaborations that the researchers face. Impacts on this can be seen through developments such as how increased competition for publications have caused hesitancy about collaborations for fear of having your work stolen.⁷⁹

Freedom

Freedom is a broad term that can be used to describe a host of various conditions. Here, within this thesis, freedom for an academic researcher denotes two things. First, it is the ability to choose the subjects and methods of their research. Second, it's the ability to make changes to the research process along the way, as the researcher sees fit.

⁷⁹ Laine 2017, p. 1.

Many have noted that researchers had to have freedom in order for the proper conduct of science. Merton, for example, wrote about how the scientists in Nazi Germany had to play into the overarching political narrative of the government, for whom science existed only as a product of the political sphere.⁸⁰ Such limitations on the ability to choose subjects and methods interfered with the due process and meant that science could only progress within a limited number of fields and along a limited number of approved paths.

While much focus in the debate about academic freedom has been focused on the ability of researchers to initiate any research they see fit, it must also deal with the ability to make changes to the research along the way. Although planning is important in research, excessive planning compromises the ability of a scientist to fully utilise the potential of a study. Since science is ultimately about gaining insights into the previously unknown, and planning is always made in accordance with what is previously known, the scientific process can lead to situations where a scientist has to adapt in accordance with the results they receive. The more rigid the structures within which the research are, the less freedom the scientist has, leading to a decreased ability to adapt a given study to the actual results found.

Whether one leans towards that scientific discoveries are more based on the ability of the researcher or the influence of luck, freedom is central for discoveries to be made.⁸¹ With freedom, the researcher can choose to conduct research along what they see as the pathways with the most potential. The researcher can also make use of any lucky find along the way. However, without freedom, the researcher is fixed to a certain research direction, even if they know beforehand or discover along the way that that path is unlikely to be fruitful. Also, almost per definition, the deeper one wants to delve into the unknown aspects of a given topic, the harder it is to fully plan that research ahead of time. Whether they are made by luck or astute observation, or both, if the researcher does not have the freedom to learn from discoveries along the way, the research is bound to remain shallow.

To study the freedom of researchers, it is important to look at if there are any structural elements that limit this freedom. Importantly, this means that freedom, as defined here, is an inherent trait of research and it is factors external to the research that limit it. Such factors can both be firm, such as bans or commands, or loose, such as incentives in one direction or another.

⁸⁰ Merton 1973b, pp. 257–260.

⁸¹ Merton & Barber 2004, pp. 195–199.

3. Methodology

In order to understand how the changes within academia in Sweden during the late 20th and early 21st century influenced the ability of university-based researchers within the antibacterial-related fields to make new scientific discoveries, this thesis will look at the situation of these researchers using the analytical framework presented in the previous chapter. However, to use this framework, it has to be applied on relevant empirical data. To this end, this chapter will present and discuss the three empirical studies that this thesis is based upon. While outlining details necessary to understand how the studies were conducted as well as details necessary to assess their reliability and validity, the discussion will focus on what each study contributes to the overall composition of the thesis.

The first study that will be presented is a policy study, which presents findings from the 12 Swedish research bills introduced between 1975-2012. This study aims to examine the political discourse and acts underlying the changes to academia in this period. The second study is a funding study, which looks at funding data from Medicinska Forskningsrådet (MFR) and Vetenskapsrådet (VR). These are the two funding bodies providing the most funding to Swedish medical research in the periods 1980-1990 and 2005-2015 respectively. This study aims to examine the development in how much funding that was provided, both in total and per project, as well as how likely a given project was to be funded. The third study is an interview study with 22 Swedish researchers active within antibacterial-related research at various points between 1980 and 2015. This study aims to understand which changes in academia they perceived as most influential during the late 20th and early 21st century as well as how these changes affected them. Finally, there will be a presentation of recent Swedish university history and a discussion on how this thesis uses Swedish academia as a case study environment.

Policy Study

Research and politics have long been connected in a host of various ways.⁸² This is all the more true in a country such as modern era Sweden, where most

⁸² For examples of such connections, see e.g. Ahlbäck Öberg & Sundberg 2016; Merton 1973b; Mirowski 2011.

universities are state agencies and academic research receives much of its funds from government sources. As such, it is important to examine the policies that might cause, or interfere with, changes within academia.

While there were numerous bills, budgets and other expressions of political will or action that could have been chosen for this study, this thesis chose to examine the Swedish research bills that have been continuously introduced by consecutive Swedish governments since 1975. Because they constituted regular and fairly comparable documents throughout the period, they could be compared over time. They also include both discussions of how the government views research and the research policies they wish to enact. As such, it can provide a contrast between discourse and actions. At the same time, it is important to remember that these bills do not constitute an exhaustive source for all Swedish research policies.

The research bills are extensive documents, most of them several hundred pages each. As all this content could not be presented in the study, the bills were read through the lens of the analytical framework in order to understand which parts were most relevant. Although the framework was used to guide the reading, it is important to remember that the findings presented from this study are dependent on a subjective understanding of the interaction between research policy and the aspects of the framework. Hence, another reading of the same bills, even one that was also guided by the same framework, might produce other findings than presented by this study.

This study should be seen as providing context for the subsequent studies of this thesis since both research funding and the lived experiences of the researchers are influenced by political decisions. However, this is not to say that the political sphere is all-powerful in this context. While the government, either directly or through various agencies, was the main provider of research funding in Sweden during this period, private funding also played a major role. Likewise, though political decisions had significant influence on the lived experiences of university scientists, the academic sphere had its own internal dynamics and changes that influenced the situation for these researchers.

Funding Study

Without funding, any research grinds to a halt as materials and labour become unavailable. As such, those who fund research are not only showing their favour by their selection, but their choices directly impact which research gets carried out and which research does not. As such, it is paramount to study funding in order to create an understanding of any research scene. Due to this necessity for funding, by following the money, one can also obtain an overview of the researchers active in a given research scene. In the case of this

thesis, such an overview was crucial in order to construct the subsequent interview study with researchers.

The choice of using the MFR and VR archives to comprehend and gain an overview of the Swedish antibacterial-related research community was based on two primary factors. The first is that these two agencies were the largest providers of research grants to the medical sciences during their respective time periods.⁸³ This means that they are likely to have had the most grant applicants for any given agency, allowing for a good overview of the researchers active in the field. In addition, it also means that the grants provided by them are the most consequential for the scientific community, both because of the amount of funding provided and because their dominant position made them a reference point which other agencies needed to take into consideration when making their funding decisions. The second reason was that both MFR and VR are covered by the so called *offentlighetsprincip*, the principle of public access, making access to their records a public right, something not necessarily true for non-public research grant providers.

In the 1980's, MFR, a government operated agency run by a subset of academic peer committees, was the main source of external funding for university-based medical research in Sweden. In 2000, MFR along with its counterparts in Humanistisk-samhällsvetenskapliga Forskningsrådet, Naturvetenskapliga Forskningsrådet and Teknikvetenskapliga Forskningsrådet were reorganised into VR. Though this caused some organisational changes, the basic functions remained the same as the previously independent agencies became substructures of the new organisation and still distributed research grants according to their previous disciplinary boundaries.

While both MFR and later VR provided grants for a variety of causes, including for travels and the enrolment of PhD⁸⁴ students, this study focused on the grants directed towards research projects. Not only did these project grants constitute the bulk of money provided by the agencies,⁸⁵ they were also the ones which most clearly articulated the research topic that the grant was intended to support. Note, however, that the study also includes *rambidrag*, framework grants, and *rådsprofessorsbidrag*, council professor grants, during the 2005-2015 period, grants not available in the 1980's. These grant-types represented pooled project funding that could be used by groups of researchers to run several parallel projects under a common theme.⁸⁶

The MFR/VR data was organised into physical (MFR) and digital (VR) ledgers. They had to be digitalised (MFR) and cleaned (VR). From both

⁸³ See e.g. Uppsala University 2006, p. 51; 2011, p. 53.

⁸⁴ PhD: Doctor of Philosophy

⁸⁵ Other grants, such as those for equipment, travel or PhD student reimbursements, each represented sums of about one order of magnitude or so less than the sum of the project grants.

⁸⁶ However, further research is required to determine why these are essentially only visible in the material during 2013-2014.

ledgers, the title of each project was manually categorised in order to sort the antibacterial-related research from the non-related research, as well as to distinguish the specifically antibiotic-related projects from the other antibacterial-related ones.⁸⁷ The projects that were not related to bacterial research were then excluded from the sample, except in calculations of total grant sums and application success rates. After this, the following factors were selected from the ledgers: Name of applying researcher, project title, researcher's academic position⁸⁸, researcher's location (1980's) or university (2005-2015), decision (accepted or rejected), grant sum (if accepted), application sum (if rejected). To these were added the deduced variables of antibiotic-related (yes or no), solution-focused (yes or no)⁸⁹ and researcher's gender⁹⁰. In order to understand the relations between these variables, the processed data was then analysed using linear regression analysis (continuous outcome variables) and logistic regression (binary outcome variables). The underlying logic of each specific regression will be presented in connection with the analysis of that particular data. However, in general, either the decision or the grant sum and/or application sum were used as dependent variables, while the others were used as independent variables.⁹¹ The general logic for this was that the latter variables were known to MFR/VR before the funding decision was made. Hence, they could potentially have affected the decision, while the decision could not influence them.

The use of the MFR/VR project funding served several purposes for the study. As discussed earlier, the dominant size of these institutions among Swedish research granting bodies means that it is likely that most researchers would apply for funding from them. This means that the applications to

⁸⁷ The total number of project grant applications were 10184 during the MFR period and 14492 for the VR period. Out of these, 685 and 922 respectively were found to concern antibacterial-related topics.

⁸⁸ Available for the whole period 1980-1990 but only parts of the 2005-2015 period.

⁸⁹ This was deduced according to the question 'Does the project title indicate that the results of the project are to be of use for solving a treatment-related problem?'. While there were formal indicators of the answer to this question in the titles, such as if they mentioned a particular infection or set of infections, if they stated a treatment-related problem or if they included references to clinical utility, the judgement of the answer was ultimately subjective. Also, it is likely that several of the projects that did not show in the title the intent of being solution-oriented still contained such intentions. Hence, this variable should be regarded as an indicator rather than an absolute truth regarding the aim of a given project.

⁹⁰ Not available in the records. Instead, this was deduced from the name of the researcher and left blank when the name did not provide reliable gender indication. Hence, the gender variable is a name-based, perceived gender rather than self-identified gender. This method of deduction, although assisted by various online name databases, is subjective and hence likely contains inaccuracies.

⁹¹ The dependent variable is the one which is to be explained, while the independent variable is the one that is used to explain.

MFR/VR should give a fair reflection of who was engaged in antibacterial-related research during the two periods, as well as provide a reflection of the research topics they aimed to pursue. Furthermore, since the funding decisions were made by senior researchers in the various fields, comparisons between those projects that received funding and those that were rejected can provide insights into what is considered priority-research within the given field. Finally, the funds provided, both in their quantity and distribution, give information about the monetary resources available to a field, how these are distributed as well as how likely it was for any given application to be accepted.

While there are substantial advantages to the MFR/VR data, there are clear limitations to it as well. The most obvious of these is the shallow level of information they contain. While all the variables that were extracted were useful, they only provide limited information about each application. All the deduced variables, many of which are key to the usefulness of the data to the study, have been surmised on limited information. This had been less of a problem had the councils themselves based their decisions on the same information. However, they would have considered the entire application material, including research plans, budgets and the like. This means that there is a lot of information from which the original grant decision would have been made that are not available in the data. Given the limited size of the Swedish research community, informal connections would have existed that might have provided a positive network effect to certain applicants.⁹² While the negative effects of this unknown information can be somewhat mitigated by the rule of numbers, assuming that variation in these unknown variables are spread equally between observations, it still means that there is a risk that the analysis captures trends that are hidden from the data.

A second limitation of the data is the hidden interactivity between researchers and the councils. It is likely that researchers, through their own and other's experience, have insights into the decision making of the councils, and hence will tailor their applications accordingly, i.e. they would write what the councils want to read. This would not be as much of a problem had it not been for the principle of academic freedom, which means that once a researcher has been given money (s)he can do whatever they please with that money.⁹³ Hence, we cannot be fully certain that the research titles provided in the application are good matches to the research actually carried out with that funding. Likewise, we can only study the actions of the councils in relation to the applications they receive. The councils' actions must therefore be regarded as reactive to the choices available to them, rather than reflect a true intention

⁹² Such an effect was confirmed for MFR by Wennerås & Wold 1997.

⁹³ However, as discussed elsewhere in the thesis (see especially the interview study) this became less of a problem towards the end of the period, as increased follow-up of project spending and research deadlines was required.

in relation to a supposed ideal scenario. Hence, we are limited in the conclusions we can draw to the research topics available in the applications that are in sufficient quantities to make statistical inferences from.

When understanding an academic research system, funding occupies a form of middle position. It is determined by whoever supplies the funds, in this case the Swedish government. In turn, this funding is one of the most important aspects determining the situation facing researchers. As such, it is one of the key ways in which science policy is implemented. As such, this funding study is of extensive importance to understanding not only the changing situation of the academic researchers but also the underlying cause of these changes. However, it is also important to realise that while the study is informative, it does not provide an all-encompassing view of the funding available to researchers. Even though MFR/VR were the leading funders of medical research in their respective periods, there were other agencies available for researchers to seek funding from, both governmental and private.

Interview Study

The policy and funding studies produced a partial overview of the political context, size, location, interests and funding of the Swedish antibacterial-related research community 1980-2015. However, for a more complete understanding of the situation facing this research, the thesis required more in-depth enquiry into the conditions facing this community. To obtain this, an interview study with researchers from the community was conducted.

The list of researchers gained from the study of the MFR/VR records was used to select interviewees. Researchers who had been awarded funding for antibacterial-related research projects in either of these two periods were included in the interviewee sample. The sample was then further narrowed to interviewees from two universities, Uppsala and Lund. This limitation was made in order to shrink the sample size of the pool of interviewees to one manageable within the resources of this study. Uppsala and Lund were chosen for three reasons. First, they both had sizable numbers of antibacterial researchers in each of the two periods. Second, they are comparable in terms of a range of factors such as size, governance structures, prestige and age.⁹⁴ Third, the use of clusters improved the capacity to conduct multiple interviews within limited time and distance frames.⁹⁵ However, their similarities must also be recognised as a weakness of the study, as it limits the generalisability of the results to other forms of universities. In relation to the Swedish context,

⁹⁴ Similarity was judged as more important than diversity in this case, increasing the precision of the study at the expense of its generalisability.

⁹⁵ In practise, this advantage came to be less valuable than first anticipated, due to the changes required by the Covid-19 epidemic.

this is most crucial when relating to the earlier period of the study because the differences between different university contexts decreased over time.⁹⁶

The interviews themselves were conducted in a semi-structured manner, based on an interview guide coupled with follow-up questions derived from the answers given by the interviewees.⁹⁷ The questions in the guide were focused on three areas. The first was about aspects inside of academia and their research, such as how their career in academia got started, the labour and material resources they had access to, the research projects they had conducted and the collaborations they had had with other researchers. The second area was funding, with questions about what funding had been most important to them, how much time they spent applying for funds and if funding concerns influenced their choice of research topics. The third area concerned factors outside of academia, such as industrial collaborations, their establishment and importance for their research. Towards the end of the interview, the interviewees were also invited to discuss anything else they considered important for the topic at hand through a number of open-ended questions.

To encourage truthfulness in the interviews, especially as some of the questions related to possibly sensitive workplace issues, anonymity was granted to the interviewees. To increase the convenience for the interviewees, the interviews could be carried out either in person, over the phone or via the internet.⁹⁸ The records of the interviews were then transcribed. Where direct quotes from the interviewees were used in the results, the given interviewee was then asked if the utilised quotes were correct, in order to avoid misquotations.

The main reason to use interviews of researchers as a source of information was that a substantial amount of knowledge of high relevance for this study is unlikely to have been written down, especially in the kinds of documents available in public archives. This includes information on social relations and practises, experiences that were taken for granted at the time and reasoning concerning alternatives and 'paths not taken'. Interviews with relevant researchers were hence required, as they had lived experiences of this information.⁹⁹

However, these interviews had clear limitations. One general limitation of interviews concerns the accuracy of memory. As showed in several studies, the human mind is imperfect at storing information, and its recollection of

⁹⁶ This decrease in differences between universities was driven by many of the policies outlined below in 'The Case of Sweden'.

⁹⁷ See Appendix 1 for the interview guide (In Swedish, as the interviews were generally carried out in Swedish).

⁹⁸ At first, this choice of interview method was arranged as a convenience for the interviewees. Later on, due to the Covid-19 epidemic, phone and internet interviews became the only viable alternatives, as the ability to travel and meet in person was severely limited.

⁹⁹ For a more substantial discussion on the need for understanding the lived experiences of people working in a given field, as well as the imperative to let these individuals' voices be heard, see Isacson 1987, pp. 22–23.

memories can be influenced by factors such as time, emotions and subsequent events.¹⁰⁰ There is also the risk that people either deliberately or subconsciously portray themselves in a better light than warranted.¹⁰¹ This is something that has to be accounted for in the analysis.

On a more practical level, the main problematic aspect of this particular interview study concerns the interviewee participation. Especially for the researchers active during the 1980-1990 period, there proved to be practical obstacles in obtaining interviews. Some of these researchers had died already by the time of the interviews. Others could not be confirmed dead but were otherwise hard to trace or unable to be contacted, as their connection with the university was no longer active. This meant that there was a selection bias in this older group towards those researchers who were relatively younger during the initial time period, as these were more likely to be alive and still connected to the university. As such, the researchers actually interviewed constitute a narrower sample than the original sample would suggest.¹⁰²

Case Study: Sweden

Sweden was chosen as the case on which this thesis focuses. Focusing on a single country was necessary in order to achieve the level of depth required for this kind of study, given the resources available. The main reason for choosing Sweden in particular were practical, as it enabled proximity and availability of sources, combined with linguistic accessibility. Also, the relative lack of similar studies on the Swedish context made Sweden of particular interest to study.

Using a single country to study what is in essence a global challenge is obviously problematic, as it limits the generalisability of the results. However, this limitation should not be exaggerated. Studies by for example Schulze-Cleven and Olson have indicated that while each country and higher educational system retains their own characteristics, there is a global convergence of the conditions within academic research.¹⁰³ Hence, as long as the specific circumstances in a given country are recognised and taken into account, lessons learnt from one system can be cautiously applied to others.

In order to understand how the use of Sweden as a case study influences the generalisations that can be drawn, an overview of the historically situated characteristics of academic research in Sweden is in order. The Swedish government traditionally had extensive influence over the Swedish

¹⁰⁰ See e.g. Schacter 1995; Schmolck, Buffalo, & Squire 2000.

¹⁰¹ Heine, Markus, Lehman, & Kitayana 1999.

¹⁰² The participation among the interviewees was also influenced by the Covid-19 epidemic, with some potential interviewees gaining increased work burdens while others were affected medically.

¹⁰³ Schulze-Cleven & Olson 2017.

universities, both in their funding and organisation. For the time-period relevant to this thesis, almost all higher educational organisations in Sweden were state agencies, with a few noticeable exceptions.¹⁰⁴ This, for example, meant that all university employees were state employees. The government also controlled the funding of the universities, especially on the educational side, both through the provision of funding and through limitations in what non-governmental funding that could be accepted. In addition, the universities answered to a governmental agency, Universitetskanslersämbetet,¹⁰⁵ to ensure their compliance with various regulations, for example concerning employee recruitment.

Possibly the most fundamental change that occurred within Swedish academia during the 20th century was the rise of mass education. Like in many other parts of the world,¹⁰⁶ Sweden saw an extensive expansion of the higher educational sector, both with the rise of new academic institutions and the expansion of existing universities. There was roughly a ten-fold increase in higher education attendance in Sweden between the early and late 1900's.¹⁰⁷ On an organisational level, this expansion led to a wider, thinner spread of resources from a few central universities to a much more geographically diverse set of minor universities.¹⁰⁸ On a more societal level, it expanded both the pool of individuals who were university-educated and the number of researchers in society, thereby decreasing the social status of these attributes.¹⁰⁹

At the same time as the Swedish university sector expands, so does the internal administration within the universities. Stig Strömholm, rector at Uppsala University 1989-1997, attributed this increase both to a natural reaction to enlarged organisational structures and to new tasks put on the administration.¹¹⁰ On the one hand, as organisations expand, the organisational, and sometimes even physical, distance between individuals in various positions increases, necessitating more in-between employees to facilitate interactions. On the other hand, throughout the decades, there were more and more tasks put on the administration of the universities, from internal human relations to establishing links with the external society.

One of the sets of tasks that expanded greatly over the period is in managerial accounting, or the use of accounting information to govern and control the various parts of university structures. An important part in the establishment of these accounting practises was to introduce strict transfer

¹⁰⁴ See e.g. Sadurskis 2008.

¹⁰⁵ Previous iterations of bodies with similar functions include Högskoleverket and Universitets- och högskoleämbetet.

¹⁰⁶ Schofer & Meyer 2016.

¹⁰⁷ Strömholm 1994, pp. 24–25; Trow 1973, p. 5.

¹⁰⁸ Benner 2009, pp. 113–168.

¹⁰⁹ Strömholm 1994, pp. 31–35.

¹¹⁰ Strömholm 1994, pp. 59–63, 69–70.

pricing schemes. Instead of using common pools of resources, every resource within the university system was to be handled as a commodity and bought, or sold, internally by the various university actors. So, for example, instead of assigning a department a number of rooms, laboratories and so on to house their activities in, the university would put a rent price on their rooms and rent it out to the departments, whom would in turn rent them out to individual researchers. This managerial accounting development was part of a larger development within Swedish state administration, seen most markedly in the 1993 financial statement bill.¹¹¹

Another administrative task that expanded within Swedish government agencies, including universities, during the end of the 20th and beginning of the 21st century was that of evaluation. As Premfors wrote, “evaluation is for the 1980’s what planning was for the 1960’s”.¹¹² Although this quote was not specifically directed at academic research, but about government agencies in general, the sentiment was echoed even in works that pertained more directly to academic research.¹¹³ The research reforms of the late 1970’s had provided the framework for this increased evaluative activity.¹¹⁴ Politicians and other decision makers wanted increasing information about the performances of the agencies they were set to govern, including both the education provided by and research conducted at universities. In the decades that followed, the technocratic and bureaucratic underpinnings of the solidifying “audit society” were erected within the Swedish university administrations.¹¹⁵ According to Rider, as measurement techniques became increasingly refined over this period, the measurements themselves grew more important than the values they were supposed to measure.¹¹⁶

This increased administration required increasingly more funds to operate. At the same time, direct governmental support for the universities decreased towards the end of the 20th century in favour of governmental and non-governmental research grant providers. Therefore, in the 1980’s, many universities introduced overhead or indirect costs. These are fees that the universities applied to incoming grants and other external funding in order to cover the added administrative costs associated with them. By the 1990’s, it became Swedish law that external funds granted to universities should provide ‘full cost reimbursement’¹¹⁷, which came to be interpreted not as a marginal increase for added costs but as paying for a share of the full administrative costs of the universities corresponding to the size of the grant provided. At

¹¹¹ See e.g. Sundström 2003, pp. 276–279.

¹¹² Original Swedish: “*Utvärdering är för 1980-talet vad planering var för 1960-talet*”. Premfors 1987, p. 257.

¹¹³ Sandström 1994, pp. 239–242; Ståhle 1992, pp. 25–26.

¹¹⁴ Premfors 1987, pp. 261, 267.

¹¹⁵ Widmalm 2013, pp. 39–41.

¹¹⁶ Rider 2013, p. 172.

¹¹⁷ Original Swedish: *Full kostnadstäckning*

first, this was set as a template percentage fee, beginning at 12% and rising to 35%.¹¹⁸ In the early 21st century, this was amended so that each university, and each department at those universities, had to set their own percentage levels based on their specific expenses.

Beside the need to afford the expanding administration, another reason that the Swedish universities needed to increase their income streams through this ‘taxation’ of external income sources was the real-term decreases in funding provided by the Swedish government. As Sundqvist notes, the ‘wages and price adjustment’¹¹⁹ index applied to calculate how the year-on-year funding of universities should be adjusted did not keep up with inflation.¹²⁰ For example, the index led to compensations for the wage increases of lecturers that were less than half of their actual increases.¹²¹ This, together with the increased importance of external funding, led to a situation where the universities were significantly less in control of their own circumstance and more reliant on external actors.

Regarding external actors, an ongoing debate during the period was over how universities should relate to industry and wider societal interests. During the 1980’s and 90’s, the old ‘sector research’, which had been set up to support the various sectors of society with research resources, was brought closer to basic research by demanding it to go through the same peer review processes and bringing it into similar organisational structures as basic research.¹²² However, in the late 1990’ and early 2000’s, with the establishment of Vinnova and other applied science funders and initiative, the pressure for universities to cooperate with external actors grew. Some voices came to be raised in the 2010’s, questioning if the development had gone so far as to rob Swedish universities of their autonomy vis-à-vis outside society.¹²³

Another aspect that eroded the autonomy of the Swedish universities over the late 20th and 21st centuries was a progressive erosion of collegial decision-making structures within the universities, in favour of governance structures more akin to other governmental agencies. In 1977, each university had to establish governing boards, whom at first were made up mainly of faculty representatives. However, over time, successive policy changes made these boards increasingly appointed by external actors, while presidency of the boards was taken away from the university rector.¹²⁴ Even when, in 2011, a reform specifically named ‘The autonomy reform’¹²⁵ was introduced, it worked to further strip away the collegial influence over university matters. It

¹¹⁸ Sundqvist 2010, pp. 167–170.

¹¹⁹ Original Swedish: *Löne- och prisomräkning*

¹²⁰ Sundqvist 2010, pp. 151–155.

¹²¹ Sundqvist 2010, p. 155.

¹²² Schilling 2005, pp. 165–166.

¹²³ See e.g. Waluszewski 2017.

¹²⁴ Ahlbäck Öberg & Sundberg 2016, pp. 51–57.

¹²⁵ Original Swedish: *Autonomireformen*

did so by dismantling the previously influential faculty boards, made up of representatives of the academic staff, and transferring their power, as well as some of the Swedish government's previous power, over to the externally controlled university boards.¹²⁶

Another development over this period was the gradual deregulation of employment conditions for university employees. For example, in 1993, some of the colleges and universities got the freedom to employ professors on their own, without direct government involvement.¹²⁷ Then, in 1999, the extra legal protection enjoyed by university professors was removed.¹²⁸ After this, in connection with the aforementioned autonomy reform, universities were able to institute their own employment forms.¹²⁹ These reform also loosened up previously regulated employment titles and standards, allowing the universities increased power over employment conditions.¹³⁰ Again, while this afforded more power to central university administrations, it eroded power and protection for academic employees.

As seen above, there have been a number of developments in Swedish academia in the late 20th and early 21st century. Some of these can be linked to specific political actions, such as the 1993 changes in government agency accounting, the 2000 merge of the previous research councils into VR and the 2011 autonomy reform. However, others are more gradual changes, such as the increase in higher education attendance, the expansion of university administration and deregulation of academic employment standards. Even those changes that might seem connected to singular political decisions were part of longer processes, such as how the gradual deconstruction of collegial influence paved the way for the autonomy reform.

The changes within academia must also be viewed in the light of other developments in the Swedish government or society. For example, the increased higher education attendance has to be viewed in relation to developments within the Swedish labour market, with increasing demands for highly educated labour. Developments such as the 1993 change in accounting standard was also part of a longer trend towards increasingly detailed financial management of government agency.¹³¹ This in itself was part of the larger new public management trends of the period, where professionalism and collegial power structures was increasingly replaced with managers without subject area expertise and organisational structures inspired by the private business sector.¹³²

¹²⁶ Ahlbäck Öberg & Sundberg 2016, pp. 62–64.

¹²⁷ Utbildningsutskottet 1997.

¹²⁸ Utbildningsdepartementet 1992; Utbildningsutskottet 1997.

¹²⁹ Regeringen 2010, pp. 52–79.

¹³⁰ Sørensen et al. 2015, pp. 8–15.

¹³¹ Sundström 2003, pp. 255–287.

¹³² See e.g. Czarniawska & Solli 2014.

While there has been substantial study and debate in Sweden about the above issues concerning the governance and funding of the universities, there has been significantly less attention paid to how these and other changes to the Swedish academic system impacted the actual academics carrying out research and education. However, there have been some scholarly examinations of these issues. For example, Hasselberg found that the increased precariousness and competition for funding in Swedish research in the time leading up to 2012 was translated into a tendency towards a production-focused, industrial logic in some research groups. In these contexts, the old norms of science acted as ways to provide legitimacy to the research, both to the researchers themselves and to the public, rather than as actual, functional norms.¹³³

As this thesis examines specifically antibacterial-related research, the medical research at Swedish universities is of special interest. Despite its rather limited size, Swedish universities have historically been at the forefront of many scientific fields, through early researchers such as Linnaeus and Celsius. Partly as a result of advances stemming from Swedish academic research, several pharmaceutical and medical technology companies were founded in Sweden, including Pharmacia in 1911, Astra in 1913 and Gambro in 1964.¹³⁴ Out of these, Astra was the one with the most involvement in the antibiotic research, as one of their most significant early in-house products was the antimicrobial, sulfa-based Sulfathiazole.¹³⁵ Importantly for this thesis though, Uppsala-based Pharmacia was bought up and largely dismantled in the late 1990's, while Astra, who had merged with Zeneca to form AstraZeneca, decided to dismantle their Lund facilities in 2010.¹³⁶

As seen above, there are certain characteristics that should be taken into account when deliberating on the generalisability of the situation in Sweden to that in other countries. However, many of these, such as the dismantling of collegial decision making structures, expansion of university administration and reliance on external funding, are similar to the developments seen in other countries.¹³⁷ The pharmaceutical sciences have also in Sweden, such as in many other countries, seen a retreat of the major pharmaceutical companies.¹³⁸ As such, lessons learnt from developments in Sweden ought to be understood in their context, yet should still in large parts be applicable to similar developments in other countries.

¹³³ Hasselberg 2012, pp. 178, 243.

¹³⁴ Johnson 2015a; 2015b; 2020.

¹³⁵ Acta Oto-Laryngologica 1943.

¹³⁶ Johnson 2015a; 2020.

¹³⁷ See e.g. Mirowski 2011; Slaughter & Leslie 1997.

¹³⁸ LaMattina 2011.

4. Policy Study: Swedish Research Bills 1975-2012

This chapter aims to study the academic research policies of the Swedish government in the end of the 20th and beginning of the 21st century. It does so using the *Forskningspropositioner*, or research bills, put forward by successive Swedish governments on a 3–4-year basis. Beyond the strict legislative parts, these also contain significant discussions about the aim of various legal actions and funding adjustments the government wished to enact. While these documents are extensive,¹³⁹ and grow in size over time, the focus of this study is on the parts of the bills that most directly pertain to the situation of university researchers, as given by the analytical framework of the thesis, especially those with particular importance for antibacterial-related research.

Another aspect that is important to remember is that these research bills were not the only means of governance that the Swedish government had over the Swedish universities. In between these bills, the government could pass other bills with an impact on university life. For example, many of the policy changes in the previous chapter were passed in other bills.¹⁴⁰ The government also had budgetary powers over the universities. Lastly, as discussed in the previous chapter, developments in other government agencies could impact the universities, such as new bookkeeping and audit practises.

It must be recognised when reading this chapter that there were several different governments in Sweden during the period of these bills. Except for three periods of various right leaning governments, 1976-1982, 1991-1994 and 2006-2014, these governments were headed by the Social Democratic party. So, while this thesis do not analyse the bills from a party political viewpoint, these shifts in political leadership ought to be recognised when considering the developments seen in the bills. Similarly, it should be recognised that the bills were written in different economic climates. Again, although the following analysis does not explicitly deal with the economic situation in which they were produced, it is important to take note that especially the oil crises of the 1970's, the Swedish banking crises in the early

¹³⁹ The extensiveness, and often wordy writing style, of these bills is the reason why this chapter hardly uses any quotes since this would require significantly extended writing without providing proportional insightfulness.

¹⁴⁰ Such as the *Autonomireform*, which came about through the bill "En akademi i tiden – Ökad frihet för universitet och högskolor" (prop. 2009/10:149).

1990's and the global recession in the late 2000's might have influenced the political approach towards academia.

Since the Swedish governments used many means to influence the universities, this study is not intended to provide an exhaustive overview of this influence. Rather, it is meant to provide an understanding of how the successive governments viewed Swedish academic research, what they wanted to achieve through their science policies and how they intended to achieve these objectives. These results can then be used to understand the developments seen in the later empirical chapters of this thesis.

This chapter is structured into four parts as well as a conclusion. The four parts each represent a decade, beginning with the 1970s, although the 2000s stretch all the way to 2012. The 1970s was included because it enabled a better understanding of both the research bills themselves and of the long-term trends in Swedish academic research policy. The conclusion summarises the trends seen in the bills, outlining the insights gained from this chapter towards the overall analysis and discussion of the thesis.

1970s

The first of the periodic Swedish Research Bills (SRBs), was published in 1975, with the second one published in 1978. A central theme in these propositions was power over the research councils, the national organisations tasked with supporting various branches of academic research, often framed in the context of seats on the council. It was especially noticeable that it was the unions who were most actively pursuing influence in these, while scientific organisations wanted to limit the influence of non-scientific actors.¹⁴¹ However, it was not only in the councils that the unions wanted more influence. In the name of steering research in more socially beneficial ways, they also sought influence within the faculty boards, the organisations tasked with distributing the basic funding, the part of state science support that did not go through the councils or other actors external to the universities.¹⁴²

Although the ratio of council funding to basic funding was significantly lower during the 1970s than in later decades, there were already fears that the council financing was too short-sighted. There were even discussions of abolishing them and transferring the funds to the basic funding.¹⁴³ Further, the bills point out that the councils were never meant to fund continuous research, but rather meant to plant seeds for new lines of research that the universities should then subsume into their own funding.¹⁴⁴ As such, it was the basic

¹⁴¹ SRB 1975: 22-25, 33-35, 39-41.

¹⁴² SRB 1978: 3-4, 34-38, 78-80.

¹⁴³ SRB 1975: 49-53.

¹⁴⁴ SRB 1975: 18-19, 65; SRB 1978: 16.

funding that was being prioritised when funding increases were discussed, with the aim to create stronger research structures.¹⁴⁵

These early bills discussed the effect of employment security and opportunities a fair deal. For example, the first one pointed to the career-making or breaking influence of the councils already at this point, despite their relatively small part of overall research funding compared to later decades.¹⁴⁶ There was a focus on how employment security and liveable salaries or reimbursements were a priority for conditions of research, especially for PhD students.¹⁴⁷ However, at the same time, research funding should become increasingly competitively distributed and the number of early researchers should continue to increase substantially, broadening the pool of competing researchers.¹⁴⁸

There was an explicit wish to prevent further bureaucratic burdens on the universities.¹⁴⁹ However, at the same time, the bill wished to put in place new bureaucratic tasks for the universities to complete. These include, for example, increased statistics production and increased local responsibilities for the employment conditions of those working at the universities.¹⁵⁰

1980s

In the research bills of the 1980s, the relationship between longevity and short-term evaluation came into flux. With the 1981 bill, the value of evaluation and longevity were stated in more equal terms than in the 1970s.¹⁵¹ By 1986, longevity was again highlighted as of primary importance.¹⁵² However, by 1989, the definition of longevity changed, where it was no longer research itself that should have longevity but the financing of it.¹⁵³ This located the issues with a lack of longevity, such as those stemming from council funding, to specific realms of research, such as in PhD education.¹⁵⁴

Also, when it came to the evaluation of research, there was an uneven trend in the 1980s research bills. The 1981 bill put a substantial focus on the evaluation of research, especially when compared to the previous bills. Central priority was given to improving this evaluation and the presentation of it. For example, with new means of keeping research statistics¹⁵⁵ and by introducing

¹⁴⁵ SRB 1978: 13-15.

¹⁴⁶ SRB 1975: 20.

¹⁴⁷ SRB 1978: 48-52, 57-58, 69-73.

¹⁴⁸ SRB 1978: 43, 60-62.

¹⁴⁹ SRB 1978: 76.

¹⁵⁰ SRB 1978: 19, 26-30, 76.

¹⁵¹ SRB 1981: 1.

¹⁵² SRB 1986: 1-2.

¹⁵³ SRB 1989: 49.

¹⁵⁴ SRB 1989: 99.

¹⁵⁵ SRB 1981: 1, 3, 109-112.

both scientific and non-scientific measurements.¹⁵⁶ The bill also emphasised novel forms of evaluation, including quality control before a project was initiated¹⁵⁷ and with evaluations being done by the research councils on entire research subjects.¹⁵⁸ This focus on evaluation was scaled back somewhat in the mid-80s, with more focus on long-term research conditions.¹⁵⁹ However, by the 1989 bill, evaluation gained an even more central role to the 1981 bill. Despite noting that it was hard to utilise the results of the research evaluation, it still emphasised the need for further and more constant evaluative pressure on researchers.¹⁶⁰ While wanting more researchers to be active in and lead these evaluations, it also noted the increased use of bibliometric evaluation, seeing it as an especially useful tool.¹⁶¹ The evaluation should also expand the range of aspects it covers. For example, it should pay increased focus to research ethics.¹⁶² To justify the need for this increased evaluation, it argued that it should be used to make sure that research did not get stuck in “unseasonal directions or structures”, noticeably without either defining these or explaining how the evaluations were to be used to avoid them.¹⁶³

More firmly than in previous bills, the 1980s research bills listed a number of politically prioritised research areas, giving them favourable treatment to other research areas.¹⁶⁴ In 1986, the idea was introduced that the country’s research should be focused on areas where it was already in the forefront, such as in medicine.¹⁶⁵ This direct government interference in the conditions of research in various areas was justified with the reasoning that researchers should determine the methods they use but not necessarily the questions they answer.¹⁶⁶

When it came to job security, the 1980s research bills had an extensive ambivalence. In some parts, they argued that the academic researcher’s work conditions should be taken into account. For example, they should promote the enthusiasm and work satisfaction needed for good results and prevent insecure employment conditions from tempting researchers, especially younger ones, to act against their integrity.¹⁶⁷ In terms of direct actions to improve these conditions, the few ones that were brought up mainly concern the conditions of PhD students.¹⁶⁸ However, in reality, the bills introduced new, temporary employment forms, and called for all teachers at university

¹⁵⁶ SRB 1981: 14.

¹⁵⁷ SRB 1981: 23-24.

¹⁵⁸ SRB 1981: 37-40.

¹⁵⁹ SRB 1986: 36.

¹⁶⁰ SRB 1989: 5, 9, 168.

¹⁶¹ SRB 1989: 5, 15-17, 167-168.

¹⁶² SRB 1989: 46-47.

¹⁶³ SRB 1989: 97.

¹⁶⁴ SRB 1981: 1-2; SRB 1986: 7-8; SRB 1989: 2-3, 29.

¹⁶⁵ SRB 1986: 10, 27.

¹⁶⁶ SRB 1981: 14-15.

¹⁶⁷ SRB 1981: 24; SRB 1986: 5, 28.

¹⁶⁸ SRB 1989: 34.

level to also do research. The bill argued that job security would be increased by this even though this meant that an increased portion of salaries had to come from flexible and hence insecure research funding.¹⁶⁹

The research bills of the 1980s contained an ever-increasing degree of comparison between the situation for science in Sweden and its international counterparts. The 1981 bill was the first bill to explicitly introduce such a comparison. Although the actual comparison was rather minor compared to later bills, it contained a crucial point about how the research in Sweden had to be evaluated in relation to research in other countries.¹⁷⁰ The 1986 bill saw an increase in this comparison and an analysis of Sweden's part in the international scientific effort. It also added a reasoning that Sweden can and should only receive international scientific knowledge if it also contributes to it.¹⁷¹ Further increases in the scope of these comparisons and analysis of Sweden's place in the scientific world were seen in the 1989 bill.¹⁷²

When it came to the balance between basic funding and council funding, there was a shift in the rhetoric in the 1980s bills. The 1981 bill mostly reaffirmed the previously held view of the different roles of the basic funding as meant for continuous activities and the council funding for new initiatives.¹⁷³ The 1986 bill maintained this view, wanting to increase basic funding, especially with contributions from sectorial research and not wanting to start or fund more research institutes external to the universities.¹⁷⁴ However, in 1989, it was the councils that were in focus for financial priorities despite highlighting the need for bigger and better research environments.¹⁷⁵ Because of the national competition for council funding, it assumed that "the councils [were] better equipped than the faculty boards to weight the quality of different initiatives against each other".¹⁷⁶ Instead of letting the faculty board distribute funds according to the most deserving institutions, it wanted the councils to take this role by taking the institution's overall quality into account when providing money to individual researchers.¹⁷⁷

In terms of the relationship between research and industry, the 1980s bills were more positive towards interactions between the two spheres than previous bills yet do not contain the same explicit goals of innovation incubation and technology transfer of later bills. The bills wanted more people, especially from outside academia, to go into academic employment, a wish supported by increased resources towards PhD education and early researchers, as well as new forms of employment geared towards those with

¹⁶⁹ SRB 1981: 2-3; SRB 1989: 182-188.

¹⁷⁰ SRB 1981: 17-18, 23.

¹⁷¹ SRB 1986: 11-16, 29.

¹⁷² SRB 1989: 12-28.

¹⁷³ SRB 1981: 28, 33, 94.

¹⁷⁴ SRB 1986: 27, 33.

¹⁷⁵ SRB 1989: 2, 29, 30, 36.

¹⁷⁶ SRB 1989: 32.

¹⁷⁷ SRB 1989: 35.

industry experience.¹⁷⁸ It also wanted the industrial sectorial research to contribute money towards more fixed positions for older researchers and temporary ones for younger researchers.¹⁷⁹ However, at the same time, the bills warned against increased proportions of research contributions from private industry and wanted to achieve a balance in academic and private research.¹⁸⁰ They expressed the need for the public to keep up its relative funding efforts and called for increased contributions from the sectorial research towards fundamental academic research.¹⁸¹

When it came to direct political influence over the academic work, there was an ambiguity in the research bills of the 1980s. At the same time as the bill stated that the political sphere wanted a higher degree of influence over academia, it also wanted to give up the power to appoint professors, wanting the universities to take care of these appointments themselves.¹⁸² There was also a critique of the increase in administrators and bureaucrats at the universities despite the new burdens put on the universities by parliament.¹⁸³ While asking for more planning of research, they also highlighted how research planning must not make research more cumbersome or stand in the way of the flexibility, stating that "Planning must never become a goal onto itself, a substitute for actual research or a refuge for researchers who have grown tired of, or are no longer able to, conduct research".¹⁸⁴ Overall, however, a shift towards less direct and more indirect control was seen during this decade. An example was how initiatives were outlined through number of positions available in 1986, while they were changed to money in 1989.¹⁸⁵

A clear trend throughout the 1980s research bills was to prioritise the small, less resourceful colleges over the larger universities. The colleges were seen as technology spreaders in their local communities and given financial priority. Funds were directed from the bigger universities to these colleges and changes to the funding structures made in their favour.¹⁸⁶ Despite a supposed focus on creating bigger and better research environments, there was a drive to even out the quality between different institutions, so it would become "high and even" across Swedish higher education.¹⁸⁷

¹⁷⁸ SRB 1981: 52, 88-91, SRB 1986: 1, 2.

¹⁷⁹ SRB 1986: 33.

¹⁸⁰ SRB 1986: 27, 29-31.

¹⁸¹ SRB 1989: 6, 9, 51-52.

¹⁸² SRB 1981: 28-32, SRB 1989: 171-173. Note that this might have been, at least partially, motivated by the will to avoid providing professors with the privileges associated with direct government appointments.

¹⁸³ SRB 1986: 29.

¹⁸⁴ SRB 1981: 26.

¹⁸⁵ SRB 1986: 55; SRB 1989: 10.

¹⁸⁶ SRB 1986: 34-35; SRB 1989: 29, 100, 200-204.

¹⁸⁷ SRB 1989: 30, 43.

1990s

A leading theme of the 1990s research bills was the move away from continuity and longevity towards constant fluctuation. Although there were still hints of paying tribute to these older values, the practical implications of most of the changes in the bills were to move away from them. This was underpinned by a stated but never empirically supported claim that science was progressing so fast that "research organisations and individual researchers have to be able to continuously adapt to new circumstances".¹⁸⁸

The 1992 research bill stated that expecting quick turnaround from research to social utility was unrealistic.¹⁸⁹ Still, it aimed to increase the capability of universities to start their own companies and foundations, partly in order to increase the speed of this turnaround and partly to circumvent employment regulations.¹⁹⁰ The 1996 bill then proposed that institutions should have legal obligations to support researchers who wish to engage with society in various ways.¹⁹¹ This should be understood against the backdrop of how the bill highlighted the need for new forms of knowledge production, with direct reference to *New Production of Knowledge* by Gibbons *et al.*¹⁹² In this highly influential book, it was argued that a more modern form of knowledge production was evolving - one that involved greater parts of society than just academia. This new knowledge production promised to promote values like democracy, prosperity and knowledge spread. Yet, it was vague on how these gains were to materialise and ignored the potential pitfalls of such a mode of knowledge production.

The 1990s research bills argued that research environment and continuity was important and should be ensured by the basic funding.¹⁹³ Still, they argued that the faculties should introduce council-like procedures internally and that the funding should be divided in competition, according to activity.¹⁹⁴ The research councils should also be allowed to create temporary professorships, previously a faculty-based profession, ensuring that the security of the position as professor was undermined.¹⁹⁵ In addition, the 1992 bill argued that the faculty boards should also push for increased specialisation and concentration of resources, while simultaneously warning of the dangers of increased specialisation.¹⁹⁶

It was in the treatment of the research councils that the research bills of the 1990s most clearly showed that continuous change was to be prioritised over

¹⁸⁸ SRB 1992: 2.

¹⁸⁹ SRB 1992: 6.

¹⁹⁰ SRB 1992: 34, 188.

¹⁹¹ SRB 1996: Inled.

¹⁹² SRB 1996: 3.1; see also Gibbons *et al.* 1994.

¹⁹³ SRB 1992:6, SRB 1996: 3.3.

¹⁹⁴ SRB 1992: 41, 74.

¹⁹⁵ SRB 1996: Inled.

¹⁹⁶ SRB 1992: 40, 166.

longevity in research. The 1992 bill argued that the councils should increase their pressure on researchers to continuously change and increase their mobility, all underpinned by an increase in council funding relative to basic funding.¹⁹⁷ The councils should also prioritise new research areas and strive for increased competition and quality. This increasingly aggressive council behaviour was to have a normative influence on the faculty boards.¹⁹⁸ However, the demands on concentration of resources that was there for the faculty boards were also there for the councils. They should be able to bind money over longer periods, up to six years.¹⁹⁹ The 1996 bill did not reverse these actions or challenge their logics, except that the otherwise generally accepted impartiality of the research councils towards applicants was called into question when discussing gender equality.²⁰⁰ This bill, however, changed a fundamental cornerstone in the councils-faculty boards dynamic. The subsuming into the university of externally funded projects, the cornerstone of previous council-faculty relationship, was expressly forbidden.²⁰¹ Without discussing the implications of this move in such terms, this dismantled the previously established logic that the council were to initiate research projects and the universities ensured their ongoing existence.

Beyond the research councils, the bills also pushed for further quality control of research since “considerable short-comings” were assumed to exist, especially pushing for gender relations and research ethics controls. Both research conductors and research funders were tasked with this control.²⁰² Low mobility, narrow specialisations, difficulty for cross-disciplinary research and corruption were highlighted as existing or potentially existing problems, though only sparse evidence was brought forward to support these claims, and only for some of the issues.²⁰³ It was also explicitly stated that part of this quality control had to be carried out with foreign researchers engaged in the process.²⁰⁴

Despite the increased focus on constant change, evaluation and quality control, some parts of the research bills still cling to notions of longevity. A part of the 1992 bill argued that success must be rewarded and failures allowed, and that researchers should be free to pursue questions based on their scientific interests.²⁰⁵ More specifically, researchers supported by basic funding should be able to choose their own questions.²⁰⁶ However, these arguments were not backed up by any substantial actions, nor was it discussed

¹⁹⁷ SRB 1992: 41.

¹⁹⁸ SRB 1992: 53, 66, 169.

¹⁹⁹ SRB 1992: 170, 172.

²⁰⁰ SRB 1996: 3.7.

²⁰¹ SRB 1996: 3.12.1.

²⁰² SRB 1996: 3.4.

²⁰³ SRB 1996: 3.6.

²⁰⁴ SRB 1996: 3.6.

²⁰⁵ SRB 1992: 6, 13.

²⁰⁶ SRB 1992: 18.

how they were to be fulfilled when other parts of the bill point directly contradict these assertions.

When it came to the question of geographical concentration or dispersion, the 1992 research bill marked a substantial shift in focus, while the 1996 brought the focus back to the bills of the 1980s. While the 1992 bill aimed for a reasonable geographic coverage, it was firm in that this should not come at the cost of splintered resources.²⁰⁷ Hence, there was only a comparatively mild push towards improving the mid-sized institutions.²⁰⁸ The 1996 bill then went even further than the 1980s bills in its general spread, wanting all colleges to have their own research resources.²⁰⁹ It also substantially increased the funding of smaller colleges, with the explicit goal of turning more of them into universities.²¹⁰ Only three years later, in 1999, this goal would be turned into practise when the government elevated three colleges, Karlstad, Växjö and Örebro, into universities.²¹¹

In the area of direct government influence on universities, the 1992 bill was clear in its aim to lessen direct involvement of the state in science, wanting to achieve an increased diversity in funding sources and resource allocation reasons.²¹² Yet it acknowledged that the state was and would remain heavily involved financially, as 82% of academic funding were derived in one way or another from the state.²¹³ However, it went further in this decoupling strife by changing the law to allow the universities to appoint their own professors.²¹⁴ While the 1996 bill did not revert any of these change per se, it undermined them both by providing for the appointment of several professors by decree and giving further directions in how appointments should be made, such as stating that gender balancing as a recruitment goals would be introduced.²¹⁵

Another example of the differences between the two bills when it came to government control of research was in their relation to the research foundations created out of the decommissioned *löntagarfonder* - trade union directed sovereign wealth funds established through a corporate tax model. When first constructed, these foundations should support various academic areas deemed by the state to be strategic research, but largely be operationally independent of the state.²¹⁶ However, the 1996 bill saw the government asserting significant influenced over these foundations.²¹⁷ Still, the 1996 bill

²⁰⁷ SRB 1992: 12.

²⁰⁸ SRB 1992: 56-58.

²⁰⁹ SRB 1996: 3.4.

²¹⁰ SRB 1996: 3.8.

²¹¹ A move that received substantial criticism, as it was made against the advice of the government's own expert agency. See Wikgren, Gustavsson, & Gerdes Barriere 2017, p. 10.

²¹² SRB 1992: 13.

²¹³ SRB 1992: 18.

²¹⁴ SRB 1992: 188-189.

²¹⁵ SRB 1996: Inled.

²¹⁶ SRB 1992: 34-39.

²¹⁷ SRB 1996: Inled.

rejected several proposals for further government influence over academia. For example, despite the 1996 bill being heavily influenced by the aim to achieve gender equality in academia, it deemed that some of the suggestions, such as demands for gender perspectives to be made mandatory in research question formulations would introduce too much government burdens on research.²¹⁸

The extent of comparisons between research in Sweden and the larger international science community was relatively constant during the 1990s research bills compared to the late 1980s, possibly with the exception of some increased comparison in the 1996 bill.²¹⁹ Much of this comparison was however directed towards further integration of Swedish research into the international sphere. This was especially apparent in the adaptations being made to fit Swedish research into the EU's framework programmes.²²⁰

Finally, when it came to discussing the actual employment conditions of academic researchers, it was PhD students and early career researchers that were almost exclusively in focus in the 1990s research bills. The 1992 bill wanted more PhD students to graduate in time, without decreasing demands, but also recognised that current employment conditions after graduation made PhD studies often seem preferable.²²¹ However, it deteriorated these conditions further by enabling temporary, three-year lectureship positions and gave universities the possibility to work around current employment protections by starting companies and foundations.²²² In the 1996 bill, rather than showing a general care for the situation for researchers, the moves to improve conditions were framed as a question of striving for gender equality. One example of this was to enable Swedish researchers to hold postdoctoral research positions, or postdocs, at Swedish universities.²²³

2000s

In terms of the conflicting goals of longevity and evaluation-based constant change, the research bills of the 2000s continued the tradition of seeming to want to achieve both, while acting almost singularly in favour of one of them. Though both the 2000 and 2004 bills admitted that longevity was important,

²¹⁸ SRB 1996: 3.7.

²¹⁹ SRB 1992: 22-29, SRB 1996: 3.2, 3.13.

²²⁰ SRB 1996: Inled.

²²¹ SRB 1992: 177, 183.

²²² SRB 1992: 187, 188

²²³ SRB 1996: 3.7. Traditionally, postdocs were short-term research positions meant to be served outside the country in which a person completed their PhD studies, in order to broaden their understanding of research in different environments. The opening of Swedish postdocs to Swedish researchers was advanced as a step towards gender equality, as it made it easier to combine raising children with pursuing a research career.

as research results were hard to predict,²²⁴ the actions they proposed seemingly contradicted this insight. The 2000 bill wanted increased flexibility and mobility in Swedish research and to distribute increasing amounts of research funding according to external evaluation.²²⁵ While the universities were supposed to provide good research environments, the resources to do so should increasingly come from external sources and the ways to do this should be by increased performance-based distribution.²²⁶ While the universities objected that lower guaranteed funding made the required strategic long-term investments needed to meet these goals impossible, the bill did nothing more than note this objection.²²⁷

The 2008 bill proposed increased basic funding to universities, though it should be used to ensure that externally funded projects were not abruptly ended, going against the 1996 ban on such take-overs.²²⁸ It assumed that this increased basic funding would take some pressure off the external funders. The bill also created a new basic research funding division scheme partly based on the number of attending students at a particular university, yet mostly dependent on various research performance criteria. This scheme was introduced despite fears that such criteria would drive universities to focus on fulfilling these criteria rather than on the broader quality of their research.²²⁹ One of these criteria was how much external funding the university was able to attract, institutionalising a Matthew effect in Swedish academic research.²³⁰ ²³¹ The other criteria were based on a metric that utilised bibliographic data about the researchers associated with the university.²³² Hence, while some parts of the new structures provided increased ability for universities to distribute their own funds, it was questionable if it actually gave them better abilities to fulfil their purported purpose as longevity providers given the short-term nature of the distribution criteria.²³³ This increased autonomy was also called into question by the continued insistence on determining how the universities should use their funds. For example, the bill argued that the basic funds should be used to support risky projects that have a hard time competing for regular external funding.²³⁴ It should also be noticed here that this is a

²²⁴ SRB 2000: 11; SRB 2004: 1.

²²⁵ SRB 2000: 36, 146.

²²⁶ SRB 2000: 146-147.

²²⁷ SRB 2000: 182.

²²⁸ SRB 2008: 23.

²²⁹ SRB 2008: 26, 51, 54-55.

²³⁰ A Matthew effect refers to a process by which initial success makes further success increasingly likely, while making it relatively harder for those without initial success to succeed in the future. It is based on the biblical reference from the Gospel of Matthew (25:29) that "For whoever has will be given more and they will have abundance. Whoever does not have, even what they have will be taken from them". For more, see Merton 1968.

²³¹ SRB 2008: 56.

²³² SRB 2008: 56.

²³³ SRB 2008: 55.

²³⁴ SRB 2008: 28.

complete reversal of the original council funding – basic funding logic, where the councils were the ones who should support risky projects and the basic funding there to uphold the more regular research.

The 2012 bill continued the trend of words and deeds not matching up to each other. It lifted up how researchers often saw solutions before anyone else, but did not carry that analysis to any meaningful conclusion.²³⁵ Instead, it increased the proportion of the basic funding distributed according to the performance criteria.²³⁶ It also concluded that there should be more basic funding and a better balance between basic funding and external funding, but with no definition of what constituted such a balance or how it should be achieved.²³⁷ Also, instead of providing good research conditions for all researchers, it instructed the universities to create evaluation systems so that conditions could be given according to the performance of individual researchers.²³⁸

In 2000, VR was formed as a combination of the previous medical, technical, natural and social science research councils in order to improve coordination between different fields and as a response to an increased importance of external financing during the 90s.²³⁹ The 2000 bill contained highly detailed instructions over how VR should operate and utilise its funds.²⁴⁰ VR was given an ambiguous mandate both to uphold small subjects and to dismantle stagnating research fields.²⁴¹ It was also to support legally ambiguous centres of excellence, established to promote certain prioritised research areas that were supposed to operate with a long-term focus but with temporary funding contingent on follow-up evaluation.²⁴²

The 2004 bill recognised that the acceptance rate at VR was 21%, without comment or historic context.²⁴³ However, it mentioned that the increased proportion of external funding constituted a challenge for university leadership, but did not mention anything about its negative impacts on individual researchers.²⁴⁴ In order to give some researchers the ability to research with a long-term perspective, VR and other governmental research grant providers should support strong research environments and provide them with extended funding, 10 year time-periods as aim. However, the universities were sceptical to this initiative and there was a lack of definition on how these strong research environments were to be selected.²⁴⁵

²³⁵ SRB 2012: 14-15.

²³⁶ SRB 2012: 17.

²³⁷ SRB 2012: 15-16.

²³⁸ SRB 2012: 18.

²³⁹ SRB 2000: 15, 28.

²⁴⁰ SRB 2000: 95-99.

²⁴¹ SRB 2000: 103, 108.

²⁴² SRB 2000: 46-47, 103.

²⁴³ SRB 2004: 39.

²⁴⁴ SRB 2004: 53-54.

²⁴⁵ SRB 2004: 88-98.

The later bills provided some recognition of the impacts of increased dependence on outside financing for individual researchers. As an example, the 2008 bill highlighted how the low acceptance rates at VR were problematic.²⁴⁶ However, instead of acting on this problem, it justified it by assuming that a lack of competition and quality control would automatically lead to low quality research.²⁴⁷ Similarly, it recognised that the increased pressure to apply for external funding had led to decreased autonomy for researchers, but held its worth because of the quality assurance it provided.²⁴⁸ Still, some movement towards increased longevity was made, where VR was tasked with providing long, 7-10 year employments for the best researchers.²⁴⁹

The 2000s research bills had a lot of potential problems and flaws with Swedish research during this period. The 2008 bill contained a long list of supposed short-comings of Swedish research - unsatisfactory quality, fragmentation, lack of longevity, deficient cross-disciplinary research, lacking commercialisation, continuous obstacles to independence and integrity, and a lack of ability to take long-term, coordinated strategic initiatives.²⁵⁰ However, the existence or severity of these supposed flaws were rarely, if ever, backed up by substantial evidence.

When it came to addressing the flaws that the research bills saw in Swedish research, the actions taken were often vague or directly contradictory. For example, in the 2000 bill, the inflexibility of Swedish research, especially when it came to dismantling non-prioritised research, was criticised and linked to the current structures that the bill aimed to change by the introduction of more competition-based structures.²⁵¹ Yet, at the same time, it was pointed out how increased competition for resources led to an excessive competition-mindset rather than cooperation in Swedish research. This then led to arguments pointing towards a need for continuity and longevity in finance.²⁵² Similarly, at one point, university leaderships were tasked with both prioritising leading researchers and at the same time support not yet established fields.²⁵³ Continuing this ambiguity, the 2008 bill aimed at increasing longevity in research despite also wanting to increase the pervasiveness of evaluation-driven resource allocations.²⁵⁴

When it came to international comparisons, the 2000s research bills found it imperative that the conditions for researchers in Sweden were good enough to attract foreign researchers.²⁵⁵ However, this did not initiate an overview of

²⁴⁶ SRB 2008: 25.

²⁴⁷ SRB 2008: 19.

²⁴⁸ SRB 2008: 23.

²⁴⁹ SRB 2012: 68-69.

²⁵⁰ SRB 2008: 19-20.

²⁵¹ SRB 2000: 38-39.

²⁵² SRB 2000: 150-152.

²⁵³ SRB 2004: 55.

²⁵⁴ SRB 2008: 19.

²⁵⁵ SRB 2000: 39, 215.

how the general employment conditions for researchers in Sweden could be improved. Instead, the bills looked to create special conditions for specially recruited foreign top researchers.²⁵⁶

Despite supposedly aiming to decrease state influence over research during this period, special priorities and strategic initiative were given extensive attention in the 2000s research bills. For example, priority was put on natural sciences and technology in the 2000 bill with the aim that 50% of all PhDs should be in these fields.²⁵⁷ Similarly, the strategic foundations started with resources from the Löntagarfonder were given extra funds in both 2004 and 2008.²⁵⁸ 2008 also saw increased monetary expenditures for other “strategic initiatives”.²⁵⁹ It also created a novel funding system where funds for priorities were supposed to be given to the university administrations, but still through the councils.²⁶⁰ Similarly, the 2012 bill was involved in how Vinnova and other research funders for strategic initiatives should develop systems for assessing the social relevance of projects.²⁶¹ It also argued that strategic research areas should be given more long-term funding since it allowed more risk taking and hence better outcomes, while not explaining why this should not apply to other branches of research.²⁶²

The 2000s research bills put more administrative burdens on universities and other academic organisations than bills from any of the preceding decades. For example, in the 2000 bill, new structures were to be put in place, both inside and outside universities, to deal with ethics in research.²⁶³ The universities should also continuously produce strategy documents, with higher level of detail than previous, temporary test documents.²⁶⁴ The 2000 bill also noted how many universities have already instituted new structures to deal with and promote outside cooperation, but that these bodies, especially the holding companies, need to be further evaluated.²⁶⁵ The 2004 bill then mandated that new action plans for commercialisation of research results should be established.²⁶⁶

Following the above example, the 2008 bill wanted to see universities engaged in increased coordination and planning despite being increasingly competing for resources.²⁶⁷ It also outlined the extensive bureaucracy needed for the new criteria-based funding system it introduced.²⁶⁸ This system was

²⁵⁶ SRB 2012: 66-67.

²⁵⁷ SRB 2000: 40.

²⁵⁸ SRB 2004: 49, SRB 2008: 26.

²⁵⁹ SRB 2008: 2.

²⁶⁰ SRB 2008: 67-73.

²⁶¹ SRB 2012: 64-66.

²⁶² SRB 2012: 72.

²⁶³ SRB 2000: 86-90.

²⁶⁴ SRB 2000: 144-145, 185.

²⁶⁵ SRB 2000: 185, 189.

²⁶⁶ SRB 2004: 2.

²⁶⁷ SRB 2008: 19-20.

²⁶⁸ SRB 2008: 60.

also introduced despite with several institutions warning that it would become a heavy administrative burden.²⁶⁹ The 2012 bill continued this increasing administration trend by requiring universities to expand the structures for evaluating their own researchers.²⁷⁰ Universities should also build new innovation offices and be responsible for protecting the immaterial rights even of non-patentable ideas.²⁷¹ It also outlined an increasing set of tasks that VR, and to a lesser extent other funding agencies like Vinnova, should handle.²⁷²

The 2000s research bills continued the trend of prioritising the development of the minor universities and colleges over the major ones. In the 2000 bill, small- and middle-sized universities and colleges were targeted to receive support for PhD education and resources to enable them to progress towards becoming universities.²⁷³ These minor institutions were also to coordinate with major universities about where certain environments were to be maintained and where they were to be dismantled.²⁷⁴ The 2004 bill expressly stated that the reason for increasing the resources to the colleges and smaller universities was for them to contribute to regional development, rather than out of academic concerns.²⁷⁵

Similar to the increased administrative burdens, the research bills of the 2000s were significantly more engaged with making academic research provide societal benefits than those of the decades before them. The 2004 bill argued that it was unfortunate that that a contrast between intra-science problems and externally motivated research problems exists, and that this distinction was progressively disappearing.²⁷⁶ However, it was the 2008 bill that put most focus on this societal interaction. Symbolically, it went from being called a research bill to naming itself a research and innovation bill.²⁷⁷ In terms of actions to this end, it made societal interaction a legal requirement for universities and demanded university researchers to report findings with commercial potential to university administrations.²⁷⁸ The latter requirement was introduced with the explicit aim to undermine the teacher's exemption, which traditionally gave university employees the right to treat their discoveries as their own.²⁷⁹ Despite stating that not all knowledge can be utilised, it claims that “[r]esearch results have too seldom lead to new jobs, new products and economic growth”, without giving any sources.²⁸⁰ Certain

²⁶⁹ SRB 2008: 61.

²⁷⁰ SRB 2012: 18.

²⁷¹ SRB 2012: 130, 135.

²⁷² SRB 2012: 150-170.

²⁷³ SRB 2000: 14, 148-149.

²⁷⁴ SRB 2000: 147.

²⁷⁵ SRB 2004: 11.

²⁷⁶ SRB 2004: 10.

²⁷⁷ SRB 2008: 1.

²⁷⁸ SRB 2008: 2, 12, 27, 118.

²⁷⁹ SRB 2008: 118-119.

²⁸⁰ SRB 2008: 16, 19.

universities were also to be made into commercial hubs with the explicit goal to enable all universities to fulfil the requirements of a new law that forces them to ensure that innovations made by their researchers come to use in society, with certain universities made into commercial hubs.²⁸¹

Much of this push for increased innovation in science was based on a perceived lack of innovativeness. A cited study reported the contradicting results that Sweden in this period was simultaneously a highly innovative country and a country that lacked incentives for people to be innovative.²⁸² This meant that all academic institutions should create incentives for increased innovativeness, even VR, whom previously was supposed to only look at academic qualities.²⁸³ An example of such incentives was how increased job flexibility should be achieved between academia and industry, with a cooperative postdoc in LifeScience as an ideal.²⁸⁴ Although the 2012 bill did not have an extensive a focus on innovativeness promotion, it went even further in its theoretical assertions, stating that “[t]here is no contradiction between how free research needs good conditions and that the research results should be useful”, denying this previously recognised trade-off.²⁸⁵ In terms of action, the 2012 bill required universities to build new innovation offices and be responsible for protecting the immaterial rights even of non-patentable ideas.²⁸⁶ It also pushed the idea that standardisation perspectives should be accounted for in all research projects from their inception.²⁸⁷

In keeping with the bills that came before them, the research bills of the 2000s focused almost all of their discussion about actual improvements to employment conditions around PhD students and early career researchers. In the 2000 bill, the focus was on educating more PhDs and creating more positions for them to fill after graduation.²⁸⁸ The 2004 bill in turn recognises that the insecurity of employment after a PhD affected the recruitment of researchers and much of this insecurity stems from the high proportion of research funding coming from temporary, external sources. However, the bill did not provide any substantial solutions to this issue.²⁸⁹ Still, it did argue that external grants should ideally not be used for PhD students while simultaneously creating a system where 25% of total PhD costs should come from external sources.²⁹⁰ The 2008 bill aimed to increase the balance between various early career forms of employment, without discussing how this balance would work apart from the creation of the postdoc title and the ability

²⁸¹ SRB 2008: 115, 122.

²⁸² SRB 2008: 141.

²⁸³ SRB 2008: 29.

²⁸⁴ SRB 2008: 218, 220.

²⁸⁵ SRB 2012: 14.

²⁸⁶ SRB 2012: 130, 135.

²⁸⁷ SRB 2012: 138.

²⁸⁸ SRB 2000: 43-45.

²⁸⁹ SRB 2004: 119-128.

²⁹⁰ SRB 2004: 129.

to receive a Swedish salary while stationed on a postdoc abroad.²⁹¹ The 2012 bill wanted more focus on individuals when it came to longevity, recruitment and good employment conditions, without explaining what practical implications such a focus would have.²⁹² Yet again, it prioritised the young by providing extra funding to employ promising young researchers and provide PhD students with better conditions.²⁹³

Finally, the research bills of the 2000s held more information specifically relevant for the field of bacterial infections and antibiotics than bills in previous decades. The 2004 bill recognised the decreased frequency of clinical trials in Sweden and wished to counteract this with the creation of a centre for clinical trials.²⁹⁴ In line with its societal relevance and innovation focus, the 2008 bill wanted Swedish medicine research to become more directly relevant to the needs of hospitals and industry.²⁹⁵ Lastly, in the 2012 bill, the rising threat of antibiotics resistance was explicitly recognised with infections and antibiotics research getting special funding.²⁹⁶

Chapter Synthesis

In the research bills above, many trends were seen in the political influence on the situation that academic researchers find themselves in. However, the most obvious trend was the increasing disparity between the words and the deeds of the bills. It was clear that in the later bills, there were numerous goals, visions and considerations brought up about how Swedish academia should work, many of them conflicting with each other. At the same time, the actual deeds of the bill pointed towards a significantly more singular vision, ignoring any contrasting goals or considerations previously brought up.

The disparity between words and deeds is most obvious in the conflict between research longevity and continuous evaluation. Throughout almost all of the bills, from the beginning until the end, there was some form of consideration for that research must be allowed to take its time and that failures must be allowed in the pursuit of scientific discoveries. In the earlier bills, these considerations were accompanied by practical ways in which this longevity should be protected or enhanced. However, towards the end of the period these considerations rang increasingly hollow. In the later bills, essentially all practical endeavours pointed towards increased continuous evaluation, with the short-term, project-based research style that this approach favoured. The bills displayed an obliviousness to what such deteriorations in

²⁹¹ SRB 2008: 215.

²⁹² SRB 2012: 18.

²⁹³ SRB 2012: 67-68, 170-174.

²⁹⁴ SRB 2004: 100.

²⁹⁵ SRB 2008: 162.

²⁹⁶ SRB 2012: 85.

employment conditions meant for the time and freedom required for functional scientific research.

Despite occasional expressions of goals to the contrary, another area where there was a clear trend in the bills was in the increased general political influence over both research and academic structures. Usually, this influence was exercised in ways that would have been problematic for research, such as when increased administrative tasks diverted resources away from core functions. Other times, demands on research to have clear societal goals limited the freedom of researchers to decide their own topics.²⁹⁷ Yet other times, smaller universities and colleges were prioritised for regional development purposes rather than considering the impact that thinly spread resources would have on research collaborations.

The impact of the political influence on research was more of a two-edged sword, such as when the employment conditions and opportunities for younger researchers were improved. This added time and labour resources to research.²⁹⁸ At the same time, the move did not consider the future prospects of these researchers and how increasing the number of young researchers at one point in time would increase competition among senior researchers at a later point in time. However, it ought also to be recognised that antibiotics research did benefit from the political influence towards the end of the period through the addition of resources to medical research in general and antibiotics research in particular. This came about, for example, through the creation of a national research programme on antibiotics resistance.²⁹⁹

Lastly, it must be recognised that the conception of the research councils was transformed over the span of the research bills. In the beginning, the research councils were there to support new, tentative lines of research while the university funding was there to support the bulk of ongoing, established research. Towards the end, this relationship had completely reversed, where the research council was tasked with funding established research while the universities were to fund the ‘innovative’ lines of research within their own budgets. This meant that even the ongoing research had to continuously compete for funding. It is important to bear in mind this change in role of council funding throughout this period when going into the next chapter, which looks at the funding provided by the research councils, MFR in 1980-1990 and VR in 2005-2015.

²⁹⁷ For example, with the government creation of the national research programmes, see Utbildningsdepartementet 2017.

²⁹⁸ Note that these initiatives might have, in actuality, have had the opposite effect. Potentially due to the increased cost of hiring PhD students, the PhD attendance in Sweden dropped in the later period of the study, both in absolute terms and in relation to population size, as seen in Universitetskanslerämbetet 2021, pp. 57–62.

²⁹⁹ See Vetenskapsrådet 2019.

5. Funding Study: Medical Research Funding from MFR and VR 1980-1990 and 2005-2015

Scientific research is expensive and hence the ability to conduct it is heavily influenced by those who fund it. As such, it is imperative to follow the money to see what research has been possible where, and by whom. The following chapter looks at the funding provided to Swedish medical research in general, and antibacterial-related research in particular, from Sweden's largest research funding agencies in the field, MFR and its successor VR, during the periods 1980-1990 and 2005-2015. As stated in the Methods section, this is done to see how availability and priority of funding changed between the two periods.

Also, as seen in the previous chapter, the role of the research councils changed between 1980 and 2015, from providing funding to new, unestablished lines of research to funding on-going, well-established research. On the one hand, this means that the chosen time periods, 1980-1990 and 2005-2015 represent the very opposite ends of this transformation. Hence, if this change can be seen in the council funding records, it should be seen when comparing these periods. On the other hand, this means that the results found below have to be interpreted in the light of this transformation.

This chapter first provides a summative overview of the MFR and medical VR provisions of funding for the 1980-1990 and 2005-2015 periods, both in terms of overall project funding and funding for antibacterial-related research projects in particular. A more detailed outline is then provided for the funding trends for the entire project funding for MFR and compare them with those of the project funding for the entire medical section of VR. These trends, presented per year, include the total project funding provided by the agencies, the average size of each project grant, the number of applications and the likelihood of an application to be accepted. After this, these same trends are presented for antibacterial-related projects. Then, a few other noteworthy results from this study are presented, including discrepancies in funding between male and female researchers. Lastly, the chapter ends with a conclusion that summarises the most important findings of this chapter and how they relate to how the situation for antibacterial-related researchers changed over the period.

General Trends

Many times, it is important to understand the general picture of a given development so as to see the details of the matter in a more comprehensive way. Following this logic, before proceeding to more specific findings of this study, the general findings are presented below. The changes between 1980-1990 and 2005-2015 are major, while the differences between general medical project funding and that of specifically antibacterial-related funding are markedly less stark.

As seen in figure 5.1, the overall funding increased significantly, roughly doubling, from around 144 million SEK per year to 283 million, even after accounting for inflation. Even more significantly, as seen in figure 5.2, the average funding per project increased four-fold. However, as can be seen in figure 5.3, while the number of applications per year rose between the two periods, the number of approved applications decreased, meaning the approval rate in the latter period was only roughly one third of what it had been in the earlier period.

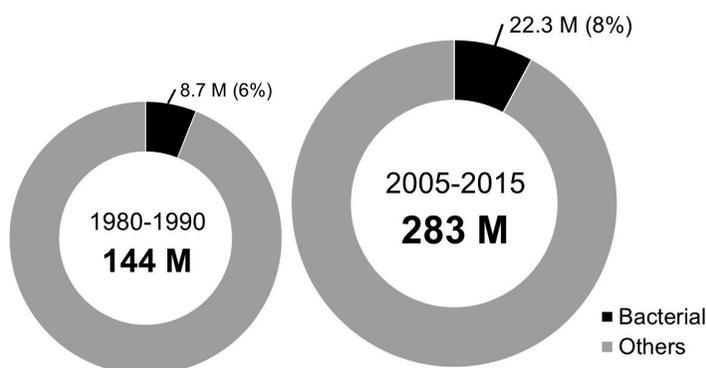


Figure 5. 1. Yearly average of total project funding provided by MFR and the medical part of VR during the periods 1980-1990 and 2005-2015 respectively. Amounts are provided in million Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI.³⁰⁰

³⁰⁰ SEK: Swedish Krona; KPI: Konsumentprisindex

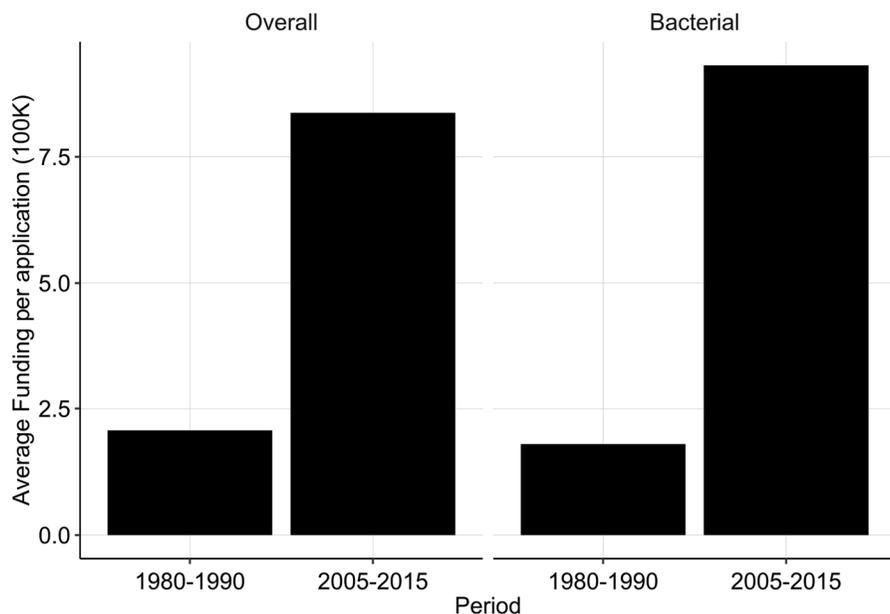


Figure 5. 2. Yearly average per project funding provided by MFR and the medical part of VR during the periods 1980-1990 and 2005-2015 respectively. Amounts are provided in 100K Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI.

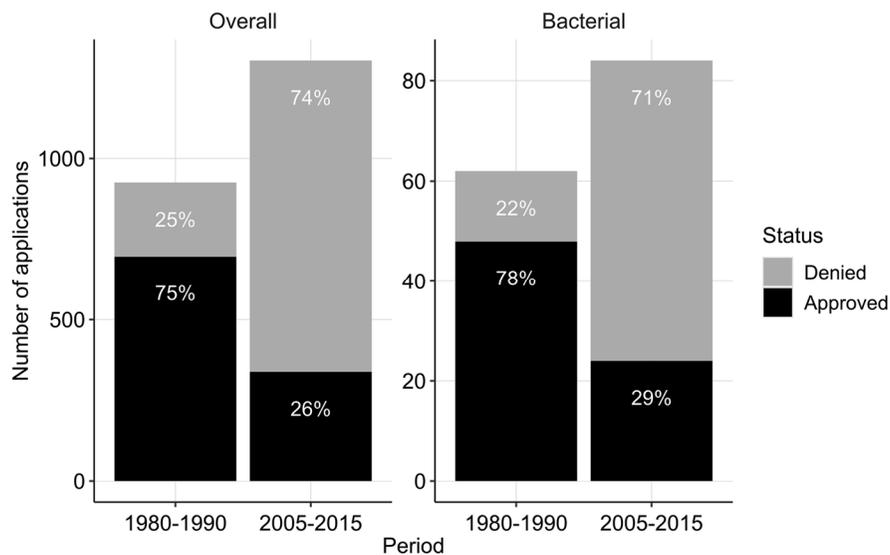


Figure 5.3. Proportions of approved and denied project applications by MFR and the medical part of VR during the periods 1980-1990 and 2005-2015 respectively.

When those applications with antibacterial relevance were compared with the overall applications, it was first noticeable that they were funded largely along the same lines as the overall stock of projects (figure 5.3). While their approval ratings were slightly higher than the general averages in both periods (figure 5.3), their funding levels were slightly lower in the earlier period and slightly higher in the latter period (figure 5.2). Noticeable though is that, despite the wide definition of antibacterial-relevant research, as presented in the methods section, the number of applications assessed as such was rather low in both periods. Antibacterial-related research made up 6.7% of the applications in the earlier period and 6.4% in the latter period.

Overall Project Funding

How many researchers could be supported with how much for how long ultimately comes down to the total supply of funding in a given academic research system. With MFR and VR being foremost of the funding agencies for medical research in Sweden over the studied periods, the total level of project funding provided by them was of extensive significance for this research. Below follows the total project funding provided for medical research by these two agencies during 1980-1990 and 2005-2015 respectively:

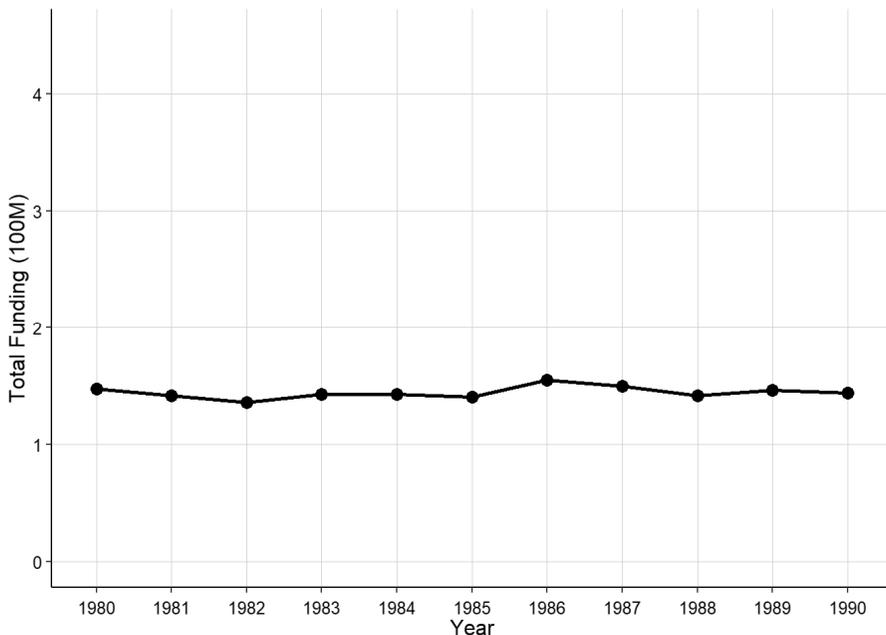


Figure 5.4 The total project funding of MFR per year in the period 1980-1990, provided in 100M Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI.

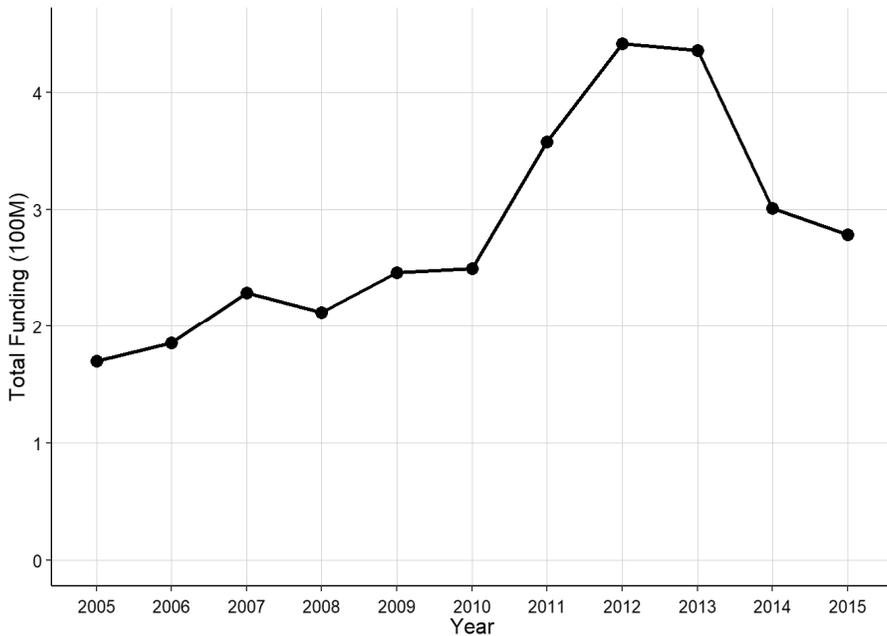


Figure 5.5 The total project funding of the VR medical research division per year in the period 2005-2015, provided in 100M Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI.

As seen in the above graphs, the funding provided was highly stable during the 1980-1990 period, at around 150 million 1980 SEK per year. Even at the beginning of the 2005-2015 period, the total project funding levels had not increased extensively. However, while the first half of the period saw a steady rise in the total funding, the three years of 2011-2013 saw considerable increases, almost doubling the amount of funding provided per year. Although the total funding in 2014 and 2015 was also above that of previous years, it had dropped back to levels more similar to those before these exceptional years.

The above graphs indicate that while total project funding was generally higher in the 2005-2015 period, compared to 1980-1990, it was also less stable. However, while this indicated that the levels of funding available for medical research in general, it does not say much about the funding situation for individual research groups. For this, we have to look at the size of the individual research grants provided in the two periods.

As seen in figures 5.6 and 5.7, the size of the average project grant provided in the 2005-2015 period significantly exceeded that given in 1980-1990 period. While this increase was relatively modest in 2005, by its peak in 2013, it was almost eight times the size of that provided in the earlier period. However, the numbers from the latter half of the 2005-2015 period should be interpreted with some caution, given that some of the extreme outliers

consisted of the framework grants and council professor grants. These were designed specifically to be significantly higher in value than the regular project grants and provided funding to more than one research group each. Even so, these numbers indicated the increased funding significance of each accepted funding application in the latter period.

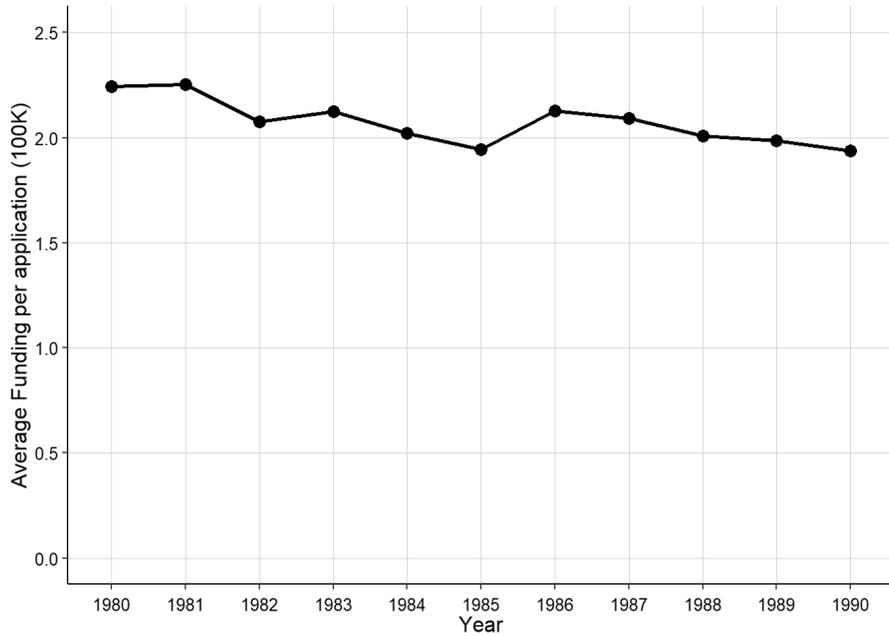


Figure 5.6. The average size of funding per accepted project application granted by MFR per year in the period 1980-1990, provided in 100K Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI.

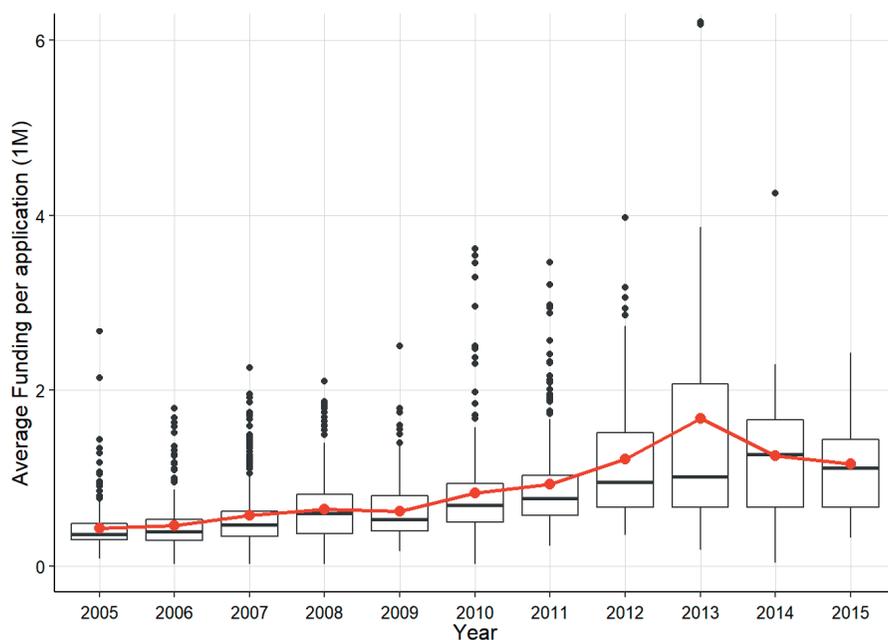


Figure 5.7. The distribution and average size of funding per accepted project application granted by VR medical research division per year in the period 2005-2015, provided in million Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI. The distribution is indicated by the box plots while the average is indicated by the line-joined dots.³⁰¹

As seen in figures 5.8 and 5.9, there were stark contrasts between the 1980-1990 and 2005-2015 periods in terms of the acceptance rate of applications. Even in the early part of the VR period, though the number of applications was only slightly higher than at the end of the MFR period, the acceptance rate had already dropped from around 75% to under 40%. However, in the middle of the VR period, an extensive increase in the number of applications was combined with a marked reduction in the acceptance rates, bringing them to under 20% in the last three years of the period. That means that the likelihood for a researcher to get their application approved dropped from about half as likely as during the MFR period in the beginning of the VR period to about a quarter as likely by the end of it.

³⁰¹ The differences between figures 5.6 and 5.7 are due to limitations in the data gathering. Collecting individual data for all non-antibacterial-related projects in the 1980-1990 would have placed an unreasonable burden on the project, as it had to be manually collected. As such, figure 5.6 is based on the total funding provided divided by the number of accepted grant applications each year.

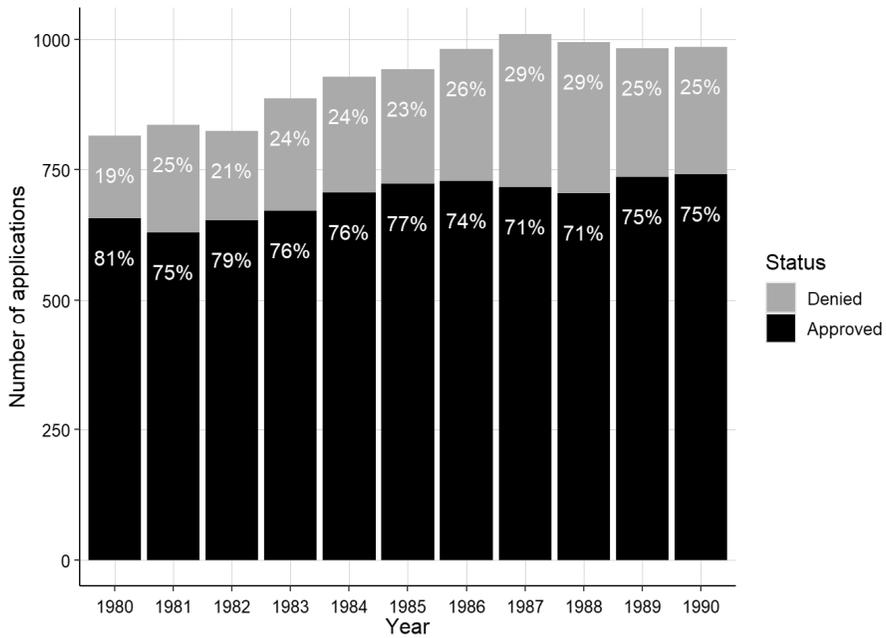


Figure 5.8. Number of applications to MFR during 1980-1990, and the proportion of applications being approved and denied. The black area represents the number of approved applications, and the percentage figure in the black area represents the proportion of applications that were approved. Conversely, the grey area represents the number of denied applications, and the percentage figure in the grey area represents the proportion of applications that were denied.

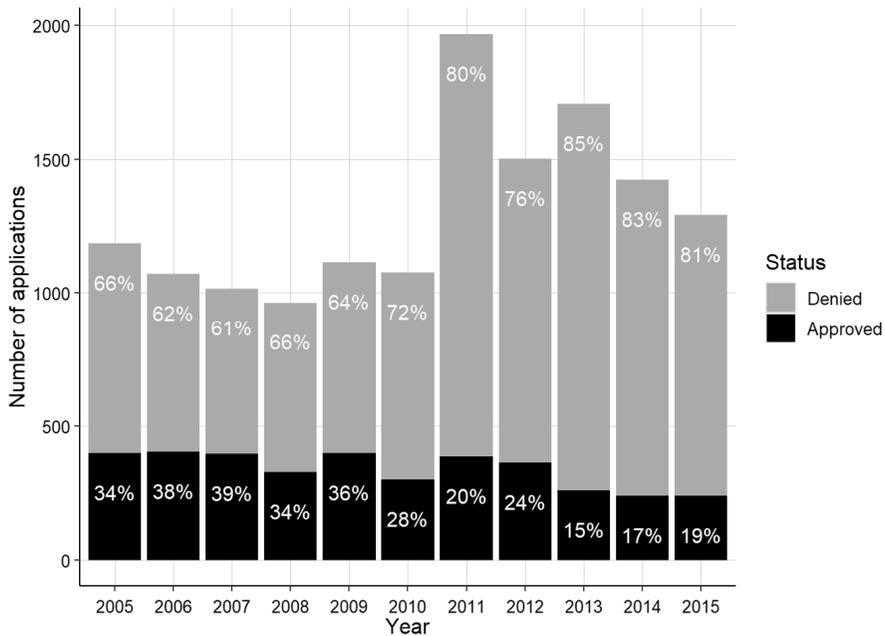


Figure 5.9. Number of project applications to the medical division of VR between 2005-2015, and the proportion of applications being approved and denied. The black area represents the number of approved applications, and the percentage figure in the black area represents the proportion of applications that were approved. Conversely, the grey area represents the number of denied applications, and the percentage figure in the grey area represents the proportion of applications that were denied.

Antibacterial-related Project Funding

From the overall project funding, we have seen how there were several developments in the MFR and VR provision of project grants for medical research between 1980-1990 and 2005-2015 such as higher funding amounts per grant and lower acceptance rates for applications. However, while these provided a general background for how to understand the changes in the funding situation between these periods, it is important to also look specifically at those projects that relate in some way to antibacterial research. In order to do so, the same statistics as previously provided for the overall funding are presented below for antibacterial-related research, beginning with the total amount of funding provided by MFR and VR in their respective periods to this field

In figures 5.10 and 5.11, we can see how the total funding for antibacterial-related research was largely stable during the 1980-1990 period, similar to that

of the overall funding. In the same way, for the 2005-2015 period, the levels were a bit higher than the earlier period and experience a substantial increase during 2012 and 2013. If anything, this increase in the later part of the latter period was even greater in the antibacterial-related research than in the overall funding, increasing two-fold from 2011 to 2013.

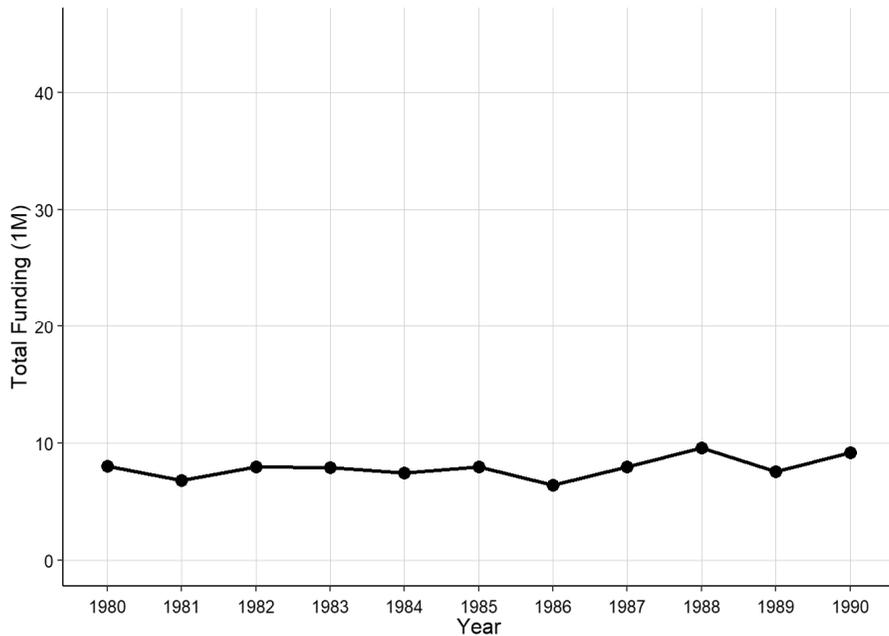


Figure 5.10. The total MFR funding of antibacterial-related projects per year in the period 1980-1990, provided in million Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI.

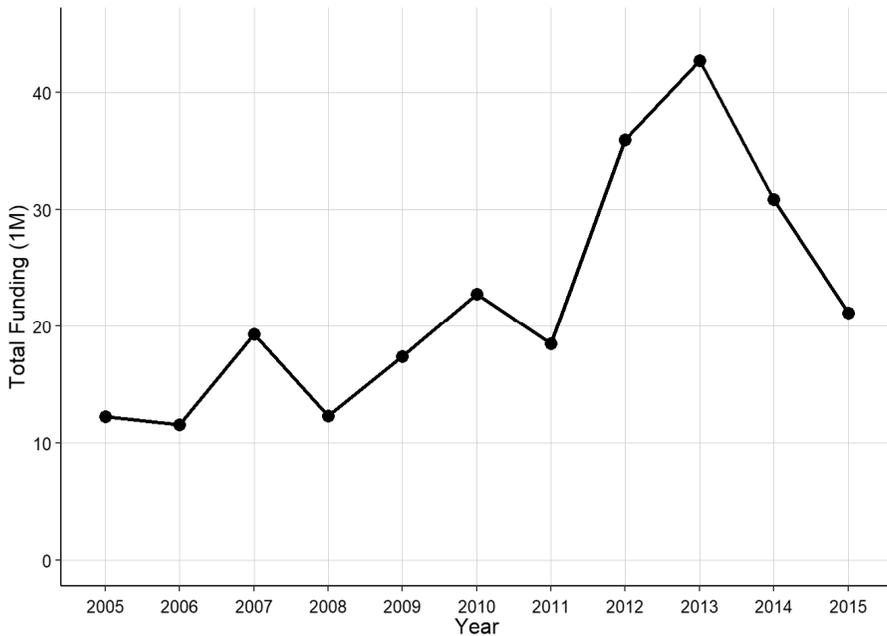


Figure 5.11. The total VR medical research division funding of antibacterial-related projects per year in the period 2005-2015, provided in million Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI.

To understand how these changes in total amount impacted the individual researchers, it is important to look at how the averages and distributions of individual grants changes over these periods. In figures 5.12 and 5.13, we can see how the average size of funding for antibacterial-related projects closely resembled that of the overall project averages in figures 5.6 and 5.7. However, there were some noticeable differences, For example, the overall project average decreased in 2014 while it reached its peak for the antibacterial-related projects in that same year. Noticeable also were the differences between the averages and the distributions. The in both time periods, we can see how there are numerous outliers well above the average funding values. In the later part of the 2005-2015 period, these outliers can largely be explained by the previously discussed framework grants and council professor grants. However, there is no such historical explanations for the numerous outliers in the 1980-1990 period.

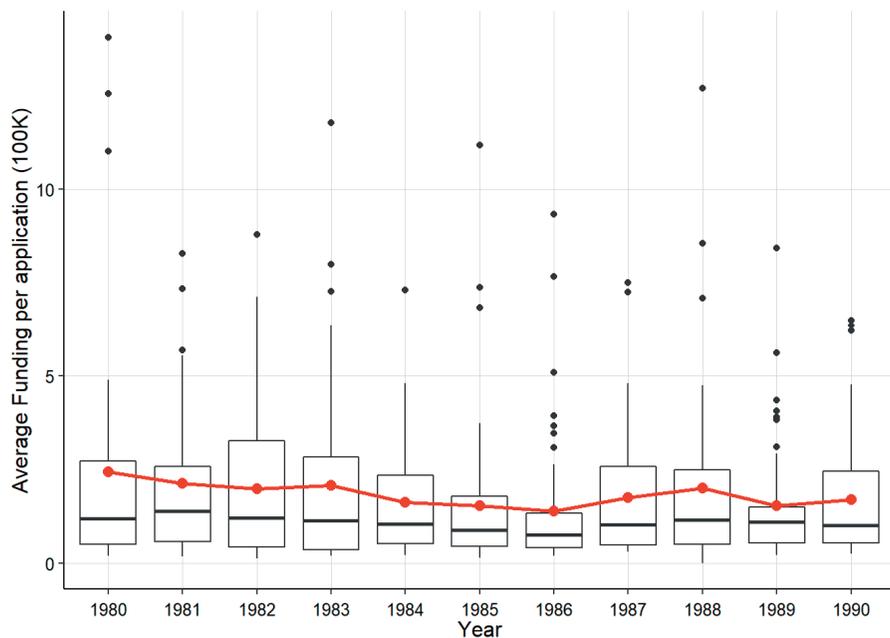


Figure 5.12. The distribution, and average size, of funding per accepted antibacterial-related project application granted by MFR per year in the period 1980-1990, provided in 100K Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI. The distribution is indicated by the box plots while the average is indicated by the line-joined dots.

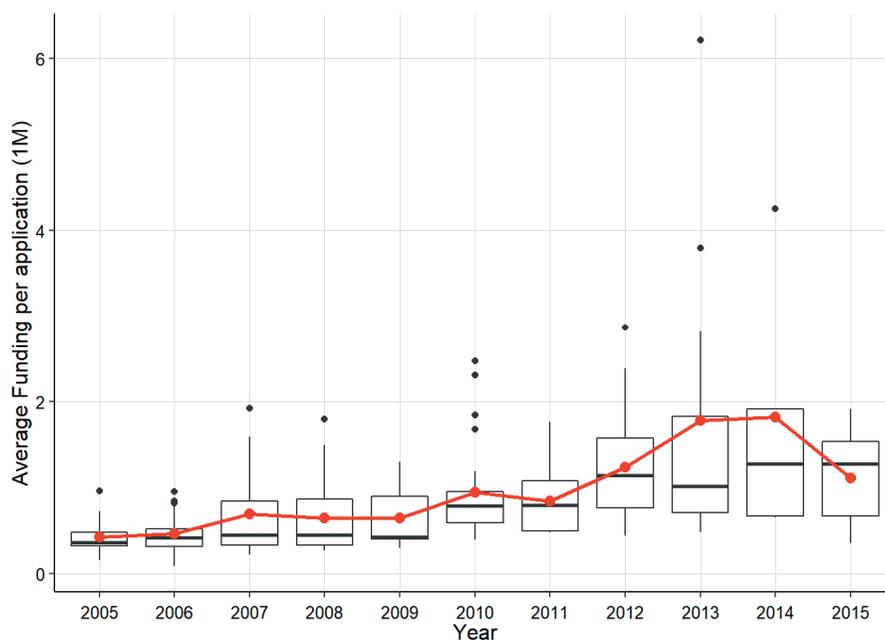


Figure 5.13. The distribution, and average size, of funding per accepted antibacterial-related project application granted by VR medical research division per year in the period 2005-2015, provided in Swedish kronor adjusted for inflation to equate 1980 SEK value using KPI. The distribution is indicated by the box plots while the average is indicated by the line-joined dots.

To fully understand the situation for antibacterial-related research, we also looked at the number of applications and how many were approved in the different periods. In general, figures 5.14 and 5.15 showed that the antibacterial-related research had a slightly higher approval rate than the overall pool of projects in both time periods. Otherwise, the application and approval patterns were similar to those in the overall population in figures 5.8 and 5.9. However, there was a more pronounced increase in the number of antibacterial-related applications per year in beginning of the 1980-1990 period, consisting of more than 50% from 1980-1985. This should be compared to an overall increase in applications, including non-antibacterial-related projects, of less than 25% in the same time.³⁰² It was also noticeable that while the approval rate for antibacterial-related projects dropped in the latter half of the 2005-2015 period, this decrease was slightly less severe than that among the overall projects.

³⁰² A minor part of this difference might be a result of how the selection process for which projects were to be considered antibacterial-related, which was fine-tuned over the data collection for the initial years of the 1980-1990 period.

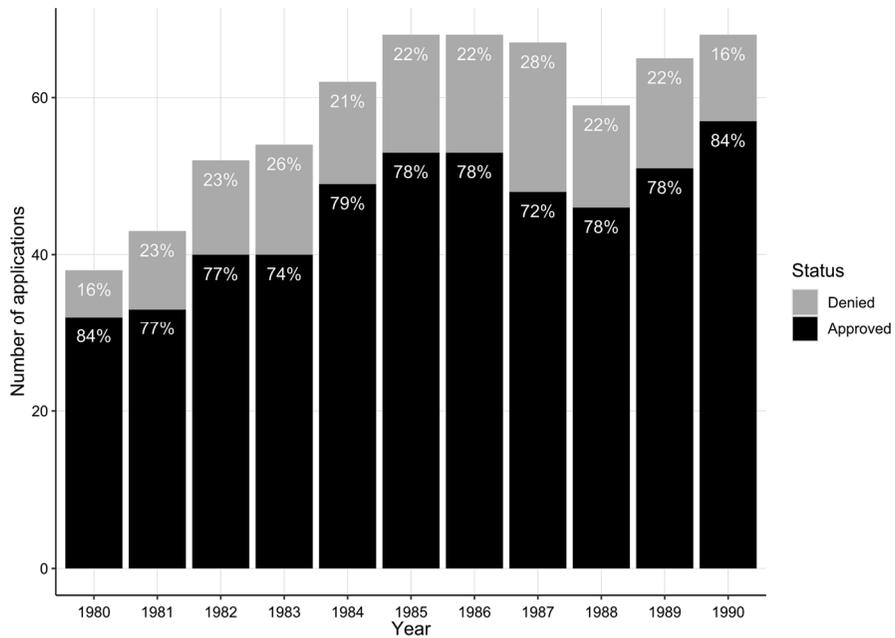


Figure 5.14. Number of antibacterial-related project applications to MFR during 1980-1990, and the proportion of applications being approved and denied. The black area represents the number of approved applications, and the percentage figure in the black area represents the proportion of applications that were approved. Conversely, the grey area represents the number of denied applications, and the percentage figure in the grey area represents the proportion of applications that were denied.

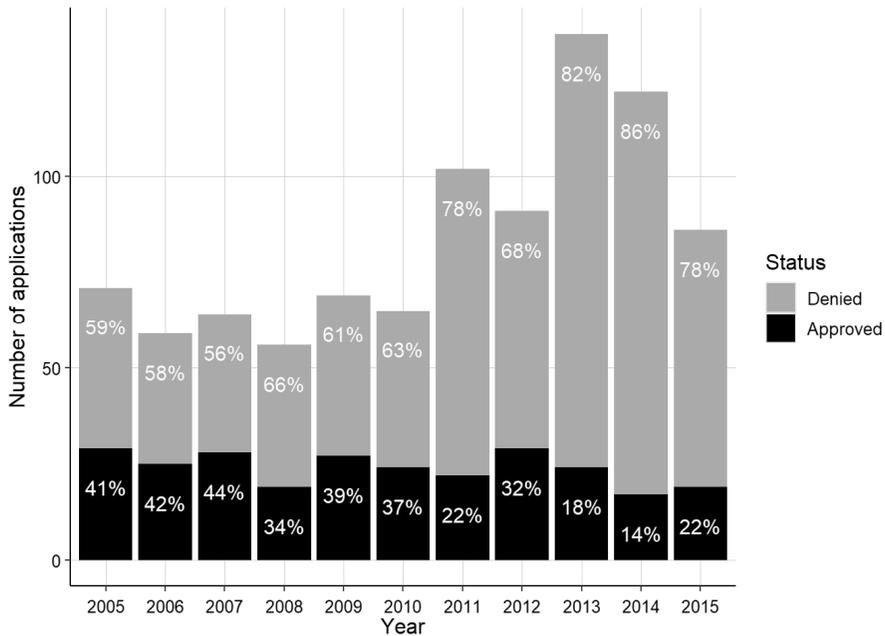


Figure 5. 15. Number of antibacterial-related project applications to the medical division of VR between 2005-2015, and the proportion of applications being approved and denied. The black area represents the number of approved applications, and the percentage figure in the black area represents the proportion of applications that were approved. Conversely, the grey area represents the number of denied applications, and the percentage figure in the grey area represents the proportion of applications that were denied.

Further Findings

The above results constituted the main findings of the MFR/VR study. However, there were some further findings in the material that were relevant to this thesis. These are discussed below.

The first, and potentially most striking of these findings, was the near absence of treatment-oriented antibacterial project. As the results for this study was compiled, it was first devised that there would be a third category registered which would include exclusively those projects that were specifically concerned with the treatment of bacterial infections. However, there was an almost complete lack of such projects in both time periods, with sometimes one or two per year, but often none. This miniscule sample meant that no meaningful analysis could be conducted using such a category. Still, this lack of treatment-oriented antibacterial studies was worth noting.

The second thing to note had been brought up before, the framework grants and council professor grants. The framework grants was directed more

towards creating environments where several researchers could conduct research in a common area while the council professor grants were meant to provide particularly well-merited researchers with the conditions required to conduct long-term research. As VR would introduce these alternative types of project funding, this indicated that they recognised that the regular grants did not fulfil these goals sufficiently. It was also noticeable that their introduction, though coupled with substantial additional total funding, coincided with a substantial decrease in the approval rate for grant applications.

Finally, while going through the data, it was noted that there were relatively few female applicants in the 1980-1990 and that they tended to receive lower grant funding than male applicants. Although the proportions of male and female were more equal in the 2005-2015 period, this brought up the question if gender had an impact on the allocation of funding.³⁰³

In table 5.1, the initial observation that female applicants tended to receive lower amount than male applications in the 1980-1990 was accurate. However, it was also noted that this difference disappeared once the academic rank of the applicants were taken into consideration. This indicated that the differences in funding was due to fewer women in higher academic ranks during this period, as can be seen in table 5.2. Furthermore, in table 5.3, the difference in funding amounts granted was also visible in the 2005-2015 period. In addition, the chance for female applications to be approved was found to be lower than those of male. Unfortunately, the 2005-2015 data lacked rank information for all but two of the years it covered so a similar analysis as with the 1980-1990 period on the effect of rank could not be conducted. However, if the results from the 1980-1990 study held up even in the latter period, that would indicate that women also in the years leading up and during the latter period were less likely to advance in the academic ranks than their male counterparts.

³⁰³ Because of data limitations, the 1980-1990 period contain only antibacterial-related projects, while the 2005-2015 period include all projects submitted to the medical division of VR.

Table 5.1. Logistic and linear regressions for application approval odds and funding per approved project for the MFR dataset, limited to only antibacterial-related applications.⁺

	Odds Ratio for Approval		Funding (SEK) per approved project	
	Model 1	Model 2	Model 1	Model 2
Male	1.22	0.70	96 550 ***	15 480
1981	0.63	0.55	-36 287	-40 298
1982	0.67	0.71	-46 261	-37 961
1983	0.51	0.50	-33 621	-38 021
1984	0.70	0.71	-74 658	-74 966
1985	0.65	0.67	-88 350 *	-84 231 *
1986	0.73	0.76	-96 610 *	-89 291 *
1987	0.49	0.42	-62 868	-69 085
1988	0.69	0.61	-33 829	-44 680
1989	0.65	0.63	-78 179	-78 021
1990	0.88	0.85	-65 937	-67 119
Docent		2.25 **		60 120 *
Professor		7.00 ***		188 331 ***

⁺Applications by non-docent/non-professor females from 1980 were used as reference. Model 1 contains applicant's gender and year of application, while Model 2 also includes professional position. SEK indicates inflation adjusted SEK granted to projects (1980-value SEK according to KPI). Significant values are in bold, *<0.05, **<0.01, ***<0.001.³⁰⁴

Table 5.2. Distribution of individuals who applied for MFR project funding 1980-1990, divided by gender and professional position.⁺

	Neither docent nor professor	Docent	Professor
Male	38	73	60
Female	12	20	4

⁺Note that some individuals have been counted twice as they transferred from one professional position to another.

³⁰⁴ For full regression tables, see Appendix 2.a-2.d.

Table 5.3. Logistic and linear regressions for application approval odds and funding per approved project for the full VR dataset.⁺

	Odds Ratio for Approval	Funding (SEK) per approved project
Male	1.27 ***	90 269 ***
2006	1.18	27 817
2007	1.27 **	150 699 **
2008	1.01	217 959 ***
2009	1.09	192 161 ***
2010	0.77 **	404 540 ***
2011	0.49 ***	504 957 ***
2012	0.64 ***	788 687 ***
2013	0.36 ***	1 256 215 ***
2014	0.40 ***	839 160 ***
2015	0.45 ***	744 807 ***

⁺Applications by females from 2005 were used as reference. SEK indicates inflation adjusted SEK granted to projects (1980-value SEK according to KPI). Significant values are in bold, * <0.05 , ** <0.01 , *** <0.001 .³⁰⁵

Chapter Synthesis

The study of MFR/VR project funding provisions in the 1980-1990 and 2005-2015 periods have provided a range of crucial insights. The total funding for medical projects through these agencies increased between the two periods, and the funding provided for each approved project application increased even more significantly. At the same time, while the number of applications per year rose moderately between the periods, the approval rates decreased drastically. This indicated that while the funding per researcher increased, enabling better access to labour and materials, the certainty of continuous funding decreased, limiting the time and freedom available to researchers. The inclusion of the framework grants and council professor grants in the 2005-2015 period indicated that VR was aware of this issue and wanted to address the disjointed and short-sighted research it might lead to.

We also saw that the trends for antibacterial-related projects were largely the same as the overall funding trends, though with slightly higher approval rates. This would indicate that when it comes to funding-related issues, antibacterial-related research, at least in the Swedish academic setting, was rather alike other branches of medical research. The part of these antibacterial-related projects that were solution oriented was highly limited both in 1980-1990 and 2005-2015, indicating that finding solutions for the upcoming antibiotics shortages had not yet become a major concern for during this period.

³⁰⁵ For full regression tables, see Appendix 2.e-2.f.

The differences in funding between male and female applicants in both periods, but especially the earlier, indicated that the conditions for academic careers were not equal for all during the period. Such unequal opportunities would lower the quality of labour available, as merits would not be the exclusive criteria for those who could pursue an academic career. It would also indicate that the collaborative environment would not be ideal, as it called into question if different forms of peer review were provided according to scientific merits alone.

However, the numbers in this chapter can only provide a limited insight into the changes in the situation that researchers faced during this period. In order to understand the observed trends and their influence on actual researcher, it is important to look from the perspectives of the researchers whose lived experiences they affected. To this end, the next chapter provides an interview study with a selection of these researchers.

6. Interview Study: The Experience of Swedish Researchers

Research is a human endeavour. Therefore, it is imperative that various developments are understood in terms of their effects on the humans that carry it out, the researchers. To study the effects of changing conditions for Swedish academic antibacterial-related research in the period 1980-2015, this study is comprised of interview data from the researchers involved in this field.³⁰⁶ This chapter provides an account of the findings from this interview study.

This chapter is divided into four parts. The first focuses on the funding situation for antibacterial-related research in Sweden, how the interviewees have perceived its changes over the study period and their understanding of the effect of these changes. The second part reports on the interviewee's views on the changes within academia over the same period, both at their local universities and more broadly. The third part provides an account of how the interviewees perceived the changes outside academia, especially within the industrial and political spheres, and their impact on academic research.³⁰⁷ Finally, there is a summary of the findings from the different parts in the chapter synthesis.

Throughout the chapter, the interviewees are referred to by their seniority, as either Older Researcher (OR)³⁰⁸ or Younger Researcher (YR).^{309, 310} There were 22 interviewees in total, with 5 OR from Lund, 5 OR from Uppsala, 6 YR from Lund and 6 YR from Uppsala. The seniority was defined not by personal age nor professional position but year of PhD graduation, with older being anyone who graduated before 1990. This was seen as important, as it provided an indication into the timeframe in which the interviewee made their academic career and hence both the times that that interviewee have personal experience of and the academic environment in which they acquired their

³⁰⁶ The researchers selected came from either Lund or Uppsala universities and received MFR or VR project funding for antibacterial-related research between 1980-1990 and 2005-2015. For a further deliberation of this selection, see the Methodology chapter.

³⁰⁷ Note though that since the three areas influenced each other, overlap will exist between them in each of the parts.

³⁰⁸ OR: Older Researcher

³⁰⁹ YR: Younger Researcher

³¹⁰ Originally, interviewees were to be referred to also according to their associated university. However, since no significant differences could be seen between the researchers from the two universities, it was seen as more important to further protect the anonymity of the interviewees by de-linking them from their universities.

understanding of what academic work is and should be. This division, between older and younger, obviously isn't an ideal representation of these factors, but was made in order to ensure a reasonable degree of anonymity while maintaining the group differentiations important for the study.

When reading this chapter, it is important to remember a few aspects of how these interviews were conducted, recorded and compiled. These aspects include the selection of participants, the language of the interviews, the construction of the interview guide as well as how the interview transcripts were processed into the text of this chapter. While some of these issues were discussed in the methodology section, it is worth emphasising them here with a focus on their implications for the interpretation of this interview study.

It is also important to recognise that the selection criteria for the participants in the study meant that the interviewees likely shared some characteristics that might not have been shared by all academic researchers of antibacterial-related topics in Sweden. It was only individuals who received MFR or VR project funding who were selected. Since this means that they reached at least a certain measure of success in the circumstances they found themselves in, it was likely that the interviewees are more positive towards those circumstances than those who did not achieve similar success. They were especially likely to hold a more positive view of MFR/VR than those who financed themselves by other means. At the same time, it should also be recognised that most of the interviewees still held some sort of academic position, especially among the younger researchers. As such, it was likely that they would advance ideas that would serve them best in their current situation, e.g. by suggesting that current research funding is insufficient.

Some other aspects of the selection worth considering is that out of the 22 interviewees, 6 were females. The male researchers were over-represented among the interviewees due to the higher number of males in the initial sample. There were only 15 females out of the 69 researchers. This uneven representation was especially pronounced in the 1980-1990 sample, where only 3 out of the 38 researchers were female. As such, the response frequency among female researchers was slightly higher than that of male researchers.

There was a markedly higher participation rate among those who received funding in the latter period (53%) compared to the earlier period (18%). This owed mainly to the substantially higher rates of researchers from the earlier period who had died or were untraceable. Among the researchers from the latter period, it should be noticed that willingness to participate in the study was markedly lower among those who had left academia for another career, while it was higher among those who were retired. While all of these response tendencies should be noted and kept in mind while reading the results of this study, they were not deemed significant enough to introduce substantial biases to the outcome.

Conducting most of the interviews in Swedish has a few implications. First, the quotes provided were translations of the original transcripts and hence not

the direct words of the interviewees. However, the interviewees were given the opportunity to read through their own quotes, as well as the translations, to minimise the risk of mistranslations. Second, the translation of the interviews was focused on conveying the meaning and implications of the quotes, rather than with an aim for literary fidelity. Third, while the choice of language was made to facilitate the fluency of the interviews, it might have had some implications for the responses provided by the interviewees. As noted by Rosenberg, the Swedish culture tend towards conflict avoidance.³¹¹ With language as a possible cue to keep to cultural conventions, an interview in Swedish might have led the interviewees to answer in ways that were less hostile, and more reconciliatory, than if the interview had been made in a different language.

The possibility of conflict avoidance or other biases also raises the question of the interview protocol. The master protocol can be found in Appendix 1 and follows the three empirical areas found below. However, the interview was conducted in a semi-structured manner, so that new questions could be introduced if the interviewee brought up potentially interesting points that required further enquiry or clarification. Some questions were also skipped, or rephrased, depending on earlier answers that might have provided full or partial coverage of the given question. The questions were also designed in order to avoid, as far as possible, introducing potential biases to the interviewees, and any modification or follow up question was provided with the same intent in mind.

An aspect that was not emphasised during the interviews were exact dates or the limitation of answers to the main time frame of the study. Although each interviewee was informed that the study focused on the period 1980-2015 in the pre-interview information, this frame was not brought up during the actual interviews, as strict limitations would hamper recollection as well as the proper flow of the interview procedure. As such, it is important to understand that the answers provided by the interviewees were likely to relate to times outside the frame, especially when it came to more recent times but also, for some of the older interviewees, to times before the period in focus.

As for the recording of the interviews, seven interviews were conducted in-person, while the others had to be carried out over video-link or telephone due to the Covid-19 situation at the time of the interview process. No obvious differences could be noticed between in-person and video-link interviews, while the two telephone interviews became markedly shorter than the other interviews, with briefer, more to-the-point answers from the interviewees. In addition, there was a technical malfunction during one of the interviews that meant that part of that interview was not recorded. While these sub-optimal instances meant that the ultimate interview material was not as extensive as it

³¹¹ Rosenberg 2002, pp. 170–171.

otherwise would have been, it was unlikely to have introduced any critical error or misunderstanding in the material.³¹²

Except for the above noted malfunction, all of the interviews were fully recorded with a portable microphone. They were then transcribed in their entirety. The transcriptions were analysed to see what themes were brought up by the interviewees within each empirical area. These common themes were then presented below as subcategories under each empirical area. For these themes, quotes were selected to represent various points made by the interviewees. These quotes were then translated to English if needed. The interviewees were given an opportunity to correct them to ensure that they provide an accurate representation of their point of view.

Finally, it should be noticed that the text below strived not to utilise quantifications such as ‘many’, ‘a few’ or ‘most’ of the interviewees, as the limited sample size made judgements based on the number of individuals holding a certain position unreliable at best. However, there were places where it used ‘some’ or ‘several’ of the interviewees. This was done for accuracy of representation rather than quantifications. It indicated that it was neither a point expressed by all of the interviewees, nor one necessarily held only by the interviewees quoted in the given section.

All of the above should be recognised and remembered while reading this chapter. The limitations of the interview process call for some reflection, and some of these are presented in the analysis of this material. However, these limitations are not enough to challenge the main findings from the interviews or the insights that can be gained from them.

Funding

This part looks at the changes in the funding situation for Swedish academic antibiotics research 1980-2015 in terms of how the interviewees perceived these changes and the effect they had on their research. As stated earlier, the interviewees were selected among those researchers who had achieved at least a certain level of success in receiving MFR or VR funding, some of them even highly successful in this regard. As such, they are likely to be more positive towards these funders and the system of external funding agencies compared to other researchers or individuals who were forced out of academia due to lack of such success.

This part is divided into five subsections. The first discusses the sources of the funding while the second looks at the amount of funding provided. The

³¹² As in, even if the interviewees in these sub-optimal interviewees would have provided insights that starkly contrasted to those of the other interviewees in the study, this would likely not have changed the overall conclusions that could be drawn from the study. Yet, details that could have provided important nuance could have been lost due to these sub-optimal interview circumstances.

third subsection brings up aspects of how the funding was distributed. The fourth looks at the connection between funding and employment. Lastly, the fifth part discusses the impacts that all of these changes had on various aspects of the research process.

Sources

OR: I received [an employment] directly after my defence in [the mid-1970's]. Then I got to use a lab assistant, or BMA³¹³ as they are called now, from my boss. After that I began to apply for funding and as well as been granted a basic funding [from the university]. It was larger when I began to research than it is now. Back then you automatically received chemicals, you were provided with an assistant, and often a second one in the form of a PhD student. And that's a great difference to how it is now, when one has to apply for everything, even your own salary.

The above quote exemplified the most significant change in the source of research funding in Sweden over the studied time period, namely the shift from university- and employment-based funding to funding provided by external agencies on the basis of repeated applications. The ORs indicated that there had been a time, generally during the 1980's and earlier, when funding for research came with a university position. Even though applications to external agencies, such as MFR and VR, were already important during this earlier time, it was more to gain recognition for one's research as having high quality and importance rather than to fund the research itself.

As discussed in previous chapters, this situation changed beginning in the 1990's when direct university research funding started to decline in real terms while the provisions from external funders increased. At the same time, the handling of money within the university became more stringent with the introduction of managerial accounting and transfer pricing changing previous research practises:

OR: Yes, it has become more complex and problematic, and it also permeates everything. There's an economism in the system now that I think is destructive. I mean, everyone needs to be paid for everything, and that's not how it used to be. You borrowed equipment from each other freely and nobody talked about getting paid for it.

This development meant a shift throughout the whole university structure in terms of allocations of funding. Because of the administrative structures of the universities, these changes were enacted differently in different departments. While some attempted to maintain semblances of the old, employment-based

³¹³ BMA: Biomedicinsk Analytiker

systems, others began allocating funding according to pure performance-based systems:

OR: Yes, yes, I mean our institution is a bit special in that way. We don't even have, we do have a few of these chairs³¹⁴ at our institution, through which we get funding from the faculty, but we have decided that everyone who is a lecturer or professor get a share of it. So you receive a basic income. It's only a few hundred thousand a year, then you pull in the remaining by teaching and through performance. So, we have a completely transparent system, but it's a harsh system, because if you can't make it within it, then things can get difficult.

The interviewees tended to have various degrees of negative attitudes towards the above changes. However, the degree to which the universities and their administrations were held accountable for them varied greatly between them. Some saw the universities as merely reacting to changes in their external environment. Others were more directly critical, indicating that they thought these developments had changed the universities at their core:

YR: Well, they have something of a structure. The universities do no longer think that they should finance research themselves. Instead, they think that they should attract researchers who can carry out the research [with their own resources].

In view of the extensive change towards science funding being based on external funding agencies, the number of such agencies did not seem to change significantly during the period, even if the relative importance of individual agencies changed. The most important external funding source in the 1980's was MFR, and for some its close associates NFR and TFR,³¹⁵ followed by minor local or disease-specific funds, as well as the clinically associated ALF-funding.³¹⁶ VR was still of some importance in the 2000's, but the relatively minor funding provided by that agency made it relatively less important for many. Instead, other agencies with more sizeable individual grants increased in importance, such as the private Knut and Alice Wallenberg foundation and EU-based science funding. Meanwhile, the minor local and disease-specific funding agencies as well as the ALF-funding maintained their importance for junior and clinical researchers, respectively.

Because of the increased importance of external funding and its multifaceted structure, guidance and help in the application procedures became increasingly important. Hence, the aid and role-modelling provided by

³¹⁴ A chair here means a professor's chair. These were traditionally tenured, permanent positions that constituted an academic leadership role at a given department.

³¹⁵ NFR: Naturvetenskapliga Forskningsrådet; TFR: Tekniska Forskningsrådet

³¹⁶ ALF: Avtal om Läkarutbildning och Forskning

supervisors and other mentors had a major influence of funding application patterns among younger researchers:

YR: Yes, I believe so, because then you get to see [different perspectives]. [X] is much more academic; he probably hasn't had as many industrial collaborations as we have had here. [Y] has always done his own thing, he's not been, you know, you have to have VR, which is really important for many. I didn't understand until later that it was important, because it looked good. No, it was more that it was good to have money, wherever it came from.

Similarly, when it came to industry-based funding, funding patterns and even direct contacts could be inherited from supervisors. However, with a few exceptions, company-derived funding was highly limited. Even for those interviewees who had such funding, it was usually a minor stream of income, e.g.:

YR: [...] I've more seen them as commissioned research for them and not something I would keep researching. For that I've had my own track, so this was more for a bit of funding.

One change in this field over the decades was how more and more of this funding was channelled through various collaborative organisations rather than directly between companies and researchers. Many times, these collaborative organisations had political entities as backers, making it hard to discern if the money received from them was actual industrial money or another form of politically directed funding:

OR: I've had small amounts from the industry in the past. Regarding the money for ENABLE, I don't know if you see this as money from industry or money from the EU. I think it's a mixture of both.

At the same time, there were a few instances where interviewees brought up substantial contribution made by industrial actors towards their research. These contributions were important not only for the amounts of funding provided, but also because they were able to circumvent some of the more problematic aspects of funding from funding agencies, such as the narrow funding periods:

OR: Yes, that was incredibly important, since had there been, you know, had there been any form of restrictions in research questions and such. I had a contract with [X], it was from [mid 1980's] and it's still the same contract today. It has changed a little, the size of the funding has been dependent on the success of his companies, one could say. But it has been continuous funding since [mid 1980's], that's [10+], that's [30+] years now. And it's been the same task the whole time, to study host-parasite interactions. But unfortunately, there aren't that many such investors.

Amount

In the previous chapter, we could see how the funding provided by VR in the 2005-2015 period extensively exceeded that provided by MFR during the 1980-1990 period on a per-funded-application basis, even when adjusting for inflation. Although some of the interviewees recognised this increase, the general viewed the amount of funding provided by the agency in the latter period as increasingly insufficient. While some of the blame for this was directed towards the decreased university funding, another point that several of the interviewees brought up was that expenses within academic research had increased more than in the rest of society. This meant that general inflation adjustment simply did not compensate for the increased costs.

These increased costs within academia stem from a number of developments. Wage development was the most common aspect brought up by the interviewees. This was especially emphasised in regard to PhD students, who for many researchers was their main source of productive labour:

YR: No, so the funding has been steady and kept up with inflation, but the salaries have more than tripled. Because now PhD students are to have a full PhD student salary, with benefits and social insurance and such. Earlier, you could receive a tax-exempt stipend and the difference between those is huge. It might be something like 10 000 compared to 50 000 [SEK] per month.

YR: Yeah, it sounds silly but receiving 300 000 [SEK] isn't much, it's not enough for salaries.

Another area of increased costs was rent. The establishment of Akademiska Hus, a state-owned company with a legally enforced virtual monopoly of university-utilised properties, meant increasing rent costs past the 1990's:

YR: Earlier on, in particular as a clinical scientist, you would probably be able to rent some space for research from the hospital rather affordably. Some space could be included in your position in the case you had a combined position in the health care system and at the university, for example an office. Now there is a government-owned company called Akademiska Hus that owns and administrates the facilities. This has clarified the boundaries between health care and research but also increased the costs for the clinical researchers.

Coupled with these price increases was the progressively increasing overhead costs during the same period, meaning that the individual researcher disposed of an ever-smaller part of the provided funding:

OR: In the beginning it was just a percent or so, now it's even up in 50%. So, it's a huge difference.

In the face of these increased costs, several interviewees gave examples of how they had been forced to strategically cut costs in order to stay competitive. One such measure was to cultivate international contacts through which foreign PhD students, with their own funding, could be obtained. Another strategy was to switch away from PhD students to postdocs, as the wage differences had decreased and the latter provided more value and security than the former. However, potentially the most criticised cost-cutting measure was to shift research away from expensive research, such as lab- and animal-based research, to epidemiological and other in silico research:

YR: But it's costly to carry out experimental work. Also, these technologies, our technologies just like all technologies, have become more advanced. And that means you can't be an expert in everything. So while I might not have thought about it quite in those terms, while there is an advantage to be broad, there's also an advantage to have cutting-edge expertise. And so we have made the choice, over time, to phase out our experimental activity and focus solely on our area of expertise, which only requires a computer. We do have these great computational machines that are costly. Hence, we have higher IT-related³¹⁷ costs than regular research groups, but our [total] costs are still low compared to experimental groups.

Several of the interviewees saw the expanded size of the academic research sector as the key issue behind these problems. Some put the blame on politicians for using the academic sector as a regional development tool, leading to the establishment of too many universities. Others put the blame on the universities for having expanded beyond their means. In either case, they think that the problem with insufficient funding per researcher came from the pot being divided among too many actors:

OR: However, I think we have a giant problem in Sweden. We have simply become too many researchers. The pie gets sliced too thin and the money isn't even enough for a decent basic funding.

YR: There weren't as many researchers, so of course you got money for what you wanted to study. Now that's not the case, as the approval rating might be around 20%. It's a tougher climate when it comes to getting external funding. And then you can wonder, are we too many researchers or is the money supply too low. Yeah, I guess it's a bit of both.

Distribution

A commonly held view among the interviewees was that funding begets more funding. According to the interviewees, funding bought the time, staff and

³¹⁷ IT: Information Technology

materials needed to conduct research and that research in turn led to the publications necessary to compete for even more funding. Coupled with the larger individual grants and increasing competition, this meant that some researchers received enough funding to expand the size of their groups far above the averages while most struggled to get enough funding:

YR: Yes, now I have, [15+] years later, I have a group that consists of 20 people, that I'm responsible for in one way or another. I've built that very gradually with different external grants, with for example EU-grants, such as IMI,³¹⁸ innovative medicine initiatives, which I was part of.

OR: [... multiple streams of revenue] are required to fund [the employment of] 15-16 people, so it's not possible. Yeah, as I said, you might get one PhD student from VR, so you have to have more [sources of income].

Several of the interviewees questioned the wisdom of enabling a few researchers to accumulate abnormal amounts of funding. Some did so by questioning if past accomplishments were good indicators of future performance, especially for older scientists who might be beyond their prime years. Others questioned if larger research groups gave the best value for money:

OR: Then there is one thing that's often forgotten. An investigation came out several years back from the then head of NIH,³¹⁹ who wrote an article, the name of which I can't remember right now. Anyway, the theme of it was "Small is beautiful". They had conducted an investigation studying how big a research group should be to produce truly innovative research, where they had looked at where the big breakthroughs came, in what type of research group. What they concluded was that the optimal number of group members was somewhere between 4 to 8 people, who were focused on a particular scientific question.

Some of the interviewees with extensive research groups even admitted that the size of their groups was above the optimal level, but that down-sizing had its own problematic aspects:

YR: And my kind of research, where I analyse a lot of data, means I could actually do fairly well just on my own and with maybe one statistician. Now I have fifteen in my group, but I could also have done a lot of research with just two. So I could, but it's really hard if one is to scale down the group, as it creates a negative atmosphere when people have to leave. If people have to leave, and it's not planned, and the group gets smaller and smaller, it'd simply cause a negative atmosphere, a feeling that we're not successful. [...] I wouldn't have anything against going down to 10, I think it would almost be a

³¹⁸ IMI: Innovative Medicine Initiatives

³¹⁹ NIH: National Institute of Health

good thing, these last 5 have just appeared from somewhere. But I would prefer to have a group of 8-10 people, and then I still have to ensure a lot of funding to keep it going.

With more competition for funding and the ability to have an academic research career dependent on gaining external funding, questions around biases in the distribution of funds were lifted by some of the interviewees. It was recognised that both the universities and the funding agencies had become more aware of various biases:

YR: With time, I think that funding bodies and also the university to an increasing extent have an awareness regarding bias with regard to evaluation and underrepresentation of different groups. Especially aspects regarding gender but also age are being paid increasing attention to. In particular more attention is focused on female researchers and their underrepresentation in different contexts and also unfair evaluations that earlier were 'under the radar'.

Still, few of the interviews expressed having themselves been the subject of any biased treatment. One who did pointed to one instance where they had repeatedly been denied funding while their professor had received funding with the same application, indicating a bias against younger researchers:

YR: And then it was really hard, because you write and fight and do everything you can, and you still don't get any money. Then, at one point, I gave my professor my application and said I didn't get any money for it, couldn't you apply with it? Then we directly received one and a half million. And those things are really irritating.

Some of the interviewees, especially from the older group, did not lift particular biases, but rather indicated that the overall quality of the decisions made by the funding agencies, as well as the competence of those on their decision-making bodies, had decreased over the years:

OR: [...] I'd say that the scientific judgement capacity and competency of those that judge the applications has decreased. It isn't necessarily, when I look at the names of those peoples in these priority committees nowadays, there are a lot of them that are completely unknown to me. And it's my opinion that the scientific competency of those who judged these applications back in the 80's, 90's and early 2000's was significantly higher. And there is also a, I have felt a difference in that, back the, the researchers in VR and MFR had much more influence. Now I've seen how VR has become increasingly bureaucratic and I am not at all as sure that the really good basic research has the same chance of receiving funding as it had before.

However, some of the selection preferences were not biases but rather explicit priorities. One of the most common was the focus on younger researchers. These age-based priorities were criticised by several interviewees, partly for

putting too much pressure on those who receive them to perform, and partly for enticing too many young people into academic research without possibilities for enough of them to receive funding further down the line:

OR: One problem has been these drives for younger researchers. In some senses it's been good, but it has been an exaggerated mantra to prioritise the young in all situations. It's had the rather amusing consequence that people who have not been had many merits and whose abilities have not really been known, have received millions, tens of millions [of kronor], just after their defences. For one thing it induces, in the long run, a performance anxiety, you really have to prove yourself before you're mature enough to do so. Then, when you are no longer all that young and promising, you've become middle aged and things have become really difficult, there was never a plan for that. Give a lot of people a lot of funding for five years and then nothing, that's not good. There should have been more basic funding for the basic sciences, and a more even distribution in the funding system.

OR: So actually the universities have, rather thoughtlessly, expanded to such an extent that there is no long-term prospect for these younger researchers to get a position. And I find this really depressing, when looking at the people I have worked with over the last few years, and their possibilities to earn a living [within academia] after they are above 40 years old are really bad. And that also leads a lot of gifted people not to pursue an academic research career, because the prospects are so miserable.

Several of the interviewees reflected on how it was to not have the right qualifications or fitting into the prioritised groups for the external funding. They then outlined various strategies for dealing with this and get funding anyway. One of the most common was to join various constellations of researchers, as many funding agencies either saw strength in numbers or had specific funding available for groups of researchers:

YR: I'm 20 years behind. That's the difficult part. They count [the publications on] your CV³²⁰ and it should be high impact factor and so on. So instead, you have to get yourself into different groupings.

YR: Sometimes, several research groups form a consortium of PIs³²¹ and apply for larger grants from important funding bodies, for example the Knut and Alice Wallenberg Foundation, the Swedish Foundation for Strategic Research, and other, in various constellations. You try to get as strong and as good synergistic combinations of people as possible and sometimes we have been successful. Then you share the main common project, as collaborators but I

³²⁰ CV: Curriculum Vitae

³²¹ PI: Principal Investigator

think you have to make sure that every PI gets a well-defined subproject that they manage as their own within the network.

Even with selection criteria, priorities and strategies, as well as biases, interviewees acknowledged the impact of luck on the ability to acquire external funding. In fact, a majority of them recognised that luck had played an important role in at least one instance of their academic career, such as:

YR: So, I don't think that it has: so far I've been lucky in that the people who provide funding seem to think that what I do is relevant. So, it was sort of semi-lucky that I chose this field of study when I started out.

Even aspects that were designed to be meritocratic, such as prior publications, were themselves often seen as based largely on luck:

OR: At least within our field it is increasingly that you have to have, you have to stand out, you have to get these papers in Science and Nature, you know, you have to get something that is really noticed. And many times, it's simply about luck, or lack thereof. It's not necessarily your qualities as a researcher that determine that.

Interviewees argued that this increased impact of luck in the academic career called into question the increased reliance on funding agencies in determining research careers over the time period. Funding agencies were seen as beneficial by some for their perceived impartiality compared to previous, institution-based hiring practises. However, the importance of luck was seen by some of the interviewees as having increased the need for local ties and friendship connections. This was due to the need for researchers to have something to fall back on in case they ran out of luck:

YR: It's increasingly random, and then it's even more important to make friends with people. If they know, this is a good person, then they will create a position. It [the current system] creates uncertainty for both the employers and the employees.

Impact on Employment

The interviewees gave plenty of examples of how the changes in the funding structures have had a significant effect on their employment conditions. Most importantly, receiving an academic research employment in the 2010's meant far less than it did in the 1980's. Some of the older interviewees reflected on how either their own employments or those of their seniors back in the earlier period came with significant research resources:

OR: For example, when I became a professor for the first time, I received both lab assistants, or money to employ a lab assistant, a secretary, a research assistant and a grant for expensive equipment.

OR: If you had reached a certain level you were guaranteed [resources for research]. If you still did any research at all didn't matter.

In the 1990's, these resources started to thin out, for example, by decoupling the resources from the employment and making them a common to the department:

OR: Yeah, there have never really existed, there were some resources during the 90's where you had technical, laboratory personnel in a pool financed partly by the hospital and partly by the university, but that hasn't existed for 20 years.

In the 2010's, employment-based research resources were mostly a thing of the past. In the few cases where interviewees had such resources, they were either highly temporal or limited to having parts of their own salary dedicated to research:

YR: Yes, so the university, of course when I came here the university actually provided me with start-up funding, and I received the start-up funding since I had no funding with me. So, to be able to get external funding, I received two years of money so that I could set up some kind of activity.

YR: What the medical faculty does, yes they pay my salary, but I have a kind of 70/30 salary, where 70% is teaching and 30% is something else. But at the same time, to be able to stay at the university, you have to keep up your research. It is really odd. So I have chosen to use my 30% on research.

In the latter case, with time set aside for research as part of their employment but no other inherent resources, things became truly problematic because of the unreliability of external funding. If a person with such an employment failed to get external funding, they could end up unable to actually utilise that time in any productive manner:

OR: Sometimes they get an employment but no research funding, that's even more ludicrous. It's not unusual, as you might have heard from others. So it'll start costing us rather soon. If we don't educate people to take over as teachers and researchers, what will happen? I think it'll become problematic.

Still, especially among the younger researchers, the ability to get time for research in the latter period was dependent on them acquiring external

funding. If they were not able to do so, and unable or unwilling to gain other responsibilities within the academic system, such as teaching or administration, their very employments might be terminated:

YR: Eventually I didn't have money to pay my own salary, so I had to leave.

Even if the interviewees were able to stay in academia, their precarious employment situation sometimes meant they had to endure financial difficulties uncommon among their non-academia peers:

YR: I had to, you know I had to ask my parents to co-sign, despite being almost 40 years old, I had to get my parents to co-sign my mortgage to get a new place and then I thought to myself 'what [kind of career] is this?'

It is worth remembering here that these were difficulties encountered by those that had already received at least one MFR and/or VR grant in their career and as such have reached at least a modicum of success, as this was the selection criteria for becoming an interviewee in this study. As some of these interviewees note, most PhD students, especially within the medical science field, either could not or did not want to stay in academia:

YR: I think there is some statistics from the US indicates that only 0.4% of all PhD graduates obtain a fixed position in academia, such as lecturer or professor, somewhere around there. So, most of them, 99.6% of all PhDs have to go somewhere else than academia to get a job. It's a bit sad that it has become like that.³²²

Even if it was not possible to verify these particular numbers, they do reflect that there was a higher intake of PhD students than future academic employment opportunities would be able to absorb. In turn, this led to a strict selection on who could enter, and progress in, an academic career. This meant that there was a high degree of uncertainty in pursuing such a career. Interviewees also indicated that once you stray from the narrow path that led to rising in the academic ranks, it was hard to re-enter:

YR: If you go out of academia, it's hard to get back in. It's, all of a sudden, VR doesn't want you give you any money.

Though diverting from the research path often meant the end of a possibility for a career in academia, there were interviewees who viewed it as advantageous, or even crucial, to have an alternative career available. Having an acceptable alternative job readily available meant that there was little risk in ending up being unemployed or in a position one did not want. This meant

³²² Note that these numbers were hard to verify and should be understood as the interviewee's perception of the situation.

that the risks involved in pursuing an academic career become more manageable. Especially those interviewees with clinical training expressed a sense of comfort in having an alternative:

OR: Now, I'll tell you, there's a massive difference if you're a clinician or not, because [if you are] you always have something to fall back upon.

If one did not have, or did not want, an alternative career outside academia, there were two paths seen as viable internal options in case of a lack of research funding. One of these was teaching, the other administrative positions. Though these were seldom planned paths, and were often seen as interfering with the possibility to do research, they were at least ways to earn a living within academia:

YR: Then I got a lectureship that made me feel less stressed, since I had teaching and which I could support myself on. Hence, I became less pressured to acquiring external funding or dependent on someone else acquiring it for me. But it was also tough, because about 70% of my time was spent on teaching, so it was hard to find time to create my own research. That means I've been in the position where I know both the pros and cons of getting an early teaching position, in my case as a lecturer.

OR: Yes, it was a little bit, it's rather coincidental, but there was a need for someone who could fill that [administrative role]. It wasn't my plan to do it for an extended time, that just happened. It fit well...

Another fact that made researchers with clinical backgrounds more secure in pursuing a research career was the availability of ALF-fund. These were government research funds given to researchers through the country's health care system and available to researching clinicians. Several of the interviewees highlighted these as an important source of funding for their research:

YR: Yes, it's been VR and ALF. ALF is that national funding that is given as compensation for researchers who work at the clinics.

YR: Then you have something called ALF-funding, and you have it for, it's actually paying your rent. And it's some form of advanced cooperation between the faculty and the county, which depends essentially on in which house you are located.

Impact on the Research

The increased reliance on external funding, and heightened competition for such funding, did not only impact the work environment of academic researchers in the studied period, but also the research itself. Below follows a few of the impacts that were most commonly discussed by the interviewees. One of the most noticeable ways in which the need for external funding affected research was by decreasing the researcher's time to perform actual research. As can be seen in the quotes below, the time that the interviewees estimated spending on applying for and administrating grants varied significantly, from about 5% to 80%:

OR: Yeah, what should I say, if you really calculate it. It's not that much time, added up, maybe 5%, so not much at all.

YR: That is really hard to say, but it might be in the order of 10-20% of my time at work.

YR: I've never properly quantified it, but I'd wager to guess that about half my time is spent on building relations, applying for and reports of various kinds, half my research time.

YR: Well, in the end, by 2015, I spent 75% of my time applying for funding.

YR: Yeah, that's gone up and down. But all of, or I'd say 80% of my time last year was spent to become a leader of a large consortium, with a total budget of 600 million kronor, which involved, I think we were 15 European partners and even some companies and government agencies. To take a wider perspective, where we would look at social and psychological effects of treatment, meaning not just the medicines but a multi-project. And we came really close.

The most common percentages of work time spent on funding applications and administration reported by those interviewees still active in academia was around 20%. The interviewees gave several reasons that could increase or decrease this time. Certain funding sources were seen as more time consuming than others, with EU grants being especially laboursome. Collaborative applications were also seen as taking longer than others, especially if one had a leading role in them. Experience was highlighted by several interviewees as a factor that lowered the time spent on applications, both as a result of

becoming a better, faster writer and by ensuring that one had previous material that could be transformed into a new application with limited effort.

Some of the interviewees pointed out that it was not simply the application for grants that had become more laboursome and time-consuming, but also the administration of them. This increased administration ranged from direct reporting concerning what the funding from each application had been used for to subdivision of common resources and more obstructive inventory management:

OR: Yeah, that, yes, I can give an example from how I made my declaration for [minor research fund], which I received [funding from] before I got VR. For that, I sent in a note stating “For that which you kindly provided me with, I have conducted this research” and then I attached maybe five articles. And for VR one has to declare every krona in specific categories and in specific ways, which one cannot manage to do without a special administrative secretary.

OR: Also, everything keeps getting more expensive and more difficult. You can't keep supplies in storage anymore, so that of course means that things get delayed quite a bit. Previously, there was less activity, you knew exactly where to get hold of things. And there was a lot of cooperation between groups, you could borrow from each other [and] there was a lot of sharing. It was only that which went to employment, to pay for employment hours [that was private], otherwise things floated around. And that also meant that, when I used materials or such, I could help out with a bit of funding, and it wasn't so strict who paid for what. Back then, we simply had a shared economy.

Yet again, the EU grants were highlighted by several interviewees as especially cumbersome to work with. The administration of the grants was so time-consuming and technical that it necessitated special assistance. The set structures of the grants also limited the flexibility on how the money could be used and hence decreased the research freedom for researchers:

YR: But some of these EU-projects, they have paper documents that have to be signed by everyone who has worked on the project, exact hours each day. It's not just me that does this, as we have administrative people doing it, it's a lot of people involved in the administration of these. It's not something I find enjoyable, but it just has to be done.

YR: EU-grants govern milestones, timelines, budgets, FTIs,³²³ all of that. And then you have certain deliverables that you came up with seven years ago, and

³²³ FTI: Fast Track to Innovation

even if you don't like them anymore you still have to find a way to complete them [...] so the freedom has become somewhat limited.

There were also interviewees who were critical of the university for adding to, rather than relieving, the administrative burdens associated with these funding applications. However, some of the interviewees noticed how the universities had improved the assistance provided to researcher in applying for and managing grants:

YR: And you see it at the university, with the establishment of more local grant offices or whatever they are called in Swedish, who clearly inform you when a deadline is coming up, point you towards grants and run workshops. There was nothing of that when I started [15-20] years ago, it wasn't even on the map. You had to guess your way, go at it and manage on your own.

The increased time consumption associated with applying for and administrating grants is not the only effect of the growing dependence on external funding over the time-period. With a few exceptions, interviewees identified the uncertainty of relying on ever more unreliable external funding as a cause of worry, anxiety and/or stress:

YR: Yeah, it is somewhat of a constant worry. You always know that you have money until a certain date, then you know that you have to apply for funding again. If I don't get any funding, what do I do then?

OR: "It becomes arbitrary, what is considered a reasonable project and what isn't. It's a real pity. So, in that sense there is more worry, that you don't know, even if you have a good application, if you'll get any money"

Two factors were especially important in influencing how much the interviewees were personally affected by this uncertainty. The first was the ease with which they thought themselves able to transition into a non-academic job. The second was how invested they were in the academic science path:

YR: I'm not especially worried, I always have a plan B [...] I know that, in the worst-case scenario, I simply change job and move to a different sector. I won't become unemployed, there will always be something fun for me to do.

Yeah, I mean you could say private enterprises are precarious, but it's different, in the sense that in often in private enterprise, you think in terms of oh, you know, I'll move to a new job because I might get a higher salary. Our university is a big organization and if you find a nice position in the university and a

research project that you enjoy, ideally you would like to stay there. You'd like moving to be your choice rather than because the VR didn't give you any money.

Another factor that influenced how much stress the funding situation caused the interviewees was if they had managed to obtain a funding-independent position, that was if their own personal livelihood was dependent on obtaining external funding or not:

OR: I mean, I think I've had a bit of luck there, since I received a permanent position early on. Others at the faculty have a really tough time. I know that 80% of the department's money comes from external funding. So, if you can't get that money, you're out. A gun against the head, all the time, because you have to have a lot of money for rent and such.

Still, interviewees were not mainly worried for their own sake. Instead, it was the responsibility associated with employing PhDs, postdocs and others, making sure you were able to pay their salaries and renew their contracts:

YR: Yeah, that's actually how it is. You have, as soon as you have the responsibility for a person you have employed, you're worried that you're not going to get funding. Otherwise, I'd say you'd not be of sound mind.

OR: I know that it's definitely a source of stress for many. We're talking about young, and middle-aged people, who have a responsibility to finance their own staff, to get the money to pay for the permanent employees or PhD students that are absolutely crucial in order to have an honest chance to compete for senior lecturer positions and such. A lot of people are stressed by that. And I have a list of examples of colleges who have passed 50 and still don't have a permanent position, so of course there is a pressure to receive funding.

While the pressure was more acute for the younger interviewees, especially those who had yet to establish a firm foothold in a university - such as a permanent teaching position - they were not alone in being stressed by the need to find funding. Even some of the older interviewees with sizeable, well-established groups were worried that things could start going the wrong way for them:

OR: Yeah, yeah, that's how it's been. Maybe not as much now, but yeah, I'm still, my assumption when I apply is always that I won't get it.

Apart from the psychological pressure of the increased need for external funding, several of the interviewees noted a shift in the social environment as an effect of this development. Some interviewees had noticed how the

informal discussions between colleagues had shifted from the actual science to issues surrounding funding:

OR: I think it has had a substantial effect in that, when I was young, we discussed, during the coffee breaks we discussed research, experiments we had carried out. Now when I sit and listen, it's a lot of talk about how to get enough money for what you're doing, how to write applications and complaints about not getting grants, and so on. I mean, the focus has shifted away from the core of the research to that which is peripheral, simply because it is hard to survive [in academia] without these grants.

YR: Yes, I believe it causes stress and worry for everyone. At the same time, if you take on a PhD student, you have a commitment for four years, but there's no funding that stretches for four years. And that means that sometimes things will turn sour. Still, I worked in a great environment, and we discussed a lot of science during our coffee breaks. But when I go there no, they no longer discuss science, but funding.

The need for external funding also meant that, to some of the interviewees, risk aversion became a necessary strategic approach to research. Several of the interviewees recognised that projects that did not fit current scientific paradigms were significantly less likely to receive funding. On top of this, it was difficult to achieve the necessary levels of detail and predictability in an application if the project was not already half-finished:

OR: One can never apply with a new project. Instead, one always has to apply with a project where one has already carried out the trials and know the results and has a half-finished manuscript. I would never [get into] research as things are today.

OR: And we, I think it was a really good project and the international evaluators said that it was a completely new idea, and everything was alright, but it lacked, you know, they needed a testable hypothesis.

The external funding requirements also meant a selection bias towards researching certain subjects, and away from researching others. With a few exceptions, interviewees argued that they had been able to research topics that they were interested in and had never been forced out of a field. Even so, several of them admitted that when choosing between possible, interesting research paths, there was a tendency towards going with the path of least resistance:

YR: That there's also been money, unfortunately that's where you can, that's what you invest your efforts [... at the same time] I feel strongly for cancer,

because that's where I started, and I still think it's highly important. So, it's like, it's a mix of where the money is and what you're passionate about.

The insecurity of funding and need for extensive publishing to be competitive in the grant application process also meant that more expensive research, as in publications per unit of funding, became increasingly non-viable. At the same time, the comparatively advantageous employment position of those with clear alternative careers meant that the kind of research that were more favourable with this group gained traction. As a number of interviewees pointed out, this meant that clinical and epidemiological studies had ever more significant advantages over experimental, pre-clinical research:

OR: And I think that experimental research is in grave danger, you know, because animal tests are really difficult, greatly expensive, with a huge administrative burden, and so on. Of course, the animal tests have improved. First of all, the ethics around it have improved, that has to be said, and the conditions for the animals. But at the same time, it has become so expensive, cumbersome and difficult that people simply can't manage them anymore.

YR: Nowadays, physicians are often less inclined to engage in experimental medical research, i.e. the kind of research that examines mechanisms and the roles of different molecules in health and disease. Instead, they devote more time to clinical research and often epidemiological studies. One may examine the effects of different types of treatment or use different registers to see how many people suffer from a disease and risk factors for it. The latter is important but becomes more descriptive research and it may not lead in the same way to new treatments. You need a combination of both, but experimental, preclinical research has become increasingly complicated and resource-intensive, often requiring full-time commitment.

The need to appeal to research agencies in order to get funding also meant that the priorities of these agencies, and those who were part of their decision-making bodies, became ever more influential in what research could, and could not, be conducted. Interviewees stated that these priorities often included 'fashionable' topics or research methods:

OR: Yes, it forces people, in order to get any funding, they have to jump into fields that are "modern", where it's easy to get money. Antibiotics is just such a field, that all of a sudden has become popular and hence has received a lot of resources that the field previously didn't have.

OR: Of course there is that latter motivation as well and there are a lot of equipment freaks, so it's a very strong component, it is. That's true. And in

these committees that approve research grant applications, they are easily impressed by such things.

While the application process was meant to ensure that only well thought-through research gets funded, some interviewees argued that the priorities of the funding agencies could mean that poorly contemplated research could be funded simply because it was in fashion:

YR: It's not that you, I mean there are those who are passionate about these [temporary priorities] or that do change their research direction, but when I hear some people, [they say things like] I never thought I'll get this, I wrote that in half-an-hour just because it sounded good.³²⁴

Since fashions change, and with them the priorities of the research agencies, this gave an advantage to researchers that were able to adapt their research to whatever was in fashion at the time without sacrificing their core focus:

CB:³²⁵ And, in your research, you said that if you have a topic that is a bit flexible you can adapt it to a topic where there is money, is it something you've seen in your research?

OR: Yes, a bit, of course that's how it goes. This with antibiotic resistance is just such an area, one of several different aspects that are of interest to my life project. The possibilities with that project, and the network, were promising, and we received support so we could pursue it for four years.

However, not everything about the application process was reported as negative. Some of the interviewees recognised that the need to send in applications made them think more carefully about their research and consider where the opportunities for future research were. One interviewee even had a point in their research career where their current research path had not panned out well and was forced to come up with a completely new approach for an application or risk dropping out of academia altogether. This new approach proved to be a highly successful path:

YR: What I have done is, for the ERC,³²⁶ I've really had to take height and aim higher, really dare to go much more 'out of my comfort zone' with that application, to reach out to a new research field. I'll be honest to say that I probably wouldn't have done it there wasn't that pressure to really nail that one. So that's where I come from when I say that applications are both good

³²⁴ The truth of second-hand claims was hard to attest to, yet some interviewees voiced them as though trustworthy enough to call the principal of thought-through research funding into question.

³²⁵ Carl Björvang

³²⁶ ERC: European Research Council

and bad. In this case it was purely good, as my research has become much better for it.

Even so, this potential for improvements through applications was hampered by the poor or nonexciting feedback that researchers often received from funding agencies. Some interviewees expressed their frustration at this lack of response, especially from smaller funding agencies:

YR: It's almost only the really big ones that you get any feedback from. With the others, you're glad if you get the money, but with almost all these small and mid-sized ones you hardly ever get to know why you didn't get any money. Then it's hopeless [trying to figure out] how to do the next time.

CB: Yeah.

YR: It's frustrating. It feels like you send your applications into a black hole, there's zero feedback.

Within Academia

This part deals with the changes within academia over the 1980-2015 period at the local, national and international level, how the interviewees perceived these changes and the effect they had on their research. It is divided into five subsections. The first discusses the local university environment while the second looks at the university administration. The third subsection brings up aspects of academic employment and careers. The fourth looks at the antibacterial-related field nationally and internationally. Finally, the fifth part discusses the impacts that all of these changes had on various aspects of the research process.

Local Environment

In terms of the local scientific environment, meaning within research groups, between research groups at the same department and between departments at the same university, interviewees tended towards being happy or at least content with their local situation. Collaboration was seen as more prominent than competition between local peers. Even when competition was present, it was usually friendly and inspiring:

OR: Yeah, within the university I have never experienced any competition. And I haven't really experienced any competition with other universities in Sweden. It's more of collaboration.

OR: No, I think that there was a fairly good collaborative climate. There were seminars and exchanges of ideas and so on. I would say it's been good cooperation and that it has persisted through the years, as long as you act generously. Sure, there was some competition going on, but it wasn't in an unfriendly way, but rather in a friendly way, it was enjoyable. You got inspired by those around you.

Local collaboration was also generally seen as easier than collaborations with peers from other universities. While a few of the interviewees found it hard to reach out and spread information locally, most saw it as advantageous that they either met their local peers on a regular basis or that they could, if they so needed, easily arrange physical, one-on-one meetings:

YR: No, but there is a great advantage to working together locally, because you can have meetings face-to-face [...] To have both Uppsala [University] and SLU so close, but also, I sit up at BMC and the proximity to the Swedish Medical Products Agency, to the Ångström Laboratory, to the hospital, it's like, and to our innovation hub, it's a maximum of ten minutes walking distance, and a little walk now and then is beneficial.³²⁷

CB: But, but this this also highlights, you say, this sort of coffee room meetings and sort of more informal settings are also important for the for the research.

OR: They're extremely important. And in fact, I think you have been to my room, and you have been in the corridor where I work. Our corridor within [our department] is the bacteriology corridor. It's extremely important for discussions and a sense of community that we are all in one corridor. We share labs, we share equipment, and we share our own little private coffee room. And so, we have lots of collaborations.

YR: ...oddly enough, it's hard to spread information within the university.

Some of the older interviewees argued that local collaboration had become harder over the years due to increased bureaucracy. However, others argued that local collaboration had become ever more crucial because of the funding and employment developments over the time period. For example, gaps in funding and other financial difficulties could be managed by reshuffling employees between local research groups:

YR: To secure employment over a longer time-period can present problems in a research environment since research funding often is varying over time. However, most times this has been solved here, for example by another

³²⁷ SLU: Sveriges Lantbruksuniversitet; BMC: Biomedicinskt Centrum

research group taking on half the employment of technical or administrative personnel.

YR: But we have a collaboration model that makes it sort of, where we have fairly tight interactions between the various research group leaders, where we try to solve things if someone needs to expand, get more space, someone needs less space, someone has a bit of poor finances or so on.

Also, local mentorship of younger researchers by their more senior peers was something that several interviewees recognised as increasingly important in order to maintain their local research environment. Especially so when it came to practical matters such as how to apply for money and managing a research group:

YR: But what I see as really important today is that the senior researchers are generous with help towards the younger researchers, in terms of help and support in applying for funding.

Throughout the period, the department structures at both Lund and Uppsala universities changed continuously. There was no clear trend if these changes were seen as advantageous or disadvantageous by the interviewees. However, changes that were designed and championed by the researchers themselves were viewed more favourably than those imposed by university bureaucrats:

OR: Early on I had a vision that, when I became a professor, I would create an environment with several independent research groups, who were united by a shared interest in molecular microbiology and chemistry, but when we pursued different research questions. Sometimes we collaborated, if we found it useful and fun, and sometimes we worked on our own studies. So the environment that we have had, and that I've found very stimulating, has been built by several research groups. Rather small, there has usually been four or three people in these groups, and all together we've maybe been 40 people.

CB: And did you have collaborations with other parts [of the university] as well?

OR: Yes, always. Or always, but a lot. When it was necessary. There were collaborations. Then you got this program coordination idea with the New Public Management thinking, which arrived sometime in the 90's, 80's or 90's. And then it began this with some administrator sitting and thinking that these should fit together in some way. And then you have to, which has proven either successful or not, most of the time not. Because collaborations are created when people have common interests and can help each other. If that's not there, then no.

Despite the generally favourable descriptions of the local research environments, some developments over the period opened up for potential problematic conflicts. One of these was the increased pressure to publish, and to be recognised for these publications. This made it increasingly important not just to be included in the list of authors of any publication you helped out with, but also to gain as good a position as possible in that list:

YR: I have never had a large research group myself, but sure, sometimes you can feel that there's a bit of competition within the group about projects and the order of authorships in a scientific publication. It may sound a bit primitive that people can argue about the order within a list of authors, but it can be very important in an academic career.

The increased competition for funding, in conjuncture with the advantages granted to researchers with a clinical background by having a back-up career and access to ALF-funding, meant an increased potential for rivalry between clinical and non-clinical researchers:

OR: Well, there is a certain animosity against clinicians, because some think that we have a privileged position within academia, since we can always go back to the clinic if things go too far.

Even so, the period has also seen positive developments in regard to the local environment. The decreased power of professors as a result of employments being mainly dependent on external funding meant that there was less potential for abuse of power or other problematic behaviour from department leadership. Several of the older interviewees indicated that professors could often act with impunity towards students and junior employees.

One aspect of the local environment that was crucial to be able to conduct research was the physical infrastructure, such as laboratories and their equipment. Several interviewees brought up that there had been an increased specialisation of the machines necessary to conduct research and hence a greater need for access to a larger array of them. No interviewee expressed having experienced any acute lack of equipment, such that it significantly impacted their research abilities. Instead, they had usually been able to find a way to obtain the necessary gear:

OR: Yes, I would say that there is a certain amount of reagents that one purchases, research chemicals and services one can buy. And then there has been a foundational equipment base where I have been, centrifuges, electrophoresis machines, heat cabinets. And then of course I've had to, alone or together with other researchers, purchase expensive equipment such as amino acid sequencing machines.

Still, some of the older interviewees recognised a deterioration in the availability of equipment. Previously, when younger researchers came into a

department, it usually had all the infrastructure necessary to conduct their research. Later on, administrative burdens made equipment sharing more cumbersome. Increased specialisation of equipment and the withdrawal of basic infrastructure support were also factors that made it harder to obtain the right gear:

OR: When I came first to Sweden it was into a fairly big department with one or two big bosses running it, it felt like we had all of the equipment that we needed. We had lots of space, lots of equipment and I would say things have gone downhill ever since. And I think it's connected with putting the pressure on to all the individual PIs to basically to get their own equipment.

Some of this deterioration was deliberate, as a way to decrease the power of the departments and shift it towards the individual researchers. However, because of the decreased possibilities for any given younger researcher to receive adequate funding, the result was, as some of the interviewees attested, that younger researchers were still dependent on getting access to equipment already acquired by senior researchers:

YR: And you need that, for if you're a fresh PhD you'll be struggling a bit with getting materials, there are machines and certain equipment that you have to have. What you can afford are the consumables, kits, laboratory plastics and such things you can buy, but everything big, like microscopes and such, they cost an insane amount of money. Most often, people end up where there is already the basic equipment is already there, so you collaborate with others.

In accordance with the increased specialisation of equipment, the need for specialised research competence also increased. This heightened the importance of employing PhDs and postdocs with a wider scope of knowledge. As such, it became increasingly important for researchers to be willing to take on individuals whose specialised knowledge of certain techniques exceeded their own:

YR: And of course I try to recruit people whose expertise supplements my own. And when it comes to postdocs, I often try to recruit people with skills that I don't have myself. Personally, I've never been afraid not knowing things or how to do them and that somebody else in the group can do things better than I can. I think, this is a way you accumulate complementary competencies.

The growth of research group sizes, at least among the researchers with most funding, also meant that there was less time for the researchers to directly supervise each employee. Hence, some interviewees indicated that they utilised senior employees, postdocs and above to carry out the daily supervision of PhD students and other junior employees:

OR: Now I have a group with a lot of senior people who have already defended, who are post-docs and even, several even have enough experience to be

lecturers but they don't have lectureships. That also means that much of the daily supervisory work, in the lab, is done by either senior PhD students or researchers, post-docs. So I have, let me think, one, two, three, four, five, six, seven, I have seven people with a PhD in the lab, out of sixteen. That's very good, it costs a lot, but at the same time you get a real momentum going, there's a lot of expertise and things run really well.

The inability to directly supervise your own students was especially significant since several of the interviewees viewed the relationship they had to their own supervisors as highly influential for their later academic careers. They witnessed about how various supervisors encouraged and inspired them, and that they often 'inherited' research areas, scientific mindsets and even students from their supervisors:

OR: You know, one inherits, I was 25 years old when I started to work with [X]. He was a delightful person and he was especially an incredibly competent scientist. If one has the privilege to be introduced to science by such a person, that means a lot. It was, then you often inherit your scientific questions.

Some of the interviewees brought up that it had been important for them to have not just one supervisor but at least a couple before beginning their own research groups. This duality or plurality meant that they experienced different approaches to science and ways to tackle various obstacles. Here, one advantage towards the latter part of the study period was that the practise of co-supervision during PhD studies became more widely used, offering the students the duality that otherwise only came with a postdoc position:

OR: Yes, definitely. There have been, there have been two individuals in my career who have, partly my PhD supervisor and partly my post-doc supervisor, who have influenced me a lot. In both good and bad ways, but altogether in a very good way I'd say. They were very different, with different things that they emphasised and different strengths.

YR: So for me, in 98 I had two supervisors, my main supervisor here and then I had a female supervisor, a chemist from [X]. It was a very good start as a PhD student, you usually didn't have two supervisors before, it was rather unusual back then. And these two had fairly different backgrounds, one with more of a pharmacist background and the other more biochemistry. So that meant that I had two role-models and the two of them were quite different, which was really good.

It was emphasised though by several interviewees that often it was not the PhD supervisor, but rather the postdoc group leader that had the most impact on their future careers:

YR: Well, I'd say that the most important thing for me was to have a fantastic mentor when I was a postdoc. I mean, my PhD supervisors were also good, they gave me a lot of freedom and such, but I'd say that the one who made me go from sort of mediocre to actually be able to submit a paper to one of the more prestigious journals, that was my post-doc mentor.

OR: Not an organisation, but someone who has meant a lot for me is my boss in the US, where I worked for two years and experienced a research environment that was totally incredible. Without that experience I would not have continued research here in Sweden.

Except for encouragement and inspiration, supervisors and other mentors could also have a more direct influence on careers. Such direct actions were fairly rare, but in the earlier period, this was more commonly through interventions to assure career advancements. In the more recent period, it was more often through direct employment of previous students:

OR: Well, I heard through rumours that they were going to cut me off at the research council and then, but then [my mentor] intervened and told them that they had made a commitment to make me a research assistant and, as such, you also have to provide the money.

Several of the interviewees, especially among the older group, emphasized that it was not only direct supervisors that influence younger scientists but the wider environment that they find themselves in. The local environment provides necessary support in a myriad of ways, including practical know-how, a sense of community, constructive feedback and so forth:

OR: Hmm, no, I believe, when I think back on it, you need some tradition, that's to say if you're at a university or somewhere else, you need there to be some heavy competencies there. You don't necessarily have to continue in the same footsteps, but it's something to build upon. That much I can say. It's very hard to start something from scratch and get anything done. It's like entering a kitchen without any pots, it makes it very hard to be a chef.

OR: Yes, there have always been mentors and interactions and so, I'm not a product of myself, no. So it's been very strong, the friendships, the influence, the moulding, the corrections, definitely. And I strongly believe that research is something that is collectively developed.

Several interviewees noted how the increased focus on providing funds to individual researchers, rather than the structure they operated within, meant a progressive deterioration of these structures. Some even spoke of the academic culture as being under threat from these developments:

OR: You know, it was an elysian time, really. We, the older colleagues, say that we got to experience a time when research came first, and younger researcher were protected from economism. You were part of something bigger, there were more mentors, here at old [previous department] we had a large connective tissue group that was well financed and that managed the finances. And there was an infrastructure that has been completely demolished.

OR: ...academia should be protected and seen as a culture that needs to be preserved. That it's not just an education factory, nor just an impact factory, and I think some of the tendencies right now aren't good [... academia is] a culture that needs to be preserved and I believe that. That's how it is, old lefties become value conservatives as they grow older, but that's how it is.

Administration

CB: If instead you look at the university, the administration, governance and so on, how has the cooperation or...

OR: I mean, there was none. The so called, now it's a support function, but back then. My wife knows Torgny Segerstedt's daughter and she told that when Segerstedt had Christmas parties for the university administration, the whole thing, probably all of them, they had them in their own apartment.³²⁸ They probably had a huge apartment, but it can't have been enormous. That couldn't happen now. Now this support function, it has changed drastically, both economically and what the meddle in and control, it's totally different. It's a dramatic shift.

CB: And has the effect of this been positive...

OR: Negative, definitely

Although the accuracy of the above anecdote might be questionable, it captured well what several of the interviewees had perceived as a reality. During the studied period, they saw the bureaucracy of the university grow, both in size and in its largely negative influence on the research carried out at the university.

There was a general sentiment, especially among the older interviewees, that the university administration steadily wanted more information about how and what various departments, research groups or even individuals were doing. However, it seemed unclear to most if the increasing intrusiveness was what drove the increasing size of the administration, or if it was the increasing size of the administration that drove the intrusiveness. Either way, it was generally seen as unnecessary and expensive:

³²⁸ Torgny Segerstedt was the rector of Uppsala university 1955-1978.

OR: Yeah, in the beginning it was very little, but then I wasn't a Professor. But even when I became a Professor, I had a lot less administration than I had when I stopped being professor after 30 years or however long it was. So it's a huge difference and, towards the end, administration could be half of one's work. So yes, it is a great disadvantage. And I think that most of it is due to a lot of rules stemming from parliament, that require them to have statistical information on everything, and that also requires them to double-check everything and make sure that you're not dishonest and using the money wrongly. [...] if you buy something wrongly, then there is an expense that was not accounted for. However, if it costs ten times as much to control that something like that never happens, then that control has a net cost.

OR: It has changed in one way and that's that the administration of the university has grown, and the bureaucracy has expanded [...] In the beginning of my career, you could handle the administrative matters in no time, a few hours a week, two hours a week if you were head of a section. I think it's something that has just become more and more, and it applies generally, one can see that development within science and other parts of society, that the bureaucracy has increased, along with the number of orders from above to fill out this or that survey, or I don't know what, it's become more and more such things. Things are more cumbersome and it's something that worries me. It's not good for the artistic part of science with a lot of decrees, often senseless decrees from above.

Different interviewees highlighted different administrative burdens that had been especially problematic in regard to their own research. For example, some complained about how the managerial accounting increasingly employed by the university, with internal transfer pricing, created a lot of extra steps when collaborating with other parts of the university:

OR: Yes, all the cutbacks have led to things like the substrate division becoming an independent unit that should declare profits or deficits and so on. Hence, the diagnostics division cannot simply go and pick up plates. Instead, they have to write that I have picked up so and so many plates and then it gets registered, and they have to make some form of internal payment. This means that researchers have to pay a lot of stuff internally, and this has made research more complicated and, at the same time, made it necessary with external funding.

Another example of how bureaucratic burdens hindered or limited research was in the impositions of various restrictions on research based on what the interviewees viewed as inflexible interpretations of research ethics. Such restrictions could manifest in requirements such as those for handling test animals or patient information:

OR: There has been a great change [...] In Skåne vi have restrictions concerning how much patient data we can look at in one go, so to speak. So, if

we have a big study, like now with 175, we can only look at 50 at a time and that means that, if you want to go back, things become very difficult. Then an administrator has to give permission for you to look at a predetermined number. If you want to look at some other, then you have to remove some from the group and then put in [the ones you want], so things become pretty cumbersome. Previously, things were far more open. We didn't even have to lock our corridors, because that kind of risks were not really present.

The main problem with these administrative burdens were that they took time away from actual research work. Several interviewees found that they had to spend most or all of their time on various administrative tasks, leaving little to no time for actual research:

OR: ...we would have had much better research if those who administer the researchers' time didn't rob them of the time they would have needed. Time, that's what the researchers have lost.

YR: The more senior you become here, the more administration is required of you. It's a good thing you have PhD students who can, who are active, so that you don't lose that, that which is fun, that which is the creative part of research.

Another often raised issue was that the researchers could seldom see what purpose these administrative tasks filled. Sometimes, this was because they were not convinced of the reasons the administration gave for issuing them. Other times it was because the administration did not provide any justification why they were issued. This led one of the more successful interviewees to contemplate if their research group would be better off outside of the university structures, while another saw it as their mission to protect those carrying out the actual research from intrusive and burdensome tasks issued by the administration:

OR: And in some ways we're almost, it feels like we are sort of self-sufficient. In truth, we don't need either the department or the university. No, but of course it has to exist, but not for what we do and our daily work. I mean, you always need administration, but most of our administration is carried out within our department. So, it makes you wonder if you couldn't move from the university, which is mostly administration, and still be attached to the university.

OR: You know, it's not just from the administrators, there are also a lot of ideas coming from the faculty and university leadership that make you wonder what kind of benefits they're suppose to bring. I remember, when I was the head of this section, there higher-ups would sometime send us requests and then I kindly asked them to tell me, before I relayed these requests to my group

leaders, to tell me what they were good for, what the purpose of the requests were. Until I get a satisfactory answer to that, I will not relay it [, I told them]. Most of the time you didn't get any reply, and I remember feeling very satisfied when I could protect the research from all of these senseless administrative requests.

The interviewees noted an increased distance between the academic and administrative staff at the university. Because of the increased pressure to research and publish, in order to retain funding, it had become ever harder for academics to take on the positions of trust. Such positions, consisting of administrative tasks intimately related to teaching and research, had previously been seen as services to the profession and had been reserved for members of the academic faculty. However, the interviewees indicated that taking on such a role was increasingly incompatible with a successful academic career. Most who did so did it either out of necessity or because nobody else stepped up to the task:

YR: It's a bit hard to continue researching at the same time [as taking on an administrative position]. At the faculty level there are a lot of people who decline and even at the department level it is fewer people volunteering to sit on the department board than in a long while. Which might be that it's a tougher climate, you have to stay competitive in your research to get funding. We are very dependent on external funding here, but at the same time it's about understanding the university, in my opinion. I get quite a lot from understanding the university better, with what I think is a rather small investment.

OR: And it has coincided a bit, the alternative had been to look for financing from the EU and others. So I chose to be in charge of the administration at the department instead.

Although the general perception of the expanding administration was negative, some interviewees gave examples of what they considered advantages provided by the increased administrative support. These examples included issues such as creating a functional psycho-social environment in a group or a department, as well as aid in managing the tasks involved in applying for and administrating certain funding:

OR: I think it is something that is very important, to have a good psychosocial work environment, in my opinion. And that has changed, I must say. At the same time, I must say that people accepted a lot more 30 years ago. You could have someone sitting at the top, behaving however they wanted, and that stuff doesn't work today. And that's a good thing, that they way we do things has changed in that regard. That said, from an administrative, department point of view, the problem is that these are the most time-consuming kind of issues, and each of them is unique and demands a lot of time. But it is, I think it's good

that there is assistance, if it happens then there's assistance available from high up, from the administration, from HR³²⁹ and so on.

YR: The Medical and Pharmaceutical Faculty has what we call an EU-office, although its actual name is the unit for research support or something like that, where there are I think four or five full-time employees, people who are employed solely to focus on understanding the calls and regulations, and to aid the researchers in identifying potential grants and handle the application process. They do an incredible job. I would say they are vital in the ability to receive grants and also when you have received one, because there is a lot of reports, documents and systems to handle.

Still, the general perception of the university administration remained negative. Some interviewees did not only question if the university administration was fit for purpose. Instead, they asked if the administration was actually designed to support the research, or if the roles had become reversed:

YR: Yeah, it is, generally you could say that, just in like in all bureaucracies the universities have a question concerning who's there for whom? Is the administration there for the researchers, or are the researchers and teachers there for the administration? And it becomes, it's always a sort of tug-of-war [between them], just like in all bureaucracies.

When questioning the legitimacy of the university administration, overhead costs were brought up by several interviewees. Especially the older interviewees noticed that the bureaucracy surrounding the administration of funding had increased significantly, with some expressing it as an added burden that they also had to pay for this through increasing overheads:

OR: When I started to research, I had funding from a private foundation and I went to the bank and deposited their cheque, then could use that money when I paid the bills. I didn't have to declare anything anywhere. Now, when I declare what I have done, I have to send it to four different places in order for everything to be done properly. On top of this you always have the 20% overhead, in order to pay for all of these control functions.

OR: Sure, it has increased a lot. In the beginning it was just a percent or so, now it's even up in 50%. So it's a huge difference. That's for sure.

While estimates of the sizes of applied overhead varied among the interviewees, there was a general questioning if the overhead paid gave value

³²⁹ HR: Human Relations

for money. One interviewee for example compared the levels of overhead deducted in Sweden with that in the US, but also the manner in which it was deducted and the expenses that it paid for:

YR: If you look at the Swedish system we pay, well it varies between universities what we pay, but somewhere around 20% in overhead costs, on all our costs. In the US the overhead charges are around 40-50%, Harvard even has 100% overhead. So, when NIH funds a grant application they then pay an additional 100%, the same amount as the grant, directly to the university, as overhead. So, it's not that your own grant is reduced, instead the NIH has negotiated together with the universities, for various levels of overhead, and that is what they pay in addition. That overhead then covers rent and all administrative functions. Meanwhile, in Sweden, for example at Lund university, rent is not included, so you have to find that money in some other way, such as through ALF-funding or other funding sources. So, there's more administrative fiddling with practicalities, which I never experienced in the US. I had to get used to that when I came here.

However, when it came to the rising costs of conducting research at universities, not all of the blame was put on the university administrations. Several interviewees also brought up Akademiska Hus, the state-owned property company operating a government mandated semi-monopoly on ownership of buildings used within the Swedish higher education sector. While it was recognised by several of interviewees that most of the facilities provided by Akademiska Hus were of high quality, their rents were perceived as unreasonably high:

YR: Yes, there is a certain merry-go-round of the funding from the state. The state gives with one hand and takes back a lot with the other hand. We have very nice lab space and offices, but the rents paid to the government-owned company Akademiska Hus are very high. It is about an order of magnitude of around 4000 [SEK] per sqm and year. The grants we receive on the university side are also usually taxed at 20-25% [overhead], which goes to various expenses and overall maintenance at the university.

Some interviewees expressed an understanding for the actions of the universities as necessary given the changes to their regulatory environment. However, others expressed a concern that these changes had altered the universities and their motivations to the core:

YR: I mean, the university is only concerned about getting in as much overhead and research funding as possible and ignore anything else. They have no interest in the actual research what-so-ever.

This fundamental change at the universities, in how they are run and their purpose, led some of the interviewees to view the university more as a research hotel. By this, they meant that the researchers paid overhead and other fees in

exchange for facilities and the quality assurance provided by being associated with a given university, instead of being the collegial bastions of scientific pursuit often seen as the ideal:

YR: I think that the university in many respects is a fairly anonymous employer, while one's own research group is run in a way that is often reminiscent of a small company. The contacts outside of the research group most times take place within the own academic department and outside of this, you have the help of HR and economists, which is of course important.

CB: Okay.

YR: As I am getting older and have taken on more responsibilities, I get more in contact with the university. I also think it is generally better now than it was before. They pay more attention to the psycho-social work environment and have better HR support than before.

YR: ...the university has a certain bureaucracy, like you simply have to pay your overhead, and of course they help us, but it mostly feels like they're pulling in money to be able to pay rents, materials, salaries and so on. And in return you get their stamp, that you belong to Lund University. But any more help... I feel like it's a constant struggle, all the time. You have to be creative.

OR: You don't have control over the situation, and there are no teams either, you are your own team. That's how it has become and it's because the universities have more operations than they have the money to handle. So, every person has to pay for their own salaries and their own rent. More like you are a consultant than a proper employee.

Employment

While employment conditions undoubtedly deteriorated during the time period, with a loss of the previous secure positions with guaranteed substantial funding, the interviewees discussed a range of various employment types available in the latter period. It was especially the younger interviewees who reported being or having been in contracts with highly different terms. These contracts ranged from secure positions with a high degree of freedom to part-time, hanging-on-by-a-thread positions:

YR: ...even if I can't get another penny, ever [in external funding], I'll still receive my salary from the faculty. So I, I don't need [to worry]. I even have a certain basic funding, so I can have a little bit of an operation beyond just myself.

YR: I am fully employed at the university, but only 70% of the salary comes directly from the university while the remaining 30% I have to earn in some other way, for example as compensation for teaching or with external grants in the case where they can be used for salary.

YR: But it was also tough, because about 70% of my time was spent on teaching, so it was hard to find time to create my own research. That means I've been in the position where I know both the pros and cons of getting an early teaching position, in my case as a lecturer"

YR: I quit, in 2015 I left the university and since then I have been working at a pharmaceutical company. Still, I have a VR grant since then, so I'm still employed for 20% at the university, where I continue to make experiments in other projects.

Several of the older interviewees discussed having seen the universities expand their staff without much or any concern for how this would impact the quality of employment contracts offered in the long run. They were worried about how this would impact the possibilities of young academics to make a career for themselves, especially with regards to the investments made into educating these individuals. There was also concern about how this would impact the ability to recruit and retain suitable candidates for PhD positions, seeing as PhD education was traditionally built on suffering bad employment conditions in the short term in order to achieve better conditions in the long term:

OR: Haven't PhD students always been seen as slaves.

OR: So actually, the universities have, rather thoughtlessly, expanded to such an extent that there is no long-term prospect for these younger researchers to get a position. And I find this really depressing, when looking at the people I have worked with over the last few years, and their possibilities to earn a living [within academia] after they are above 40 years old are really bad. And that also leads a lot of gifted people not to pursue an academic research career, because the prospects are so miserable.

OR: But I see younger researchers now that I am worried about. Good people with good ideas, but they don't get any funding. And it's a huge waste for

society, that these people, you pay a lot to educate these people and then their basically just discarded. It's completely senseless. They don't even get a salary, they have no employment, no salary and no funding. Sometimes they have an employment but no funding, that's even more ludicrous. It's not unusual, as you might have heard from other.

Interviewees who had had employments outside of academia in recent decades testified about better employment conditions in other sectors. Generally, these interviewees viewed the choice between academia and non-academic work as a trade-off between freedom of research and better employment conditions. However, one interviewee had previously held a position at a governmental research institute that had both better employment conditions and the ability to pursue a substantial amount of self-directed research:

OR: It was actually really good, I was able to have my own group there because I got one of these, they don't exist any longer, special research position that they had at VR. It was a 6-year long position where you got, you got your salary and research money, a sizeable grant. Since I got one of those, while I was employed as head of microbiology there, it was worth it to pursue my own research there. Then I had, somewhat paradoxically, but I had more time to do research at [a government agency] than I have had at the university.

One aspect of employment that several interviewees mentioned had improved over the latest decades was the decreased power of the professors. Previously, with the professors having substantial control over the functioning of the departments, such as hiring and firing decisions, they wielded a substantial amount of power that, when used arbitrarily, could have unjust consequences for younger academics. However, with the increased power of central university HR departments and decreased importance of departmental funding in relation to external funding, this power had decreased. Still, at least one interviewee admitted that because of this importance of external funding, and its increased concentration into the hands of a few researchers, the arbitrary power had merely shifted from those with certain positions to those with the money:

OR: And the professor, back then professors were professors, and there were good professors and there were bad professors.

OR: Or it's more those who have the money. Those who have all the money, they are the ones that make the decisions now.

The decreased power of the professors was supposed to limit biases in employment and other important decisions. However, biases persisted, sometimes implicit and sometimes explicit:

OR: It's the same, now there is, this is a parenthesis but at [a faculty at a Swedish university] they had an advertised position that was supposed to be filled with a female applicant, even if there were male applicants as well. Then they had to withdraw the position, because the men that applied were more qualified. Then there is, then there's real, substantial discrimination. You can't keep doing that kind of stuff.

Decreased abilities for local hiring practises also created their own biases. Some interviewees indicated that it had become harder for people who had a genuine passion and aptitude for a subject but lacked inter-personal and self-promotional skills, what one interviewee referred to as the 'nerds', to make a career in academic science:

OR: It's very much become that you have to market yourself and that kind of stuff. And some of us are a bit shy by nature and wouldn't have made it. That's how it is. And the nerd is completely out, and often that's the one that comes up with something new.

There were indications from the interviewees that the increased reliance on self-promotion came from the shift from departmental hiring to external funding as the determinant for careers within academia. Previously, department heads could have a rather intimate knowledge of the skills and potentials of a candidate, since they had often worked together for some time. By contrast, funding agency reviewers were provided with a short, standardised glance at a junior applicant's history, which did not say much about their actual capabilities:

OR: And that, I have evaluated a lot of things, at various level and I find post-docs to be among the hardest, because they have their PhD thesis and then you have to predict what will become of them, if they have a career [in academia] ahead of them? Are these good people who will be able to do good research in the future? It is truly difficult. But when you have someone a bit more senior, then it's much easier, because then you can simply, then you can see, has this person delivered.

This difficulty to judge the potential of junior applicants also led to a bias towards giving funding and employment opportunities to senior researchers with a more proven track record:

OR: But now everything should be done through applications to funding agencies who know nothing about these individuals, and then they tend to go for safe bets. So new talents don't get anything at all, it's just the old ones that the same thing for years that get the money. That's the picture we see right

now, that it's a few researchers that get all the money, and they don't have the mental capacity anymore. It's a waste.

The need for junior scientists to be able to self-promote and show scientific skills was something that the interviewees were well-aware of, and some even admitted to letting it influence their research. It was not ethical to put a PhD student on a high-risk project since it might not provide them with the credentials they needed for their future career:

YR: [...] but of course, if you've started something really difficult that's not going to work out, then of course you don't keep banging your head against the wall. But I've still chosen, the things that I've chosen, I've always had ideas that, you sort of have a feeling for what is going to work out and what isn't. It's really important when you have PhD students, you can't start someone on something that isn't going to work out, no.

It was also important to protect the junior staff from the effects of the insecure funding situation, essentially shielding them from understanding the full degree of volatility of academic employments:

CB: And the possibilities to get external funding, has that been a source of stress or anxiety for you?

YR: Yes, it has been quite a few times, that you do not really see how to sort it out all the time. You have hired PhD students or postdocs and then, in worst case, you may not receive extended grants. Of course, there is always some stress. You do not want to transfer that stress to those you have hired.

Even while some of the interviewees were trying to protect their junior staff from feeling the realities of academic employment insecurity, such protection could only go so far. Interviewees recognised that many PhD students would grasp the insecurity and competition facing them if they should continue with an academic career and were put off by them:

OR: And, you know, they come in as a graduate student in their 20s and then they see that there are people in their 40s and mid 40s and late 40s, still without permanent positions. And I think that's very frightening.

YR: It seems like it has become many more people with a PhD, so the selection [for funding] has become narrower. It's interesting to think about those who are eliminated, who don't get funding.

Junior staff also recognised that senior staff rarely had time to be involved in the fun, interesting parts of science, and therefore might not be willing to continue their career in academia. Some interviewees also recognised that the

education given to junior staff didn't match the tasks they would face if continuing in academia, but were better suited for production-oriented jobs:

YR: Then there are many who think the best part of research is to work in the lab, to produce results, and you don't get to do that as a group leader. So, in that regard our research education is a bit lop-sided, since there is very little in there about managing a group, applying for funding, and all these administrative parts. You have to learn that later, on the job. So what we have, it's not career focused. Actually, as I see it, to a large degree we use our PhD students as lab labourers.

The insecurity of a research career, coupled with the fact that senior academic researchers seldom engaged in actual science, were highlighted by a few interviewees as possible reasons as to why few clinically-trained individuals continued with their academic research career despite facing better conditions than their non-clinical counterparts:

OR: Sure, that's how it goes, it's a medical school here and a medical department, yet we have only a few medical doctors who continue with a research career. We want them. Then you can ask yourself, they have a professional education with secure, well-paying jobs from the county. Then you can ask why they chose to endure an insecure career as researchers.

While the general view was that employment conditions in academia had deteriorated significantly over the period, there were a few positive developments in the latter part of the period. With universities competing internationally for certain senior staff that were seen as leading within their fields, and aided by the 'autonomireform' discussed in the methodology chapter, some had introduced a few positions with better conditions in order to be able to attract or maintain these particular individuals:

YR: Well, the most important thing for me has been that I've been happy at Uppsala University. Another important factor for why you stay at the same place [is] the possibility to become a promoted professor that exists at Uppsala now, though we'll see how it becomes in the future. It's incredibly important.

General Field

All interviewees had taken part in some kind of a collaboration outside of their own university at some point. Such collaborations could range from individual contacts with researchers at other Swedish universities to large international networks. The interviewees indicated that the most common successful way to establish such contacts was informal, through meeting people at conferences, being introduced through common contacts or reaching out after reading interesting publications:

YR: Actually, most of the time it's informal in some sense, like, you meet people at gatherings, or you know someone who knows someone and you begin talking and you find that you have similar interests, and the collaborations start that way. So that's quite common. It's a less formal, and in Sweden scientists know each other, or know about each other to some degree, so you know what expertise people have and so on.

Several interviewees saw these collaborations as crucial for their ability to research and, for some, these external collaborations were more important than their interactions within their own university. Some aspects of these collaborations had become more crucial in recent decades like the ability to cooperate on expertise and technology. Others had remained of steady importance throughout the period, such as the need for moral support and mutual encouragement:

OR: Purely from a morale/personal point of view, the research group in Lund was very important and also this research group, who were always positive. You could say there was a good atmosphere without competition.

YR: In the beginning you were fairly independent, with your own equipment. The equipment wasn't all that expensive, so you didn't have to collaborate. Now the projects have become so complex that you don't always have expertise in all areas that are needed to answer the question, you don't have access to all the equipment on you own, so you need to cooperate with others and their equipment. So, in that sense, the complexity and the need for equipment has meant that you collaborate a lot more.

Some of these collaborations could become rather complicated, spanning multiple countries. This was especially true when highly specialised equipment or facilities were required:

OR: I did a study a few years back, which I did together with professor [X] from Ireland and a company from England that produce assay discs, as well as a researcher from France who could conduct the tests, because I couldn't do much myself. So the English company produced the assay disks, [X] and I formulated the thoughts and experiments, and the girl from France did the actual experiments. Then I wrote the publication. Such [collaborations] are necessary.

YR: We have it on the clinical side here, but we're not allowed to do any experimental trial there, so we're restricted to the patient samples that come to us. In order to be able to do my research in this area I have had to go back to England to get help. When you, you have to verify, in the end, certain products then you have to have, we have to use mice. And these are big facilities with negative pressure, where people go dressed in coveralls, since it's airborne

diseases we work with. It's worse than HIV,³³⁰ which is transmitted through blood. And through this I've gotten in contact with other people. I've been to Germany, to deliver documents for EU-groups where you get an insane number of collaborations, such as about nano-particles, groups that research these small particles that you can package your products inside.

While several interviewees attested to the increased need for collaborations in order to combine the methods and expertise needed to publish in high-end journals, and how this need had become greater over the last few decades, there were also those who indicated that collaborations had also become more problematic during the same time. This was primarily because competitions for the premium spots in the list of authors had increased due to their importance when applying for research funding:

YR: Research collaborations are good, but there are sometimes built-in difficulties. The order in the author list of a resulting scientific article has great signal value as a merit. You cannot really be more than one last, senior author of a manuscript. Being the last author is often a sign that you have the main responsibility for the scientific article. Often you are also the one who receives correspondence from other researchers who have questions or views about the published work. It may sound a little strange, but sometimes it has now been done so that you mark that several researchers are senior authors, in order to share the merit value and also mark that you share the main responsibility. Research collaboration can be difficult but at the same time very positive and strengthens research in many ways. As a young researcher, you are often the first author, which is important at an earlier career stage. If you usually end up in the middle of the author list, it can be difficult to get research grants because it is not then clear that you are running the project.

Because of the difficulties brought on by increased competition over spots on these lists, social compatibility between collaborators had become increasingly important. When choosing collaboration partners, interviewees seemed to value getting along well with their partners as much or more than their particular skills or assets. It was especially important to understand the field of study in a similar way:

YR: But it's often a lot like, I'm drawn to people with sort of the same philosophy as I have, in some sense. And then there are other people who are more, who are maybe a bit more hierarchical than I am. They have to be included everywhere and if they have lent a strain to you, they may want their name on your papers and such. Then there are very strict rules about this. And then you might think, well, is this really necessary and you don't really get the same kind of bond with that kind of person. So, you create a network with people who kind of share your philosophy.

³³⁰ HIV: Human Immunodeficiency Virus

OR: [...] he came here and told me he'd found my article somewhere and he got amazed, because he felt that this guy understands these things. Back then he was in marine microbiology. And then he closed himself in a room, after getting all of my articles that he could acquire, and after reading them he told himself he had to meet that guy. But what has nice about this guy was that [...] this guy understands these things. It's not everyone that does.

To reach this social compatibility and facilitate collaboration, mutual understanding of each other's situations was lifted by several interviewees as highly important. Such understandings could be established by working together, especially in a supervisor-student relation, or at least visiting each other's laboratories and local societies:

OR: Yeah, it's usually old PhD students that you keep in contact with as they disappear into other, commercial establishments or into society, or they themselves become researchers or teachers. So it's almost lifelong contacts you establish. Some you have more contact with, some less, depending on circumstances. It is rather important I think, for both parties.

YR: But it's necessary, in order for it to become an efficient collaboration, you still need to have some physical meetings. The ones that have worked absolutely best have been where you have actually been to their lab. [X] in [Y], where I have been there things work really well, I know exactly where people are seated when we have a discussion, you know, and I know what their lab looks like.

YR: Yes, I think that what's important if you want to research these kinds of topics is to have a connection to the context. The health care system, the disease context and such, and I got that by working at the health ministry in [X] and being associated with the [Y] university. And I worked partly with PhD students from [X] and partly with Nordic and Swedish PhD students, whom I twinned with the PhD students from [X] for this. So, I think that there are a lot of university collaborations that are reasonable in that way, because you can contribute with different things.

The situation within individual fields or subfields could have a large impact on the ability to establish and maintain collaborations, to the point where it could scare people from entering them. If the leading researchers in the given field thought too much of themselves and acted petty, the whole climate could become hostile. Generally though, the interviewees seemed rather satisfied with the situation in antibacterial-related field:

OR: There are some fields that are, it varies a lot depending on who the leading people in the field are. Sometimes you can be like, I definitely don't want to even touch this, since there are so many massive egos that are there and that are fighting each other. I don't want to get involved in something like that. But I'd say, from my perspective, that the field of antibiotics resistance, the whole field, the medical, natural science part of it, I feel as though it is fairly open.

Several interviewees also indicated that there is a lot of value in networking between fields and even disciplines. Certain initiative and centres created in later decades, especially around wider issues of antibiotic research, had boosted such opportunities. However, this otherwise mostly happened slowly over a research career through various institutional connections:

OR: Then I've been, I am a member of [prestigious national organisation] and there I have had exciting meetings with people who have another scientific background, whom I've learnt a lot from. And I have met people from other faculties. I mean, when you've been in Lund almost your whole adult life, you'll have ended up in a lot of different university contexts, like committees and the like. So I've met people from other faculties with completely different research focuses, and that has also taught me a lot.

Interviewees brought up the importance of not just collaborating with other researchers in Sweden but to reach out internationally. For some, this was especially important, either because there were a limited number of potential collaborators nationally in the area of their specialisation, local clinical situations and knowledge that enable and enhance research possibilities, or because they simply found it easier to work with international collaborators:

OR: [...] there isn't so much nationally, or even within Scandinavia, but more internationally.

YR: And I have partly run it through research collaborations [X University] - Uppsala University - [Y University] in [country Z] partly through research funding, but also come to realise that this is actually about business case development.

YR: Yeah, it's also a bit odd, but I find international collaborations easier. [...] The closer you are the harder it is and the further apart the easier, in my experience.

Unfortunately, rigid structures for international exchanges, such as through postdocs, can be hard to combine with social obligations and family life. Therefore, some of the interviewees expressed a desire for more flexible ways

to gain international experiences and connections that could enrich their research:

YR: Yes, it's a lot about, I think that this thing with conferences. Now, I've been rather restrictive a while, since I have young kids, so you can't go as you please [...] But this with going to conferences and meeting people, it's very inspiring and it makes you think in different ways than the environment you're already in, as it can become a bit restrictive. I've never been to a post-doc abroad, which can be a disadvantage as well. I can definitely see that. I'd really like, if one could wish for something, if there were better systems in Sweden for going on the sabbaticals. And it doesn't have to be these two-year positions, because that'd be hard with the funding, the family situation and so on. Those could also be useful, a year abroad where you can bring the family, but say a two-three-month position, it shouldn't be that hard to manage and it also needn't be that expensive.

Whether national and international, the one key feature of many of the most successful collaborations were, according to the interviewees, spontaneity. While some favourable collaborations came through large, organised structures such as EU applications, these were often cumbersome and time-consuming with unsure outcomes. Instead, when individual scientists connected on their own accord because they knew they had various assets that could be combined well or because they formed friendships around common passions, these were more likely to function smoothly with better results for less investments:

CB: And these collaborations, are they the result of formalised circumstances or are they more spontaneous?

YR: No, they've been very spontaneous. For example, some research group have a certain mouse that has a specific mutation that could be interesting to use or someone else has a certain reagent or something. So, it's very spontaneous, no formalised, written collaboration.

CB: Then you get to know about these things through rumours or through publications?

YR: Yes, you see what people have published or you hear about them somehow.

OR: Yes, that's my view of it, definitely, and friends. You sat around discussing research and then you thought, maybe you should try someone's method on something, things like that. It wasn't... I believe it was quite successful, I do.

Another indication of the informal nature of the scientific collaborations were the lack of contracts or other legal structures for them. Although some collaborations in the latter decades had to be contractual, usually because of requirements from funding agencies, most collaborations throughout the whole period were based on trust between the participants:

OR: No, for God's sake, there were no written agreement. No, no, no. Just, you know, [informal deals] between buddies. But no contracts, no way.

This trust between scientists was substantially challenged in the publication process. In order to get results published, researchers have to submit articles to journal editors so that they could be peer-reviewed. However, a few interviewees recounted how their findings, or those of people they knew, had been hijacked by editors who had made sure to delay their publications in order to publish similar articles, and how this had made them more cautious in their publication efforts:

OR: You can sometimes notice, in this harsh world of publications, when at first we looked at a completely different interaction and sent in a manuscript that was very well written. They dragged their feet and wanted us to specify specific bindings to absurdity. Then it turned out, in the end, that when they finally published it, then in the same month, the editor of that journal published a paper of their own that was very similar to ours.

OR: There is a tactical element to [publish in lower impact factor journals] and it's not just because it is easier, even if that's also good. But if you send a really good essay to a major journal, then there are many who can pick up the idea and quickly, with huge resources, redo it themselves and reject your first essay. I've seen it and I have thought about it.

However, the risk of stolen results was one that every academic scientist has to accept since publishing one's findings was seen as mandatory. Scientific communication and spread of results was seen as a core duty. However, interviewees also found that the pressure to publish for the sake of having published had increased over the period. The individual researcher needed to publish articles in order to improve their own career possibilities and gain the ever more important external funding. In addition, the universities were also judged by how many and how prestigious their publications were:

OR: If I had been a full-time researcher it would definitely have been publish or perish, and of course I see that in others. But due to this [clinical employment] I haven't been as stressed. Things are not quite the same when you have a clinical background. Of course, this can sometimes be a disadvantage, because you don't publish as rapidly [...], it had been better if

things had been faster. Yes, it would have been more important for your career to be able to get more money.

YR: It is more like there are pressures in various ways. What's a little unfortunate now, that was published recently, there was an evaluation made about two years ago for all the research performed at the various universities and in the various health care regions, and where one of the things that was brought up, within research output was publications and so on. And if you look at Lund University, then it showed that we publish too much but not good enough. However, at the same time, it showed that what is published at Lund University, in large parts, is of use within health care and other sectors. It makes you wonder about how we measure impact through journal impact factors and how they relate to useful information being published. You could wonder: What's so important with high impact factor publications?

It was viewed as important to publish often, and in well-renowned journals. Several interviewees also discussed the need for researchers to get their names in the right places on the list of authors of any given articles, with the first and last position being the most sought after, as those indicated the most merits when later applying for positions or funding:

YR: Scientific publishing has a special culture. It is important to publish articles in as good journals as possible, i.e. with as high an impact factor, an indicator of the journal's quality standing, as possible. From a purely career point of view, it is then good to be the first author at an early stage, when you are a PhD student and later on as a postdoc. But thereafter, it is important to develop an independent profile and mark this as the last, senior author to show that you have your own line of research.

Several interviewees brought up that the pressure to publish had changed the mentality around publications - from being a way to spread new knowledge – towards becoming an instrumental way to gain the recognition needed for career advancement. Previously, even some of the most well-renowned researchers had only published relatively few articles in non-top-tier journals. By the end of the period, such researchers would have likely lost their funding since such publication strategies had become incompatible with maintaining a place in academia:

YR: After all, looking at one's merit, not only does the number of scientific publications apply and perhaps not even to the journal's prestige reflected as an impact factor. For example, I remember that those who discovered that a bacterium could cause peptic ulcers, the *Helicobacter* bacterium, had difficulty publishing their results in the beginning and had not published that many articles either. Despite this, their discoveries have had an enormous impact and they received the Nobel Prize eventually. Similarly at the university here where one of the historically foremost researchers, I do not think published more than

in the order of 90 articles, often in what is today seen as a lower impact journals. At that time and in his case, it was not so important, the research still attracted attention. This has changed. Now it probably does not work that way any longer, instead there is a great advantage of having the scientific articles published in reputable magazines to disseminate the new scientific knowledge and get continued support for your research. However, in one's merit, other factors are also important, such as supervision, teaching and the ability to recruit research grants.

This pressure to publish was recognised by several interviewees as detrimental for the quality of scientific publications. It incentivised researchers to publish thinner and thinner articles, so as to maximise the number of articles one could obtain from a given body of results:

YR: When I began, we didn't talk about impact factors, we knew that there were things called impact factors and that you should have a certain number of publications in your thesis, but you didn't talk about this mass publication for the sake of publishing. And I've somehow ignored it until maybe 5 years ago. But when I look at what my international colleagues publish, I find it to be cheese slice publication. There are some substantial works, but generally they get thinner and thinner.

YR: Yes, my feeling is that the amount [of publications] have driven people towards publishing lighter, thinner and more. Before, there were not as many opinion papers, people studied and proved things. Nowadays, there are these 'I believe...', 'This is a wide paper about...', simply with people's opinions. Which provides a publication, but might take three weeks to write. You see a lot of that now.

The reliability of the published articles was also called into question by the way journals, who were supposed to ensure proper peer-review, were incentivised to publish as many articles as possible:

YR: There are strong economic forces in scientific publishing. Publishers have large costs for editing and printing. However, the entire publishing landscape has changed dramatically with the introduction of electronic publishing on the internet. It allows a much larger number of articles to be published. An example is the scientific journal PLOS One, an 'open access' publication, which publishes in the order of 25-30 000 articles per year and the publication fee for each article is in the order of SEK 15 000. This explains the strong economic interests in scientific publishing. Nowadays, publishing companies often have a cascading system where manuscripts rejected by journal with a high impact factor are cascaded for consideration in a journal with a lower impact. That way the publishing companies try to protect their incomes. The Swedish Research Council and the universities have often promoted "open access" publication, i.e. scientific articles are available for everyone to read. Previously, university libraries paid large sums of subscriptions. It is not

entirely obvious that it is better with a large volume of “open access” publications that also costs a lot for the universities. It is also very important that publication volumes do not increase at the expense of quality review. You simply cannot publish everything.

Apart from influencing the articles produced by academic scientists, the pressure to publish also affected the actual science. Instead of considering what research would be most interesting, helpful or needed, researchers had to take into consideration what research was publication-friendly, especially if they wanted to publish in the most prestigious journals. As the interviewees pointed out, this could mean things like making sure to use the most in-fashion methods and equipment and abandoning fields that were no longer considered ‘hot’:

YR: It’s that, if you are to publish in good journals, it requires a lot of different methods and many various forms of expertise, and if you don’t have a giant group, you’re not going to be able to have all that expertise in-house, so you go into collaborations with others.

YR: But it helped that once upon a time, peptides were a hot research area and then suddenly, when an area is established, it’s no longer as hot, making it harder to publish and harder to get funding.

CB: So, there is fashion in ...

YR: Yes, as in everything, there is fashion within science. And all of a sudden, the research I was doing was the colour of [inaudible]. And this largely determines which methods you can use.

Some of the interviewees also discussed their perceived need to always have a stream of low-risk research in the pipeline to cover for more high-risk projects that might not provide publishable results:

YR: [...] it’s always about producing new things to get your next grant. And that means that, while these grants are for three years, it’s really hard to finish a project within three years if it is a bit bigger, and a bit more forward-thinking and exploratory so to speak, because you don’t know exactly how things will work out. Then it becomes easier to do these, we measure this and report it, check, then we’ve ticked another box. I don’t think that’s an advantage, so you have to try to, if you have enough money you can try to balance a bit, so that you have some people who produce something and show that you’re constantly doing something, and then these bigger [projects] that will enable you to receive more substantial funding.

Projects that did not align with previous research in a field or even questioned existing expectations became ever more dangerous to pursue from a career perspective, as journals might be reluctant to publish them. As one interviewee gave an example of, even findings that would later become broadly accepted as a major advancement for a field could initially be hard to publish in any reputable journal:

YR: [...] once, with a new method that me and a PhD student had developed, it was incredibly hard to publish it in the beginning, but we managed to get it into a fairly good journal. Still, afterwards, it proved to be a fantastic method that has led to a lot of publication and has been featured for awards and so on. But when I started out with it, I received no support from my colleagues. Rather the opposite, they voiced their disbelief in it. And it's hard to know really why I stood up for it and subjected a PhD student to that. Sometimes I feel that it's easier to just do same-same, it's met with less resistance than doing something different. It's a pity.

Apart from the choice of topics and methods, some interviewees were afraid that the pressure to publish was also obstructing the scientific discussion between academic researchers. This is because the fear of someone stealing ideas or results, and the increasingly negative impacts of such a theft, made academics less likely to discuss results and share ideas that had not already been published:

OR: Yeah, if you go to conferences there are very few who talk about anything that isn't already published, that's for sure. Which is disappointing, and not good. But I guess it depends on the money, I think it's the competition for money, ideas and careers. It's important to hold on to what you've got. It's something that has changed with time.

In regard to this hostile competition, few of the interviewees who had wanted to uphold the norms of openness had paid a price for doing so:

YR: I have consciously chosen to, when I go to conferences, I don't like being all that secretive in my communication and in the vast majority of cases that's worked out fine, but a few times I have been scooped, people have actually nicked my ideas [...] after a while you learn whom in your field you can talk openly with and whom you have to be a bit careful around.

With all of these changes, several of the interviewees questioned if the scientific journals still held a real purpose in today's academia. Publications had become an increasing burden both in terms of workload and funding towards the end of the studied period. Furthermore, the articles that were published were hardly read anymore because the sheer volumes of publications made it almost impossible to read more than a fraction of what was published within a field:

OR: It has changed over time. Even so, I try to retain the view of it that I used to have because, from the beginning, publishing was about spreading discoveries and things you had found out, nothing else. But now it has become some sort of career device, since both employers and funding agencies look at where you have published, how often and such, and it's very unfortunate in my opinion. And it has become a huge burden for research, because there are so many publications now that you don't have time to read them. It also depletes the research funding as well, since in most cases it costs money to get published.

There were, however, a few interviewees who did not voice the same concerns. To them, publications were still a positive part of science and retained its former core values:

YR: That's how it is in our world, that others get to partake of what you've been doing and what you've found out. But I wouldn't say it's a pressure, rather it's a natural part [of science]. I'd even say it's a relief to publish something, because it marks an end to something, to get it on paper. So I see it as a natural part, a good part, also that others can benefit from it.

Others though argued that the increased publication pressure did not only undermine the value of the publication within modern science, but also challenged the core principle of honesty in science. With increased incentives to steal the ideas of others or to publish thinner, less well-researched articles, there was a heightened risk that scientists chose utility over truth. Some interviewees expressed this as a growing moral failure that they tried to guard themselves and others against. One interviewee had told junior colleagues the following:

OR: "Never, never, never ask if it is beneficial, only if it is true"³³¹ And that has to be the guiding principle for a researcher. Otherwise, I sometimes joke that, if you lie to others, that's alright, but if you lie to yourself, you're doomed.

One way of defending against the erosion of values, such as honesty, was to take pride in one's work and one's subject. Several of the interviewees pointed out the importance of traditions and a shared sense of history, both locally and within the wider discipline:

OR: It's very, the environment is important and it's really important with a history. This field that I work in, and have chosen to stay in, had its absolute peak in the 60's, maybe 70's. And the environment as a PhD student was extremely creative, and the networks I started to build then are an important part of why I've chose to stay in the field. So the environment is important, to have a continuation within the field. It sounds old fashioned, but it's really

³³¹ A quote from Kaj Munk, a Danish playwright and freedom fighter. Original Danish: "*Aldrig, aldrig, aldrig spørge, om det nytter, bare, om det er sandt*".

important, it's in the walls somehow, a tradition. It's been important to carry that tradition forward.

Another way to strengthen the integrity of a subject was to take pride in one's educational activities and view it not only as a way to earn one's wage but primarily as a way to supply the field with well-educated individuals:

OR: And it becomes a different kind of activity since, as a teacher, more than 50% of your time is spent on education, if you have to engage with the students. So your main activity is to educate, on both graduate and post-graduate level. So your research becomes a part of your teaching. It's another purpose to it. You're not aiming to develop some kind of product, no, or the product is student you educate. That's how it is, it's a different point of view.

A further way to guard against a drift in quality or values was to compare the state of a discipline in on the local or national level with its international practise. Interviewees made several such comparisons, using both positive and negative examples:

YR: If you look at the situation at Harvard and other large institutions, there are a lot of big labs where they have two postdocs who have to fight about who can complete things first. That is, in my opinion, rather unpleasant and not especially productive. They get assigned essentially the same project and then you see who is the first to deliver, and they know about it. In one way it increases productivity by competition, by I think it reduces it in many other ways.

YR: If you look at different countries, China has come very strong during the last decades, not least in terms of preclinical, experimental research. The reason is an increasingly strong economy with large investments in research, not least preclinical. The fact that research requires increasing resources has made it more difficult for us in Sweden to compete. Historically, we have been successful in Sweden with preclinical research. Many basic discoveries and technological developments have been made in Sweden, especially the decades after the war, in the 50s, 60s and 70s, and are still being made here.

Research

The changes occurring in academia over the decades that the study is interested in clearly had significant impacts on the research being carried out at universities. Often, the perception of the effects of these changes on scientific research was negative among the interviewees. Even so, with a few exceptions, they indicated that they had been able to pursue the research paths that interested them and that they thought were most fruitful, even if it had become harder to do so:

OR: In the beginning I was generally interested in finding out new things that were truly unknown. Then you have to steer towards where there are some resources for this. So it's a mix of what one wants and then you discover important research projects, so you go there. It's a mix I'd say.

OR: I have wanted to work with interest-driven research, be around other people who also want that and enjoy it, and talk science and such. And I've had the possibility to do so. I feel like, if I had been young today, I wouldn't have been able to.

Interviewees did not report having been forced by circumstances to make drastic changes on their research focus. If anything, even if they would have wanted to go in another direction, they could not have done so as their credentials would not carry over from one field to the other. This would make the transition too demanding, unless the field in question was one of the prioritised ones with substantial amounts of easy funding:

YR: Researchers often have a line of research that they follow through their professional lives. It can be difficult to change fields, for example from cancer research to research on atherosclerosis. If I lack experience in the new field, it is much more difficult to get research grants because you may not have any clear competence in the new field.

OR: Yes, and that's what so sad, to see these short-sighted investments on whatever it might be, where the government says we will solve this problem and throws a 100 million [kronor] at it. And what comes of it, nothing. Either people are already working on those questions, or someone changes the title of some project, but they keep doing more or less the same thing. People continue what they are already good at and there not much new stuff coming from it.

Sometimes, minor changes in specialisations could be necessary to differentiate yourself from other researchers, especially previous supervisors:

YR: I guess it was when I was starting up my own research area. That was also a little bit about achieving an independence from my previous supervisor.

Another reason why diverting from your main area of competence was dangerous in the latter decades was that failure became less and less of an option. This meant that you had to play it safe by not switching fields. Even within your field, you had to make sure that the research you carried out would provide expected, publishable results. The room for trial-and-error that had existed previously had, according to several interviewees, disappeared:

OR: And there it's, you know, there's always been 'publish or perish', but by now it has become acute in a different way. So any kind of long-sightedness or to try, I mean it can be very different. Very good researchers might have a higher hit percentage but many that I talk to, my friends then, it might be 1 or 2 out of 10 ideas that turn out successful. But it has, there are no margins for that today.

Another change over the studied period was that it was relatively more common for the younger interviewees to identify as being part of a discipline that was defined by how it studied things (i.e. its methodology or technology) rather than what it studied (i.e. its subject matter):

YR: [...] through my colleague [X], we actually received the first professorship in this subject in the world. That's meant that we've attracted people to our research group and have had a great international reputation for this technique, which can be applied to various therapeutic areas, not just antibiotics. So we have been known more for the technique, rather than it's applications.

This focus on 'how' rather than 'what' you study coincided with a reported increase in the complexity and specialization of the scientific methods. Several interviewees point towards how this meant that it was harder for the individual researcher to have access to and master all of the methods necessary to make the kind of findings that could lead to publishable articles:

OR: Yes, there you point to an important change actually, that hasn't been so clear in my own research. But research today is so completely different from how it was 50 years ago. Then I could, in the US, sit with an immunodiffusion on a small glass plate and receive a result that I could interpret in such a way that it became a whole article. Today one has to have one of these super computers, Whole Genome Sequencing.

As noted earlier, senior researchers had little time towards the end of the period to be part of the actual research work. Some of the interviewees remarked that this had impacts on the science. They admitted that they often did not know about, or did not understand, the details of the studies their employees conducted:

YR: [...] after a while you don't really have time for that [lab work]. And that's a transition that a lot of people struggle with, in the beginning. Because you want, that's what you're good at, what you have been educated within. Both as a PhD student and as a post-doc you manage your own projects and really have full control over every detail in a project. And then you have to let go of that to someone who will do the actual work and you yourself is supposed to become some sort of leader.

There were a few interviewees who said that they still took time to be part of the actual research work. However, this was done out of a passion for the work and meant making other sacrifices like working overtime:

YR: You certainly get less time to be active in the lab. Naturally, I did lab work all the time until I defended my thesis and also during my postdoc years. And then, once I started my own group, I more had to take on the role of supervisor and mentor and manage a lot more projects at the same time. Still, I'm the kind of person who likes to be in the lab, so that one understands what kind of problems might pop up and so on. So, during weekends and summers I still run experiments. I try to engage with my students and I have my own bench in the lab, so that I can actually do stuff. But of course, there's a lot of time that now goes towards administration, planning, and grant writing; that's what happens when get into more senior positions, you miss that stuff a bit. You do a lot of planning for things though, which can also be fun.

CB: But to get this personal time in the lab you might have to work extra, in a sense, beyond your contractual hours?

YR: A bit like that, yes, you don't really work 40 hours a week exactly, no.

Several interviewees reflected upon how the transition to a leadership and administrative role took some or much of the enjoyment out of their careers. Leading up to that point, they had been the ones doing the actual scientific groundwork. This was what they were good at and enjoyed. However, as group leaders, they often had to turn to other sources of enjoyment or inspiration, such as their group and social environment or a feeling of importance in their work:

OR: Let's see, it's maybe it's not what you're asking about, but something that's very important and inspiring for me are the people that I get to work with in my group. That's also why it's important that you choose the right people because you bring in people, not just to not to do your work, but you really want people to come in and to develop and to become collaborators. People that will challenge and argue with you, contribute ideas for research, and you know, have fun with, intellectual fun [...] You know, it gives you a reason to come in every day actually.

YR: No, well, concerning antibiotics the feeling is that, if academia does not step up and do something, then nothing much will happen. That you have an important role to play. And in that I'd say that people like [X], who have raised the questions and talked a lot about it, have been great sources of inspiration. So I'd say that has been a bit of an inspiration towards pursuing this path.

The inability to do what you actually enjoyed, coupled with the insecurity and pressure of senior academic positions, meant that even interviewees who

viewed science as their calling in life might rather prefer to pursue that passion outside of academia:

YR: And I must say that I really appreciate that I still have some DNA³³² that I do experiments on. I appreciate my day a week at the university, and I really like researching. I miss [academic research] a lot, but I don't miss the university. And I'd thought that I would spend my whole life researching at the university. And I would gladly research all the time, but not at the university.

Several of the interviewees concluded that this lack of science-based enjoyment was hurting or would come to hurt academia. For example, it would cause individuals to perform worse than their optimal, encourage careerism and discourage people with a genuine interest and propensity for science from going into an academic career:

OR: I think it has had a substantial effect in that, when I was young we discussed, during the coffee breaks we discussed research, experiments we had carried out. Now when I sit and listen, it's a lot of talk about how to get enough money for what you're doing, how to write applications and complaints about not getting grants, and so on. I mean, the focus has shifted away from the core of the research to that which is peripheral, simply because it is hard to survive [in academia] without these grants. And I think that it's something that actually, you know this since you're also in the field, that what's enjoyable about [academia], what attracts research-gifted people, is the scientific questions, discussions and theories around them, what you plan and conduct, and the whole intellectual stimulation that's there when things are as best. That all disappears when people sit around talking about how to get funding and such.

YR: [X] was one of the old guard. It was the questions [that were important] and the passion for science. Now there are many who view it as a career and hence they're not that interested in answering the questions, but rather it's the publications that take priority, and that's not improving either the quality or originality.

The above quotes highlighted the importance of the social environment in science. This pointed towards how collaboration should not be seen in a strict sense - not only the functionality of official cooperation and formalised procedures but also the day-to-day interaction between colleagues and how these interactions influence the individual researchers. They also pointed out how developments in seemingly unrelated areas, such as funding structures, could have a significant impact on such interactions.

³³² DNA: Deoxyribonucleic Acid

Outside Academia

This part deals with the changes outside of academia over the 1980-2015 period, especially within the industrial and political spheres, how the interviewees perceived these changes and the effect they had on their research. It is divided into three subsections. The first discusses the pharmaceutical industry. The second looks at political influence on university research. Finally, the third subsection discusses the impacts that these changes had on various aspects of the research process.

Industry

With a few exceptions, interviewees had had some form of interaction with companies during their academic career. Even so, most of these contacts were not thought of as especially important. Instead, the most common form of industrial cooperation was some form of service provision, either performing some sort of test or providing scientific consultation, in exchange for some relatively minor monetary compensation:

OR: Often it's been that we conduct a service that we're good at. Then I've sent a cost proposal to them, 'This is how much [money] we need to do this', and then I have exaggerated a little, as one has to have a bit of freedom to change things. Then they have sent [the money] to me, sometimes it's been based on how many tests we have done and sometimes it's been a set amount for a set time, independent of how many tests we have done.

YR: We didn't share any material resources, but I'm kind of some sort of consultant. If I receive anything from them it might paid expenses to travel for example to go and meet and discuss things with them. And then we discuss, if we develop any ideas in the lab then I transfer that knowledge to them so that they are able to implement it at a bigger scale.

However, a few of the interviewees had had some more substantial cooperation with industrial actors. There were, for example, those who had industrial PhD students or postdocs, where a company paid for these positions in exchange for an influence on their research direction, or collaborations on developing substance or medical equipment:

YR: Then there was one post-doc who was an industrial PhD Student, or industrial post-doc, from [major pharmaceutical company]. Otherwise, our industrial PhD students are in oncology and other pharmacometric areas.

YR: No, I actually have a collaboration with a company in [city X]. There we have been trying to develop a new drug against inflammation for a year now. That collaboration has worked very well, and we also have an exchange of technical expertise.

Apart from these closer industrial contacts, the interviewees saw industrial connections mostly as a way to bring in funding. The incomes from these connections were also often fairly small and seldom more than that it covered the costs of the assistance provided:

CB: Yes. And how, yes how substantial has this compensation been?

YR: Yeah, it hasn't been that big, it has been a few thousand a time, maybe 200 000 [SEK] for a trial or a smaller scientific work.

CB: Okay.

YR: But a few of those can make it possible to keep things afloat.

For some of the interviewees, the incomes from industrial connections did not come directly from the companies but via various collaborative organisations and common funding applications:

YR: It is a small biotech company that is associated with a research group at [university X]. We have received a joint research grant from Vinnova, a government agency that supports innovations, which we use to develop the discovery as a new treatment.

YR: [...] I've also had rather extensive collaborations with companies, but they have been established through [programme X], through [funding agency Z], through this platform we are working with right now that is funded by Vinnova, Uppsala University is also funding it and the companies finance part of it. But it [the funding] is not going to me as a person, but to the centre and then we carry out research within that centre.

One aspect that was important for interviewees when contemplating more substantial collaborations with companies was to have a personal contact with the owners, scientist and/or other representatives. This increased the understanding for each other's situations and generally helped things run smoother:

OR: It's almost always been very good collaborations and I've been able to become friends with many of the company researchers on a personal level.

YR: Yes, then you notice that it's good to meet people face-to-face. It usually becomes better, in various ways. Then you always have those that you get along with better and that you have more in common with.

Another important aspect when interviewees contemplated collaborations with the industry was the protection of their own freedom. A few interviewees had considered themselves lucky since they had been able to obtain unrestricted funding. They could use the money they received as they saw fit with the only restriction being that the company in question should get a heads up before they published anything that could be commercially valuable:

CB: Has there been any other exchanges of each other's social resources, I'm thinking sharing of expertise, something like that?

YR: No, not from Vinnova's side where they have been interested in the results per se, but they have not affected how we run the project itself. They have not influenced design, method or anything else, they have only unconditionally supported projects that they find interesting.

OR: [...] it says somewhere in that agreement, it was such a long time since I read it, it says something about that the grant such be utilised as [the recipient] see fit. And then the money is deposited at the university, so it's gone to the university. And because it says so, it's stated in the deed of gift that is attached every year as the money is deposited, it says that it should be utilised by [I, the recipient] for his research, as he sees fit. Or something like that. So it's totally up to us how we use it.

Freedom was also a reason for some of the interviewees to avoid going to industry, or to return to academia:

YR: [...] the major difference, in my experience, was that you had a boss that you had to report to. And understand me the right way here, but I appreciate that, at the university, it feels like you are your own boss. I don't have to report back to anyone, that's the big difference. And that's not to say, I mean it works great for a lot of people at companies, but as I said, I started to miss the basic science. I felt like I wanted back. And that wasn't because I didn't like it [in the industry].

Another point that several interviewees reflected on in connection to industrial collaborations was the prospect of potential conflicts. The interviewees stressed the need to be aware of the risks involved in these collaborations and address them, for example, by having clear contracts that were well understood by both parties:

YR: No, I think that's been important to me from the start, that you have a company that shares the same goals as you do, that we aim for the same things.

And you don't really know that from the beginning, but it has actually worked out really well.

YR: You have to be very careful with that from the beginning, otherwise they [the conflicts] are just around the corner.

Their fears were not unfounded, as several interviewees had run into trouble or knew others who had. These incidents included unauthorised use of data, refusals to allow publications, refusals to accept results or being caught in one-sided contracts:

YR: I have experience where it was an employee at a large pharmaceutical company who also had an academic adjunct position at the university. In that case, it did not work so well because the dividing lines between the company and the academic research were unclear and research results were communicated to the company without apparent control and transparency. This also became an ethical problem.

OR: And then we ran into a big problem because it was PhD student working on this and they flatly refused us permission to write up the details because it involved novel compounds they had made. And they didn't want to publish them at this stage. And so, this caused a big, big problem completing the PhD thesis. The lesson is that one cannot risk having a PhD student working on any project where there is not complete freedom to use and publish the data.

YR: Most of the time I'd say things have been fairly smooth, but sometimes you end up in these discussions where they [the companies] want to see different results than what you actually find. But that might be more of a thing with small companies, I'd say, as they might like to turn a blind eye towards some things.

OR: Yes, there have been examples like that, and some companies have had troubles because they are supposed to deliver things according to a contract and in the end, they end up having to [only] work towards fulfilling that contract. Me, or our group, we have never had any troubles like that, but it could have happened, yes, I think it could have.

Something that several of the interviewees brought up was how it was different working with small or medium-sized companies were than with the major pharmaceutical firms. The dynamics of the companies were described

as different, such as at what point they considered abandoning a product that was currently in development:

YR: In those circumstances it ranges from six people companies to AstraZeneca at the other end. So there are small start-ups all the way to giant elephants in the same thing. It becomes a very interesting dynamic to be part of.

YR: You notice that especially those from [major pharmaceutical company], that they are experienced in drug development and want to do these experiments that could kill the substance, because it's better to do it early on and invest in something else. Meanwhile, the smaller companies might have their darlings that they want to protect and not give up on.

The decline of the pharmaceutical industry in the 2000's, especially in Sweden, was noted to have had a negative effect of the ability to form industrial collaborations. It was especially the closure and down-sizing of the major companies, such as Astra and Pharmacia:

YR: But a few of those can make it possible to keep things afloat. Now it has decreased, because the domestic pharmaceutical production has decreased or moved. Pharmacia and Astra have withdrawn a lot from Sweden. So there aren't the same possibilities that there were maybe 20 years ago.

OR: This [start-up company] could have become something if it had been pursued more strongly, but it's the same thing there, they were too small to do that. It's a real problem for Sweden and for medical research. But now the whole pharmaceutical industry has changed at its core. These big ones have left Sweden.

However, even before closing down or scaling down, some interviewees spoke about changes to the internal structures of those major companies that deprived academic researchers of capable collaboration partners:

OR: Nowadays they are more geared towards scouting, to bring in ideas. There's also a lot of market thinking going on. I mean, they aren't primarily there to cure illnesses [...] That's also what is said about the antibiotics research, since most infections need to be treated, [especially] if they are life threatening, and then the patient is cured and needs no further treatment. It's better [for the companies], with anti-alfa against rheumatism, which is something you take your whole life.

CB: And could you use each others labs and such, if you had different equipment?

OR: Yes, they could do that, when Pharmacia, they had that kind of interests back then. So then you could make some analyses there and then you did some analyses here. Then they also got this new economic management. They started to demand internal payments in the company, so that one division paid another, and then the spontaneity started to disappear.

While the decline of the pharmaceutical industry was a general phenomenon, some of the interviewees pointed out the situation being especially problematic in the antibacterial-related field:

OR: 30, 40 years ago there were a lot of collaborations between companies that sold antibiotics and bacteriological laboratories, because then we made analyses of the new antibiotics that came out. Back then there was a steady stream of new antibiotics, but that has ended.

OR: Yes, when it comes to antibiotics resistance it's been, it's been a little difficult to find partners who are interested. And a lot of it is about the economic realities within the companies, where they make an economic assessment early on concerning what profit a potential collaboration can provide them.

However, with the question of antibiotic resistance development becoming more highlighted towards the end of the period, political pressure and investments were seen as impelling some companies to increase, return to, or start investing in antibiotic research, especially through programmes like ENABLE:

OR: I've had small amounts from the industry in the past. Regarding the money for ENABLE, I don't know if you see this as money from industry or money from the EU. I think it's a mixture of both. It's largely EU money as far as we're concerned, but I think the industry is important because their attitudes guide a lot of what we do.

YR: Then, within ENABLE, we've had collaborations with companies. Mostly small companies, but GSK³³³ has also had substances. It's rather intense. There's everything from companies with just a few employees to bigger ones.

³³³ GSK: GlaxoSmithKline

Politics

Interviewees noted that, over the period, political influence over research increased, driven primarily by the combination of the heightened importance of external funding and increased political direction of that funding. The interviewees generally questioned the wisdom of this, arguing that such political influence threatened research quality in various ways:

OR: One notices very clearly that some areas are favoured by parliament. My experience is that those are the areas that they themselves understand, like epidemiology. They understand really well that there has to be research on antiviral substances for Covid. Then, all of a sudden, there are millions available, and I have nothing against that, but I don't like that one should let, so to speak, politicians make decisions on exactly how one should direct the research. Because the great breakthroughs come from free, basic science.

YR: I think there's a risk with these temporary funding initiatives sometimes. I can probably be good to boost an area that has been under-financed, but it can become choppy, meaning you as a researcher try to always catch the latest fashion, where the money is, instead of being able to stay in your area and actually research there.

Several of the interviewees argued that, while politicians often meant well, they lacked proper understanding of the consequences of their actions:

YR: I think that from a political perspective, research and higher education policies have actually been discussed and prioritized to a fairly small extent by any government, whether social democratic or right-wing really. On the educational side, [K-12 education] dominates for understandable reasons, because it affects so many more people directly.

YR: So you have an exception in higher education, that you can still register PhD students from other countries on stipends. But it's just a matter of time before that...

Still, several interviewees also recognised that the increased political attention towards antibiotic resistance by the end of the period, especially from international actors like WHO and EU, had positive consequences for the field:

OR: I think we have arrived in a better spot now, since WHO declared antibiotics resistance an international emergency, but during most [previous] years there has been a lack of interest.

YR: Also, a major contributing factor was [...] the break-down of the Soviet Union. [...] from having been a well-controlled state with healthcare, they were very good in the Soviet Union, the responsibility for access to medication, meaning the import of medication and so on, it broke down. And then they were struck with a major resistance problem in tuberculosis, and certainly other [infections], in the former Soviet countries. So, while most of the cases of tuberculosis are not in Eastern Europe, that's where there are most problems. [Because of the increased movement within Europe], this became a problem for all of Europe. [Hence,] in 2011/2012, the European Commission decides to invest in new substances against tuberculosis, to develop new ones pre-clinically.

A few of the interviewees pointed out another positive, semi-political influence on research having gained increased prominence in the latter part of the period, namely civil society organisations. Within the antibiotics field in Sweden, the resistance awareness organisation ReAct was pointed out specifically by these interviewees:

OR: [...] when it comes to the antibiotic-resistance part then of course, what Otto Cars has started and lead, like Strama and ReAct and those, that's been in the background, even if I haven't had that much interaction with them. Well, on and off with ReAct actually, they have been sort of like a centre of expertise that we have been able to turn to concerning some things.

YR: And hence I came to establish a collaboration and a dialogue with the ReAct-network in Uppsala, about exactly how you, in countries with weak health care systems, create interventions that both provide better quality from the perspective of the children and leads to more rational drug usage.

Another politics-related field that had high importance for several interviewees was the clinical care, which in Sweden was politically controlled at the county level. The interviewees reflected on how clinical cooperation was a source of ideas and inspiration. There were, however, also concerns raised about how political priorities influenced the possibilities for such collaborations:

YR: But what you want, as a treating physician, is to prevent resistance from occurring, so that discussion and those collaborations I see more as a place where we can do something beneficial, rather than just pure knowledge gathering. So they are, I feel, a source of motivation and it's fun with these collaborations, when you have this applied side, that we could do things like this instead, and then you see an effect of that.

YR: It shows much more clearly that there are thoughts about investments and more of the needs in healthcare for research. Sometimes there may be a connection to highly specialized care, especially linked to so-called 'national health care assignments' such as complicated heart operations, lung transplantation, child heart surgery and then it follows naturally that you need follow-up and research on these activities. I think this sometimes leads to earmarking funds for such research for strategic reasons.

For several interviewees, their clinical cooperation was more geared towards other countries. Some of them had collaborations with research groups abroad and gained clinical contacts that way. Others expressed that the research questions they were interested in required materials from or interactions with clinical problems not present in Sweden:

YR: Let me think, we often [collaborate] on clinical data, like when it comes to colistin where we have a collaboration with a research group from [X], where they have a lot of colistin resistance. They have done quite a lot of studies that we have analysed. Then we've had collaborations with two different groups in [Y]. They have also been clinicians who have collected data on dosages, and might not fully believe in the supposed recommended dosages, but want to study and come with suggestions on how it should be.

YR: And I ended up focusing on, via about ten PhD students I supervised in collaboration with [University X] in [County Y], how a village health care worker, and possibly a pharmacy in the village, could use the same symptom-based algorithm as we have at the primary care facilities and apply them in order to help children with fever. And then, is this an inflammation, is it malaria or diarrhoea, or possibly just a cough and you should go home. So that the children can receive the right treatment, at the right time and in the right dosage. And that was my research area back then, and after a while it became highly relevant not just for health care quality from the children's perspective but also for rational drug usage from a pharmaceutical perspective.

Research

While the interviewees expressed mixed feelings towards how actors from the external society influenced academic research, there was one key role that external actors filled and that was as future employers for students. Several interviewees expressed a feeling of responsibility towards those they had taken on as PhD students and postdocs, and some noted that they tried to guide their students into satisfactory jobs when their contracts were about to end. Since academic jobs were tough to get, and increasingly less appealing, alternative employments in industry and other places in society were important:

YR: That's something that you have to discuss on an individual basis, that the person is interested in. It's a little varied how people, I mean if you think a bit larger, since [our research group] haven't had that many PhD students who have defended, but if you see how we have done here in the corridor, when we have discussed these things, there are very few who've had this feeling that 'I started my PhD education in order to pursue a career in academia'. Instead, it's just the next step of the way, and they don't really know what happens after. And then you of course have to discuss, you know, what do you want, could you see yourself as a group leader? And very few could.

OR: I've had that and we've a fair bit with it, especially for PhD students so that they can find somewhere to move on to after graduation. And within microbiology it's working out fairly well. I think it will continue like that in the future as well, that they'll be able to get jobs somewhere, or in the worst case become teachers somewhere. Or it's good if they become teachers. So it's only been a few that haven't been able to get an employment that they are happy with.

For some of the interviewees, the industry or the health care sector had provided alternative employments even for the interviewees themselves. The interviewees provided examples where they had been able to switch to the industry because they either did not like the conditions in academia or because they had been forced out through a lack of funding:

YR: Well, I've fallen behind when it comes to all of the economic opportunities. But I got this, there were a few things that happened in my life, and I wanted something completely different. I actually wanted to change research group, because I ended up in my old research group and I didn't want that. But then appeared this position at [company X], now [company Y].

YR: No, but I have been lucky, since I am a medical doctor. And of course, there are always jobs for MDs³³⁴ within the pharmaceutical industry.

However, there was also one interviewee who had continued in academia because they could not find a suitable industry job after their PhD:

YR: I defended in [early 2000's] and for me it wasn't actually a given that I would remain in academia, which you could think now that I am where I am [15+] years later. But when I defended there weren't that many industry jobs. So, although I was rather certain that my aim was to go into the industry, when an offer about a long research employment at our institution to establish a profile lab came up, I took it.

³³⁴ MD: Medical Doctor

Another potential way to interact with the industrial sphere was to create your own company. Although there were several interviewees who had experience of this in some form or another, others expressed a reluctance about it, or at least at the prospect of getting too involved in them. Instead, these interviewees often expressed such companies as initiated by necessity, such as for tax reasons, to continue the development of a product that might otherwise cease development or to get a product developed enough for it to be bought up by a bigger company. They often also expressed keeping their own involvement with these companies at a minimum:

OR: Instead now, I mean we have a few projects going right now that we hope to be able to commercialise, but there we hope, we want to build up enough value in the company that a bigger company becomes interested and wants to buy it. Because we don't, I don't want to build companies. We tried a few years, and it turns out that it requires so much knowledge, that we don't have, and more resources than you anticipate. [...] Some people manage to do it, but I couldn't and I don't want to either. That just isn't what I want to do.

OR: Yes, it was a new target that we found from my research. That's where we began, and then my colleague and I, we worked together a bit and had conferences together, then we had this idea and went with it. And it is very much based on my research, especially what I did back then. But now I don't keep track of the company.

Another point that a few of the interviewees brought up in connection to why running their own companies were unappealing to them was the issue of patents. However, this was an issue where several interviewees found that the universities had improved their support substantially over the period, even if it wasn't always enough:

YR: Traditionally, academic research has been almost purely driven by curiosity and has been non-commercial. However, the last 10-15 years, more focus has been put on trying to identify commercial applications and to obtain patents. In Sweden, there is a so-called teacher exemption that makes it possible to patent discoveries and then own the patent yourself. A fairly extensive support has been built up for innovations made in an academic environment. You can get help with patent applications and the like.

OR: For the patent application itself it was very formalised; it was with the patent agency via the university's own structures. Then, to find an industrial counterpart wasn't easy. So, unfortunately, in the end there was no, it didn't lead to anything.

In general, despite their increased rhetoric of encouraging researchers to engage with industry, the interviewees generally expressed the opinion that the university administration had become more and more of a burden on such interactions. Previous spontaneous collaborations were hampered by the need to be registered and approved by the university administration, and increased financial steering meant that industry contacts could no longer provide the same benefits to researchers as before:

OR: Yes, it has become more formalised, that as well. Previously you could have a research community, but now everything has to be formalised and it has to be recorded in a certain way and you have to be a number of people that go to the administration, who have to approve and fill out that one is carrying out work. So it has become more complicated.

YR: Well, talking about the reimbursement we receive, previously we were able to charge more or less what we thought [the service] was worth, but now it's much more regulated. The department now wants us to show how we calculate this in relationship to material costs, overhead, salaries. And it has become that the projects should consume all of the funding provided for them. Previously one could use these to accumulate resources in the good times, so that you had money saved up for the bad times.

At the same time, Swedish universities had not been able to compensate this increased administrative burden through the kind of innovative collaborative projects that could be seen abroad:

YR: Over there, I'd say that the university was very good at this, they had various events for it. So, we went to, I went to one of the many events they organized that was really interesting. Based on having a commercial idea the tech-transfer organization at the university gathered and recruited people with different roles from smaller industries in and around [American city X], where I lived: some were CEOs, some CFOs, people with other financial roles in companies.³³⁵ They also had students from the business school at the university, a patent attorney. All of these people there to work with me, who came with the idea, to provide input on how to move forward to evaluate if the idea could be commercialized and to give advice and support to pitch the idea to industry and investors.

With the limited benefits and increasing bureaucratic burdens, the interviewees seemed more deterred from substantial collaborations with the industry towards the end of the period. However, this did not mean that they did not want to contribute to societal development. Although the main incentive for the interviewees was generally the intellectual curiosity and

³³⁵ CEO: Chief Executive Officer; CFO: Chief Financial Officer

challenge associated with scientific research, several also expressed a want to make things better ‘in the real world’:

YR: Oh yeah, I think you always have, or most people have. Or I don’t know, but I’ve always had a goal to make things better for a group of patients. I mean, to increase survivability has almost always been what we’ve worked towards. Definitely, that is what you want to reach. You want to find something that works.

YR: Yes, for me I’d say that it’s always been, I think I’ve always wanted to work towards what’s good for society, it’s a very strong motivation, or for things to get better for individuals.

In this regard, the main driver for these interviewees seemed to be the ability to contribute to improved clinical treatments, rather than industrial progress. A few of the interviewees made sure to point this out specifically:

YR: The thirst for knowledge is what has been my main motivation, for sure. The other source of inspiration I feel closest to isn’t the industry but rather the healthcare sector.

OR: Well, to the real world I count the health care sector, not the companies, but improving our diagnostics has been a goal. And to increase the understanding of the pathology of infectious diseases has been a great motivator.

Several of the interviewees reflected on having become more open towards various external collaborations, especially with industry, over time. They largely seemed to ascribe this to personal character development rather than changes to the external environment:

OR: Yeah, that’s a good question. I think it has changed quite a lot during my career. I the beginning, I think I had a bit of a contact fear with the industry. It was a sort of purity; one should not associate with those people who do something that can actually make a difference. Instead, one should remain in the academic ivory tower. I think I was quite strongly like that when I was a PhD student, a post-doc and when I returned. Then, over the last 10-15 years it has changed quite a lot, actually. I think it’s much more fun now with, and we have changed direction a bit as well, that we go more towards projects where, like we have made a whole diagnostics thing, different kinds of rapid diagnostics. And I have become more and more interested in the clinical aspects of antibiotics resistance.

YR: No, well, I guess you can say that I'm an intellectual in that, for me, it's been the intellectual stimuli in research [that] I've been interested in. Sure, as one grows older, and this is also what I think I like about the industry, [I have wanted] to work with something tangible that can help a person who is ill.

A few interviewees also pointed out that even if one did not consciously intend to bring 'real-world' benefits, it did not necessarily mean that one would not do so:

YR: There are examples of researchers who have focused on molecular interactions for a long time, on a theoretical level, but then suddenly there is a research breakthrough that becomes an epoch-making shift and a new pharmaceutical drug. In that way, there can be a large output with respect to results in small research groups that can make great discoveries at a low expense, which may not always have been the case in the large pharmaceutical companies with their large research resources.

The distance that several of the interviewees expressed towards industry was also indicated by how most of their industrial contacts had been established. While a few had directly contacted companies, it was more common that the companies contacted them. Otherwise, contacts could also be established because research projects had stumbled upon something with industrial potential or other by-chance events:

OR: But it's been in both directions when it comes to levels of contact. There can have someone at some company who has seen that we have written something, or sometimes we might have contacted them because they are experts in something. But usually they come to us.

OR: Yes, all three of these [SMEs],³³⁶ yes, we were contacted by [X], asking if we should do something, but [Y] and [Z] have been academic projects that have then turned into companies.

One kind of collaboration where the interviewees entered more consciously was various forms of academia-industry cooperative organisations, often initiated and/or supported by political actors such as the EU. These became more popular towards the end of the period, and the interviewees expressed more positive attitudes towards these forms of collaborations than regular one-on-one situations. The first aspect of this was that there was often funding involved from the political backer. The second was that the involvement of a political mediator meant that the interviewees felt less at risk of being abused by the companies. Third, these collaborations were usually consisting of

³³⁶ SME: Small- and Medium-sized Enterprise

multiple research groups and multiple companies, making them more dynamic and inspiring:

YR: They might have been interested in a specific type of project that we have been working on and then you work [together] with a project that becomes an article, and then you exit. Or they have provided an industrial PhD student, so that the student is located at the company and I'm their academic supervisor, or at least we have written that kind of application together. Or all the way to their participation in the greatest scenario I've been active in [...] a Vinnova centre of competence, where I am heading a cooperation between [a university and a range of companies], where these [...] companies are to work together towards the same goal.

OR: I think the collaboration within ENABLE feels much better because it feels like it's enforceable. It's at a much higher level. And you know, beyond the companies, we have the EU Commission on top of it.

YR: Yes, it does, to some degree. I mean, the dynamics if you take these massive collaborations, then it becomes like in all big research collaborations, that there are more influences, more ideas, access to a greater infrastructure. Perhaps there are many different cultures that come together. In the centre we have companies from Finland, Sweden, Denmark and just as often as there are different company cultures there are also different cultures in different countries, that can differ quite a lot.

Chapter Synthesis

In this chapter, interviewees brought up a host of developments that influenced the situation that Swedish antibacterial-related researchers found themselves in. These ranged from how the funding of research evolved to various changes within and outside academia. Seen as a whole, these developments meant that the situation around 2015 was significantly different from what it had been in 1980.

One key development was how much more dependent researcher were on external funding, such as through various grant providers, in the latter years compared to earlier. The changes in the funding situation meant that researchers spent increased amounts of time on applications towards the end of the period. The increased importance of external funding also meant that research had to be adapted to shorter time spans to account for the risk of losing funding, as well as a decrease in freedom for the researcher to choose how and what to research.

The increased cost of research, especially rent and labour costs, also meant that substantial parts of the increase in per project funding seen in the previous chapter were at least partly used to compensate for the higher-than-average inflation within academia. As such, it could not be devoted to increase the real-term resources available to the researchers. The combination of more uncertain funding and an uneven increase in costs between different forms of research also meant that the freedom of researchers decreased, as high-cost research methods became increasingly less viable. While it was seen that the increased funding for antibiotic research towards the end of the period helped researchers in the area, it was unclear how far these could compensate for these cost developments.

When it came to the internal dynamics of academia, one of the key developments that the interviewees brought up was the increased pressure to publish in order to stay and advance in academic research. This led to decreased availability of time for research since more of it had to be spent on writing. There was also a decreased quality of information available to researchers since this pressure produced a proliferation of thin, insubstantial articles. On top of this, the pressure caused problems with the collaborative environment between researchers because, as the fear of having one's ideas stolen increased. There was also decreased freedom for the researchers to choose their own research paths, as they needed to limit themselves to topics that were easy to get published.

Another change in the to the internal dynamic of academia was that increased specialisation in research methods led more researchers identifying themselves with the research methods they used rather than the topics they studied. This simultaneously increased and decreased the freedom of these researchers, as they could be more flexible with their topics but were restricted to a limited set of methods. This specialisation also improved the collaborative environment, as researchers often needed to rely on each other to amass the critical number of expertise's needed to carry out increasingly more complex research.

Increases in managerial accounting and other administrative tasks had decreased the available time for research. They also made resources such as labour and materials more expensive, and limited the freedom of researchers by making some lines of research relatively more cumbersome than others. Finally, the decreased room for trial-and-error and possibilities for undisturbed research brought about by deteriorating employment conditions had decreased the quality of labour available by disincentivising introverted, highly focused individuals from going into or staying within academia.

When it came to the external engagement of the interviewees, most noticeable was the lack thereof. Especially towards the end of the period with the collapse of major pharmaceutical industries, interactions with industries seemed to have been minimal. This implied that neither resources nor scientific collaborations could be garnered from such contacts. However, the

few substantial links that could be seen with external partners seemed to have come about organically. University-driven external engagement, or other forms of politically motivated direction of research towards societal goals, were seen, at best, as non-optimally spent resources and, at worst, as infringement on the freedom of researchers.

7. Analysis

The previous three chapters have presented the data gathered for this study, specifically political documents, statistics from MFR/VR and interviews with researchers. This data presents an overview of how various aspects of academic antibacterial-related research changed between 1980-2015. Based on these chapters, the following chapter provides an analysis of how the observed changes is likely to have impacted the ability of researchers to make antibacterial-related discoveries. To do so, this chapter uses the analytic framework provided in the Methodology chapter.

The chapter is divided into six core sections, in accordance with the factors outlined in the analytical framework. Each section first outlines the changes noted in the data related to the given factor. It then analyses how these changes are likely to have impacted the ability of the concerned scientists to make scientific discoveries.

Information

As presented in Methodology, when analysing the information available to researchers, it was important to take both access and quality into account. Dealing first with access, it has become significantly better over the studied period. With online publication becoming the norm, and even more so with the open-access trend discussed by some of the interviewees, researchers could gain access to essentially any scientific publication they could need, free of charge and without having to order it or even go to a library to read it. As such, while debates went on around open-access and purchasing structures,³³⁷ the question of access to scientific literature had largely become a non-issue for individual researchers at Swedish universities by the end of the period.

However, when it came to the quality of information, the trend over the period seemed negative. The first aspect of this was the increase in sheer number of publications with a corresponding decrease in the depth of research, leading to what one of the interviewees referred to as “cheese slice publications”. This increase in volume and decrease in substance meant more time had to be spent reading articles since more of them had to be read in order to gain the same amount of information.

³³⁷ See e.g. Dellstig 2020.

Even more damaging was the perceived decreased validity and reliability of the information provided. With the increased incentives for researchers and journals alike to publish articles with insufficient robustness and/or inadequate peer review, it was clear that several interviewees had become increasingly wary of inaccuracies in the scientific literature. Put simply, they did not trust the content of journal articles the way they used to.

How did this increase in the number of publications, with the associated decrease in reliability of said publications, impact the ability of researchers to make discoveries? With thin shallow publications becoming the norm, it was likely that the research it is based on would tend towards also becoming thinner and shallower. Instead of the publications being the by-product of research, there was the risk of research becoming the by-product of the need to publish. This would shift the focus away from the process that actually had a potential to create discoveries. Such deprioritised research was unlikely to utilise the talent of prospective discoverers to the full extent, at least not towards discovery-making. It was also not likely to lead to the kind of risk-taking that was associated with accidental discoveries since high-throughput requires research predictability.

Even worse, if researchers no longer trusted each other's results, they were unlikely to build on those results to inform their own studies. Hence, research aiming for deeper understanding of a subject, building on previous research to find more core principles on that subject, would be discouraged simply because that previous research could not be trusted. This was problematic as deeper research was more likely to be able to utilise both talent and chance in order to make scientific discoveries.

Shallow research that *almost* replicate previous studies, only with another bacteria, substance or other slight factor change, would be more appealing, as that type of research had already been proven to be publishable. Here, 'almost' was a key word because the need for some sort of novelty in scientific publications precludes actual replication studies, those that exactly repeat previous research in order to test its reliability. If such true replication studies would be permitted, they could actually increase the trust in the results of previous research and hence facilitate discoveries.

Hence, the increased mass, decreased quality and lack of replicability of publications is likely to have had negative impacts on the ability of academic researchers to make scientific discoveries. It should be noted though that most of these changes were due to developments within the international scientific environment. This was in contrast to the other aspects in this framework, which were largely a result of domestic policies and developments, as outlined below.

Time

Unlike the information aspects of science, which are largely determined by international developments in academia and scientific publishing, the time available to researchers was largely a domestic or even local issue. It was mostly a product of employment statuses and various obligations put on researchers. The data suggests that there was a noticeable deterioration in the time available for Swedish researchers over the period of this study.

In terms of the amount of time available for actual research activities, the interviews pointed towards a number of trends that increasingly intruded on this time. One was more frequent and detailed research proposals needed to acquire external funding. Another was the increased administration required in order to comply with the demands of both funding agencies and internal university regulations. Yet another aspect was the withdrawal of support staff that had previously been assigned to researchers to deal with non-academic matters.

This decreased research time per researcher should, however, be put in the perspective of an overall increase in the number of academic research employments within Swedish academia over the period. In fact, some of the interviewees referred to this expansion in the number of research staff at universities and colleges in Sweden as the reason for the deteriorating employment conditions in academia. The MFR/VR data also showed that there was a substantial increase in the number of applications they received during the period. Hence, although the time available for each researcher decreased, it was unclear if the total, aggregated research time within Swedish academia decreased.

The marked decrease in the conditions that allowed for longevity of research over the period was, however, much clearer. This could be seen in the widely attested decrease in job security within academia with a proliferation of short-term or funding-dependent employments, which the research bills showed was driven by an aim to shift the funding of the bulk of research activities away from the universities to the research councils. The deteriorating effects of the need for external funding following this was exacerbated by the decreased acceptance rates seen in the MFR/VR material. In addition, continued external funding was dependent on rapid publication rates, as attested by the interviewees, forcing even shorter research project times to be adopted.

It was unclear how the changes to the pure amount of research time available for Swedish researchers influenced their ability to make discoveries. If we view it from the talent end of the serendipity debate, providing less time to more people would dilute the time for those with greater talent, leading to fewer discoveries. However, if viewed from the 'happy accident' point of view, this distribution would not necessarily influence the creation of discoveries, as discoveries can be made by anyone with time to make them.

However, the decreased longevity of the time provided to researchers ought to have had a distinctly negative impact on their ability to make new discoveries. It is also likely to have favoured such studies that require less active time from the researchers, either because they generally were less laborious or because they could more easily be delegated to junior staff. The decreased longevity would also have favoured research directions with shorter turn-around time. Whichever end of the serendipity debate we look from, this would have yielded negative results for the likelihood of discoveries. From a talent point of view, these developments led each researcher to have less time to focus on any given project, and potentially even encouraged them to put more of the research burden on junior, potentially less talented researchers. From a chance discovery perspective, while shorter project times might increase the number of projects carried out in any given amount of time, the likelihood for accidental findings decreases when researchers do not have the time to follow up interesting leads.

Materials

It was clear from the interviews that the material requirements for antibacterial-related research had changed significantly over the period. There were many more, and more complicated, machines required to conduct cutting edge science. At the same time, few interviewees complained about any lack of access to such machines and most seemed satisfied with their material needs.

While facing increasing demands for top-of-the-line material conditions in order to stay competitive within research, the interviewees pointed towards developments such as the establishment of core facilities such as the SciLifeLab and the increased ability to cooperate with colleagues nationally and internationally as factors that improved the material situation for researchers. The increased external funding seen in the MFR/VR data also suggests that researchers had greater resources at their disposal to needed material goods. Still, there were issues raised related to increased bureaucratic measures that made material collaborations between groups at the same university, or with the local hospitals, more complicated and expensive. Also, certain material costs were pointed out as having risen more than general inflation levels, especially rent.

The changes to the material situation seem to have had some degree of influence on the ability of academic antibacterial-related research to come up with new discoveries. First, access to more precise equipment ought to have enabled increased precision and new forms of research that were simply impossible with previous equipment, increasing the potential for both accidental findings and providing talented researchers with better insights into the areas of study. Second, obstacles to accessing this equipment, especially

in a convenient matter, were recognised. However, developments in information technology that improved long-distance collaborations and the increased investments both directly and through vehicles like the SciLifeLab, ought to have compensated for, if not eliminated, the impact of these obstacles.

Labour

If one has the equipment one needs, one still needs someone to operate it to do the labour of producing the actual research results. This can be either oneself or someone one assigns to do it. During this period, there seemed to have been a shift away from the former, where researchers did their own studies, to the latter, where the researcher acted as an overseer of the work of others.

This is not to say that researchers did all of their own research in the beginning of the period. However, they had more possibilities of actively taking part in the various stages of the research process with less time spent on funding applications and administrative tasks. As such, the researcher was more able to have hands-on understanding and praxis of the techniques practised by their employees. In the talent-focused understanding of the serendipity debate, this development away from hands-on experiences would decrease the likelihood of discoveries since the more senior, talented individuals would have less insights into the details of the research, where unsuspected discoveries were made.

Earlier on, the group sizes were also smaller, especially since the more even distribution of funding prevented the creation of the massive groups of ten or more employees seen towards the end of the period. On the one hand, this meant less labour available per researcher and less ability to hire a greater range of specialised employees. On the other hand, this also meant that researchers could more closely act as supervisors, instead of having to delegate many of the supervisory functions to their more senior employees. In the accidental discovery view of serendipity, the increased labour resources towards the end of the period would facilitate more discoveries as there would be more opportunities for people to stumble upon something. However, in the talent-view, decreased ability to supervise junior employees would mean fewer discoveries both in the short term, as a result of inferior supervision, and in the long-term, as talent was not being passed down as well between the generations.

The increase in the cost of junior employees in both monetary and administrative effort, as noted by both the research bills and the interviewees, ought to have limited the availability of labour and hence the rate of discoveries. When it came to the composition of the labour force, there were divergent trends. The relatively greater inclusion of women, as indicated by

the MFR/VR records, meant that the selection of talent improved and hence the likelihood for discoveries. However, the deteriorating ability for introverted, single-mindedly focused individuals, those who found it uneasy to 'sell themselves' or did not wish to become group leaders nor navigate or find enjoyment within academia over the period meant a potential loss of significant talent and a corresponding decrease in the ability to make discoveries.

Collaboration

Even if research groups are where most research is conducted, the greater community is needed for science as a whole to progress. While the structures for collaboration within the academic antibacterial-related research community remained relatively unchanged over the period, many of the interviewees pointed towards how various changes had, over time, shifted the dynamics within it.

Some of these changes were positive. Interviewees pointed towards the increased incentives for collaborations between research groups, nationally and internationally, due to the increased demands for the combination of expertise and advanced methods in order to publish in the best journals. Also, while it wasn't emphasised by the interviewees, it should not be ignored that improved communications technology, such as the introduction of e-mails and video calls, reduced many barriers to smooth cooperation over distances. From the view of talent as the key factor to serendipity, this ought to be extra important as it indicated that a greater variety of talents were involved in any given research project, increasing the likelihood that one of them would spot a crucial unexpected finding.

Other changes were negative. In terms of direct collaborations between groups, the increased competition for specific spots on the list of authors for any publications could, as the interviewees described, caused tension between potential partners. However, more damaging was the deterioration in other academic services that occurred during the period. We could see how the interviewees increasingly came to question the integrity of the peer review process, in light of the increasingly opportunistic behaviours from journals. As discussed previously, this might hamper the accumulation of knowledge upon which both accidental and talent-based discoveries were made.

The political drive towards supporting smaller colleges and universities throughout Sweden, instead of centralising resources, was unlikely to have fostered a better collaborative climate as it would have made communication between researchers more difficult. However, as discussed earlier the information technology development might have decreased the negative influence of this, enabling better communication with more distant colleagues. Similarly, the decline in the pharmaceutical industry, especially the major

actors like Astra and Pharmacia, as indicated by the interviewees, resulted in fewer fruitful industrial collaborations. In terms of discoveries, this might have caused researchers to overlook, or not to seek, potential discoveries with more pharmaceutical rather than scientific value since the avenues to act on such discoveries became fewer and more cumbersome.

Freedom

Academic freedom is a much-lauded concept. When it comes to making discoveries, this high esteem for freedom is understandable. Talent is of limited use if it is not able to direct what is researched and how. Neither does accidental discoveries have any place in a system where researchers are not free to act upon such findings.

The interviewees provided numerous examples of how the freedom of researchers deteriorated over the period. The decline of safe academic employment and increased need to apply for external funding meant that researchers were constantly in need of approval from others to continue their research, a development that the research bills indicated was politically engineered. The increased competition for these external grants and the value the approval committees put on field relevant knowledge meant that researchers were punished for trying something outside of their area. Increased reporting of how grant money was spent also meant that even after funds were granted, researchers were less and less able to deviate from the original proposals.

With this deterioration in freedom, researchers were increasingly pressured into staying in line with previously agreed plans, even when more fruitful alternatives might have revealed themselves along the research path. As such, they became more strongly locked into potentially sub-optimal directions of research. As a consequence, time and resources were indirectly diverted to less discovery-prone research.

The freedom of researchers was also restricted by increasing expectations and demands on their research. From a political angle, both the research bills and interviews indicated an increased pressure for research to be provably beneficial to society. From a research career point of view, the research needed to be as publishable as possible, preferably both in terms of numbers of published articles and the prestige of the journals in which they were published. This was mostly a problem if we viewed discovery from the talent perspective, in which case it prevented the actual talents from deciding where their efforts were most likely to pay off. From the accident perspective, it simply determined in what area of science the discoveries would be made. This might also be part of the explanation for the increased identification with research methods, rather than research areas, seen among some of the interviewees. This gave a higher degree of freedom in terms of what area to study,

enabling researchers to take on questions that are politically or scientifically in season. However, it simultaneously restricted the freedom to choose how to study a given topic.

8. Discussion

In a teleological worldview, science ought to become ever more prepared to face the challenges of its day, such as the rising antibiotics resistance of the late 20th and early 21st century. However, according to the findings of this thesis, the situations for university researchers deteriorated in this same period, making it less likely for them to make the scientific discoveries needed to address this issue. The following chapter discusses these findings and their implications for the aims of the study. It first focuses on the situation for university researchers as it pertained to their ability to make scientific discoveries, especially how the different factors brought up in the analysis interact. After this, it reflects on what this implies for the antibacterial research of the time.

As stated above, the findings of this thesis point clearly towards the conclusion that the situation for antibacterial-related university researchers in Sweden deteriorated significantly in the late 20th and early 21st century. Scientific information decreased in quality and reliability. The time available for experienced researchers to focus on actual research decreased while academic labour was increasingly carried out by junior, less experienced scientists. The freedom of scientists to pursue the most promising leads was restricted by pressures to publish, the power of funding agencies to determine what research could be performed and the need to adhere to increased regulations.

The only two aspects of the academic research situation studied in this thesis that had positive, or ambiguous, impacts on the ability of researchers to make scientific discoveries was the material and collaborative situations. It was undeniable that technology progressed significantly over the period and that the material resources available for research improved with it. Even as the cost of equipment rose in response to increasing technological sophistication, it seemed that the interviewees were able to attain their material needs through increased individual grant sizes, local or regional technology centres, or increased cooperative efforts between research groups. Technology, along with the increased need to amass sufficient expertise and equipment, was also what increased the ability and drive for more frequent collaborations between researchers nationally or internationally. This increased interpersonal or group collaboration was contrasted with the general deterioration in the international academic collective with decreased standards of peer-review and publication quality.

From the thesis, we can see how the causes of the deteriorating situation for researchers stem from developments both inside and outside academia. The main culprit was the increased reliance on external funding. By shifting the funding to the external grant agencies while relaxing legal employment conditions, as seen in both the research bills and the MFR/VR funding records, the researchers lost the ability to rely on employment as a way to gain research funding, or even to pay their own salary. This undoubtedly created the competition that the research bills sought after. However, it also meant that researchers had to devote significant time towards applying for resources, were restricted in what they could research by what the funding agencies would look favourably upon, and could no longer plan research that stretched beyond what their funding allowed.³³⁸ It also meant a steady worry to not receive funds, even among the most prominent researchers, and a subsequent amassment of resources by some skilful and lucky few, well beyond the point of diminishing returns.

It is also important to note that the researchers' situation was shaped by the simultaneous regulation and deregulation of the academic profession and university activities in Sweden during the period of this study. The increased political control over academia was targeted at both the university governance and individual researchers, resulting to increased cost of research, added time spent on bureaucracy and limitations on research freedoms. Meanwhile, the deregulations were only directed towards improving the situation for the university governance while dismantling both influence structures and employment security for actual researchers.

The increased focus on publishing well and publishing plenty within the academic community can be seen as a strategic adaptation to the increased competition for the ever more needed external funding. While it could be hard to ensure that a given funding agency would look favourably upon a project idea, the number of publications and their rankings was a more tangible indicator of merit. While it was clear that publishing had a strategic value, spurring on the trend of ever decreasing article quality, it could be questioned if this focus on publishing also had a psychological component as one of the few manageable parameters in an otherwise increasingly chance-dependent career.

Just as it is visible that the academic community adapted to its changing situation, university leaderships also changed their organisations in line with their circumstances. Most noticeable in this is the transformation from an organisation that funds research to one that is funded by research. In

³³⁸ It is worth contemplating if this deterioration in research conditions could have caused an exodus of the most talented researchers to other countries with better conditions for them to ply their trade. Although the sources used for this thesis could not be utilised to either prove or disprove such a hypothesis, the international trend towards similarly deteriorated conditions globally indicate that Swedish academia might have been spared such a brain-drain by virtue of there being few markedly better alternatives during the period.

combination with a perceived hollowing-out of institutional culture, this was what the interviewees referred to as the ‘Research Hotel’. This indicated a loss of collaborative environment and a decreased longevity since hotels were traditionally short-term accommodations.³³⁹

Much of the added administrative tasks bestowed upon the academics during the studied period was due to the increased efforts to assess, or enable the assessment of, quality within teaching and research. This was an aim that the research bills clearly endorsed. However, neither the bills nor the interviewees indicated how this increased assessment actually correlates with quality. Indeed, quality was often left undefined in such discussion, beyond vague adjectives such as excellency. While these assessments imposed restrictions on the researchers’ time and freedom, it was questionable if it brought the quality envisioned. It raised the question of how much quality it is worth sacrificing in order to measure quality.

In its pursuit of understanding how the changes in academia influenced the ability of university-based researchers to make scientific discoveries, this thesis has highlighted the role of the situation that the researchers found themselves in rather than either talent or chance. Still, it is important to recognise that situation alone could not explain serendipitous discovery. Rather, it was as important in its interaction with talent and chance, enhancing or obstructing their potential. As the study has shown, the situation that researchers found themselves in had substantial impacts on their research practises. Hence, the research situation is a factor that ought to be taken into account both in the study of scientific discoveries and in any science policy that aims to facilitate such discoveries.

In terms of how the changes within academia during the late 20th and late 21st century impacted the development of antibacterial treatments, the decrease in potential for scientific discoveries was clearly problematic. While this study was focused on the situation for antibacterial-related research in Sweden, similar changes in academia as those in Sweden were seen in many other countries during this period.³⁴⁰ As such, while it would be unwise to directly apply the insights gained from this study to any other country, it is still reasonable to assume that the antibiotics field as a whole suffered from this pattern of changes.

It is also important to realise that most of the findings in this study are not exclusive to the field of antibacterial research. Although caution should be observed when generalising results gained from studying one academic field to other fields, it should also be noticed that few of the findings relate specifically to antibacterial research. The findings from the research bills were

³³⁹ To what extent this transformation into hotels was a necessity and to which extent it was voluntary is beyond this thesis to study. However, it would be an interesting topic to study, as well as how this shift has changed the self-perception of upper university management.

³⁴⁰ See e.g. Kauppinen 2012, pp. 337–345.

almost entirely field-independent while the funding agency results relate to all of medical research. Even the interviewees, though all with a broadly bacteriological background, mostly brought up points with little-to-no field specificity. Hence, though more studies are required to inquire about the effects of the studied changes on other fields, a reasonable tentative assumption would be that there is a fair degree of similarities between the antibacterial field of study and other academic fields.

It is in this light that the political research initiatives in the 2010's ought to be viewed. While they were meant to bring additional focus and funding towards efforts to combat the growing threat of antibiotics resistance, they simply counteracted some of the damage brought upon all of academia by the politically driven changes this thesis has studied. With the study ending in the mid-2010's, it is outside its scope to enquire how well these measures towards compensation for the deteriorating environment for scientific discoveries worked out. This question, if such a field specific band-aid could address issues created by a larger, academy-wide wound, deserves its own study.

What can be said from this thesis is that the field of antibacterial research did suffer from changes to the academic environment in the late 20th and early 21st century that made it more difficult for university researchers to achieve new scientific discoveries. However, it is beyond the scope of this thesis to estimate how much of the decline in new discoveries of antibacterial treatments can be attributed to these deteriorating conditions. What can reasonably be argued is that, while such a deterioration of their research situation would be problematic for researchers from any field, it was especially so when it came to antibacterial studies since it aimed to improve our ability to manage illnesses whose causes were continuously evolving resistances against current treatment methods. The severity of this research situation was further compounded by the simultaneous decline of industrial research on antibiotics and the decreased yield of the remaining industrial efforts during this period. Hopefully, by shedding light on the changes within academia and their consequences, this thesis has brought some insights that may be of use in the struggle to find new antibacterial treatments.

Finally, it must be recognised that while the changes studied in this thesis made it more difficult for researchers to make new scientific discoveries, they did not make it impossible. Indeed, much fruitful research continued to be carried out that could help in finding new antibacterial treatments by many a talented researcher, not least the interviewees that participated in this study. However, what this thesis argues is that these researchers made, and continue to make, new discoveries despite, rather than because of, the changes studied here.

9. Conclusion

This thesis has studied how the changes in academia in the late 20th and early 21st century influenced the ability of researchers to make new scientific discoveries, with a special focus on Swedish researchers dealing with antibacterial-related topics. To do so, it first asked how the situation for Swedish researchers in the antibacterial field change between 1980-2015, It then asked how these changes, or lack thereof, affected the ability of these researchers to make new scientific discoveries.

To answer these research questions, three materials were collected and studied. The Swedish research bills, key political documents from the period, indicated that the research policy discourse in Sweden became increasingly geared towards politically governed research based on market-like competition between researchers. However, the bills still displayed a continuous recognition of the ideals of academic freedom and longevity in research. Yet, this recognition was in word but not in deed, as the actual policies implemented essentially all emphasis establishing and enhancing the market-like system, while encroaching on the professed ideals. A study of funding provided by MFR/VR, the largest Swedish funders of medical research during their respective times, indicated that while the size of average grants increased significantly over the period, the application success rate dropped from around 75% in the 1980's to around 20% by the end of the period. At the same time, antibacterial-related research generally fared a little bit better in the grant competition, especially towards the end of the period. An interview study with researchers active in antibacterial-related research during the period indicated that the increased competition for external grant funding, in combination with deteriorating employment conditions in academia, had extensive consequences on their research. While they pressured researchers to conduct and publish a more research, it also pressured them to conduct easy, less comprehensive and more predictable research.

Using the debate about the role of serendipity in scientific discovery, whether the main component in discoveries is talent or chance, the thesis analysed how the above changes influenced the ability of researchers to make new discoveries. The analysis showed that the ability for both talent- and chance-based discovery were negatively impacted by the changes. Talent-based discoveries were made harder by the increased absence of senior researchers in the actual, on-the-floor research process, as well as the decreased freedom for researchers to determine their own research activities.

Chance-based discoveries were made less likely by decreased time for each researcher to devote to actual research activities as well as the increased need for safe research, where the outcomes could largely be predicted beforehand. Both discovery sources were also stifled by an increased need to stick to research plans constructed before the actual research, imposed by both funders and university administrations, preventing deviations to examine potential leads found during the research process. As such, although discoveries in antibacterial-related fields continued to be made even towards the end of the period, they ought to be viewed as having been made despite, rather than because, of the changes in academia.

Sources

Interviews

Interviews with individuals chosen, and conducted, in the manner described in the Methods and Interviews chapters. For an anonymised list of participants, see Appendix 3.

Swedish Research Bills (Forskningspropositioner):

SRB 1975: *Regeringens proposition 1975/76:129 - om forskningsrådsorganisationen inom utbildningsdepartementets verksamhetsområde*. Available through <http://data.riksdagen.se/fil/AF05980C-6DC9-4218-8667-119910B78D56> (21 Aug 2021)

SRB 1978: *Regeringens proposition 1978/79:119 - om vissa frågor rörande forskning och forskarutbildningen*. Available through <http://data.riksdagen.se/fil/B55D695E-F167-4F09-AEA7-B09FD946D09C> (21 Aug 2021)

SRB 1981: *Regeringens proposition 1981/82:106 - om forskning m.m.* Available through <https://data.riksdagen.se/fil/3C3CE263-3EED-43C1-A72C-EE44538DCB3C> (21 Aug 2021)

SRB 1986: *Regeringens proposition 1986/87:80 - om forskning*. Available through <https://data.riksdagen.se/fil/4E97A0CA-AD9D-47AD-AEE2-30BE2ECB0838> (21 Aug 2021)

SRB 1989: *Regeringens proposition 1989/90:90 - om forskning*. Available through <https://data.riksdagen.se/fil/D673CCAD-AD40-4A19-AEC9-C8DBFF6A8599> (21 Aug 2021)

SRB 1992: *Regeringens proposition 1992/93:170 – Forskning för kunskap och framsteg*. Available through <https://data.riksdagen.se/fil/12A4B9B8-81CE-45E4-B9FC-46F10F6ACED2> (21 Aug 2021)

SRB 1996: *Regeringens proposition 1996/97:5 – Forskning och samhälle*. Available through https://www.riksdagen.se/sv/dokument-lagar/dokument/proposition/forskning-och-samhalle_GK035/html (21 Aug 2021)

SRB 2000: *Regeringens proposition 2000/01:3 – Forskning och förnyelse*. Available through <https://www.regeringen.se/49b72c/contentassets/02af30e0df8b42cdb278c8524eb476ea/forskning-och-fornyelse> (21 Aug 2021)

SRB 2004: *Regeringens proposition 2004/05:80 – Forskning för ett bättre liv.*
Available through
<https://www.regeringen.se/49b72b/contentassets/b807df77fcb646feb634ca0823dd2a3c/forskning-for-ett-battre-liv> (21 Aug 2021)

SRB 2008: *Regeringens proposition 2008/09:50 – Ett lyft för forskning och innovation.* Available through
<https://www.regeringen.se/49b72a/contentassets/05cb6c62a34e4b37a114611a3ebcbd5b/ett-lyft-for-forskning-och-innovation-prop.-20080950> (21 Aug 2021)

SRB 2012: *Regeringens proposition 2012/13:30 – Ett lyft för forskning och innovation.* Available through
<https://www.regeringen.se/49b728/contentassets/4ef9d72bd1b84b3fad482671b5509fa7/forskning-och-innovation-prop.-20121330> (21 Aug 2021)

Riksarkivet

Medicinska forskningsrådet (Statens Medicinska forskningsråd)
Protokoll och föredragslistor - Rådets protokoll och föredragslistor
Rådets protokoll 1978-1980 -> 1990-1992
SE/RA/420710/A/A 1/A 1 A/23-28

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References

- Aboal, D. & Tacsir, E. (2017). "The impact of subsidies on researcher's productivity: Evidence from a developing country", *Research Evaluation*, 26 (4).
- Acta Oto-Laryngologica (1943). "Chapter 1: Local treatment with chemotherapeutics", *Acta Oto-Laryngologica*, 31 (sup49).
- Ahlbäck Öberg, S. & Sundberg, E. (2016). "Avkollegialiseringen av den svenska högskolan", in S. Ahlbäck Öberg, L. Bennich-Björkman, J. Hermansson, A. Jarstad, C. Karlsson, & S. Widmalm (eds.), *Det hotade universitetet*, Stockholm.
- Alanis, A. J. (2005)., November *Archives of Medical Research*, "Resistance to antibiotics: Are we in the post-antibiotic era?," Nov. 2005 *Archives of Medical Research*.
- Aldridge, S., Parascandola, J., & Sturchio, J. L. (1999). *The Discovery and Development of Penicillin 1928-1945*, London.
- Anderson, M., Clift, C., Schulze, K., Sagan, A., Nahrgang, S., Ouakrim Ait, D., & Mossialos, E. (2019). *Averting the AMR Crisis: What are the avenues for policy action for countries in Europe?*
- Asztalos, M. (1991). "The Faculty of Theology", in H. de Ridder-Symoens (ed.), *A History of the University in Europe*, Cambridge.
- Axtell, J. (2016). *Wisdom's Workshop: The Rise of the Modern University*, Princeton.
- Baraldi, E., Lindahl, O., Savic, M., Findlay, D., & Årdal, C. (2018). "Antibiotic Pipeline Coordinators", *The Journal of Law, Medicine & Ethics*, 46.
- Bartholomew, R. E. (2014)., October 8 *Journal of the Royal Society of Medicine*, "Science for sale: The rise of predatory journals," SAGE Publications Ltd, 8 Oct. 2014 *Journal of the Royal Society of Medicine*.
- Bassetti, M., Giacobbe, D. R., Vena, A., & Brink, A. (2019). "Challenges and research priorities to progress the impact of antimicrobial stewardship", *Drugs in Context*, 8.
- Benner, M. (2009). *Kunskapsnation i kris?*, Smedjebacken.
- Blevins, S. M. & Bronze, M. S. (2010). "Robert Koch and the "golden age" of bacteriology", *International Journal of Infectious Diseases*, 14 (9).
- Butler, M. S., Blaskovich, M. A., & Cooper, M. A. (2017). "Antibiotics in the clinical pipeline at the end of 2015", *The Journal of Antibiotics*, 70 (1).
- Collard, P. J. (1976). *The Development of Microbiology*, Cambridge.
- Conly, J. & Johnston, B. (2005). "Where are all the new antibiotics? The new antibiotic paradox", *Canadian Journal of Infectious Diseases and Medical Microbiology*, 16 (3).
- Copeland, S. (2019). "On serendipity in science: discovery at the intersection of chance and wisdom", *Synthese*, 196.
- Czarniawska, B. & Solli, R. (2014)., October 27 *Hur går det för New Public*

- Management i svenska kommuner? Organisation & Samhälle* [<https://orgsam.se/hur-gar-det-for-new-public-management-i-svenska-kommuner/>] (accessed: 02/23/2022).
- Dellstig, D. (2020). *Den efterfrågade vetenskapen : Universitetsbibliotek, akademiska tidskrifter och vetenskapliga förlag 1968–2018*, Ekonomisk-Historiska Institutionen, Uppsala.
- Domagk, G. (1947). "Further progress in chemotherapy of bacterial infections", in *Nobel Lecture*, Stockholm.
- Falavigna, G. & Manello, A. (2014). "External funding, efficiency and productivity growth in public research: the case of the Italian National Research Council", *Research Evaluation*, 23 (1).
- Fleming, A. (1945). "Penicillin", in *Nobel Lecture*, Stockholm.
- Folkhälsomyndigheten (2018). *Future costs of antibiotic resistance: Final reporting of Government commission on direct and indirect costs and consequences of antibiotic resistance in Swedish health care*.
- Frith, J. (2012). "Syphilis - Its Early History and Treatment Until Penicillin, and the Debate on its Origins", *Journal of Military and Veterans' Health*, 20 (4).
- García Y García, A. (1991). "The Faculty of Law", in H. de Ridder-Symoens (ed.), *A History of the University in Europe*, Cambridge.
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, London.
- Gilbert, K. J., Andrew, R. L., Bock, D. G., Franklin, M. T., Kane, N. C., Moore, J.-S., ... Vines, T. H. (2012). "Recommendations for utilizing and reporting population genetic analyses: the reproducibility of genetic clustering using the program structure", *Molecular Ecology*, 21 (20).
- Ginsberg, J. (2008). *Pfizer's work on penicillin for World War II becomes a National Historic Chemical Landmark* *American Chemical Society* [<https://www.acs.org/content/acs/en/pressroom/newsreleases/2008/june/pfizers-work-on-penicillin-for-world-war-ii-becomes-a-national-historic-chemical-landmark.html>] (accessed: 11/11/2019).
- Gross, K. & Bergstrom, C. T. (2019). "Contest models highlight inherent inefficiencies of scientific funding competitions", *PLOS Biology*, 17 (1).
- Grundmann, E. (2004). *Gerhard Domagk: The First Man to Triumph Over Infectious Diseases*, Münster.
- Hackett, E. J. (1990). "Science as a Vocation in the 1990s: The Changing Organizational Culture of Academic Science", *The Journal of Higher Education*, 61 (3).
- Hackett, E. J. (2014). "Academic Capitalism", *Science, Technology, & Human Values*, 39 (5).
- Hasselberg, Y. (2012). *Vetenskap som arbete: Normer och arbetsorganisation i den kommodifierade vetenskapen*, Möklinta.
- Heine, S. J., Markus, H. R., Lehman, D. R., & Kitayana, S. (1999). "Is there a universal need for positive self-regard?", *Psychological Review*, 106 (4).
- Hollings, C. D. (2016). *Scientific Communication Across the Iron Curtain*, Cham.
- Horodnic, I. A. & Zait, A. (2015). "Motivation and research productivity in a university system undergoing transition", *Research Evaluation*, 24 (3).

- Innovative Medicines Initiative (2021).a, August 16 *ENABLE* [<https://www.imi.europa.eu/projects-results/project-factsheets/enable>] (accessed: 08/16/2021).
- Innovative Medicines Initiative (2021).b, August 16 *IMI supported antibiotic passes Phase I clinical trials* [<https://www.imi.europa.eu/news-events/newsroom/imi-supported-antibiotic-passes-phase-i-clinical-trials>] (accessed: 08/16/2021).
- Ioannidis, J. P. A. (2005). "Why Most Published Research Findings Are False", *PLOS Medicine*, 2 (8).
- Ioannidis, J. P. A., Stanley, T. D., & Doucouliagos, H. (2017). "The Power of Bias in Economics Research", *The Economic Journal*, 127 (605).
- Ippoliti, E. (2017). "Scientific Discovery Reloaded", *Topoi* 39:4, 39 (4).
- Isacson, M. (1987). *Verkstadsarbete under 1900-talet: Hedemora Verkstäder före 1950*, Lund.
- Ivancheva, M. P. (2015). "The age of precarity and the new challenges to the academic profession", *Studia Universitatis Babeş-Bolyai-Studia Europaea*, 60 (1).
- Johnson, A. (2015).a *PharmaciaFöretagskällan* [<https://www.foretagskallan.se/foretagskallan-nyheter/lektionsmaterial/pharmacia/>] (accessed: 08/19/2021).
- Johnson, A. (2015).b *GambroFöretagskällan* [<https://www.foretagskallan.se/foretagskallan-nyheter/lektionsmaterial/gambro/>] (accessed: 08/19/2021).
- Johnson, A. (2020). *Läkemedelsföretaget AstraZenecaFöretagskällan* [<https://www.foretagskallan.se/foretagskallan-nyheter/lektionsmaterial/astrazeneca/>] (accessed: 08/19/2021).
- Kåhrström, C. T. (2013). "Entering a post-antibiotic era?", *Nature Reviews Microbiology*, 11 (3).
- Kantorovich, A. (2014). "An evolutionary view of science: Imitation and memetics", *Social Science Information*, 53 (3).
- Karamanou, M., Panayiotakopoulos, G., Tsoucalas, G., Kousoulis, A. A., & Androustos, G. (2012). "From miasmas to germs: a historical approach to theories of infectious disease transmission", *Le Infezioni in Medicina*, 1.
- Kauppinen, I. (2012). "Towards transnational academic capitalism", *Higher Education*, 64.
- Kinch, M. S., Patridge, E., Plummer, M., & Hoyer, D. (2014). "An analysis of FDA-approved drugs for infectious disease: antibacterial agents", *Drug Discovery Today*, 19 (9).
- Kuhn, T. S. (1962). *The Structure of Scientific Revolutions*, Chicago.
- Laine, H. (2017). "Afraid of scooping – Case study on researcher strategies against fear of scooping in the context of open science", *Data Science Journal*, 16.
- LaMattina, J. L. (2011). "The impact of mergers on pharmaceutical R&D", *Nature Reviews Drug Discovery* 2011 10:8, 10 (8).
- Leff, G. (1991). "The Trivium and the Three Philosophies", in H. de Ridder-Symoens (ed.), *A History of the University in Europe*, Cambridge.
- Marshall, E. K. J. (1964). "Historical Perspectives in Chemotherapy", in A. Goldin & F. Hawking (eds.), *Advances in Chemotherapy, Volume 1*, New York.
- Merton, R. K. (1973).a "The Normative Structures of Science", in R. K. Merton (ed.), *The Sociology of Science: Theoretical and Empirical Investigations*, Chicago.

- Merton, R. K. (1973).b "Science and the Social Order", in R. K. Merton (ed.), *The Sociology of Science: Theoretical and Empirical Investigations*, Chicago.
- Merton, R. K. (1968). "The Matthew Effect in Science", *Science*, 159 (3810).
- Merton, R. K. & Barber, E. G. (2004). *The Travels and Adventures of Serendipity: A Study in Sociological Semantics and the Sociology of Science*, Princeton.
- Miller, M. B., Atrazadeh, F., Burnham, C. A. D., Cavalieri, S., Dunn, J., Jones, S., ... Campos, J. (2019). "Clinical Utility of Advanced Microbiology Testing Tools", *Journal of Clinical Microbiology*, 57 (9).
- Mirowski, P. (2011). *Science Mart: Privatizing American Science*, London.
- Morgan, G. & Wood, J. (2017). "The "academic career" in the era of flexploitation", in E. Armano, A. Bove, & A. Murgia (eds.), *Mapping precariousness, labour insecurity and uncertain livelihoods: Subjectivities and resistance*, Nre York.
- Morichika, N. & Shibayama, S. (2015). "Impact of inbreeding on scientific productivity: A case study of a Japanese university department", *Research Evaluation*, 24 (2).
- Newsom, S. W. B. (1993). "Pioneers in infection control - Ignaz Philipp Semmelweis.", *The Journal of Hospital Infection*, 23 (3).
- Newsom, S. W. B. (2003). "Pioneers in infection control - Joseph Lister", *Journal of Hospital Infection*, 55 (4).
- Newsom, S. W. B. (2006). "Pioneers in infection control: John Snow, Henry Whitehead, the Broad Street pump, and the beginnings of geographical epidemiology", *Journal of Hospital Infection*, 64 (3).
- Nielsen, P. & Davidson, R. M. (2020). "Predatory journals: A sign of an unhealthy publish or perish game?", *Information Systems Journal*, 30 (4).
- North, J. (1991). "The Quadrivium", in H. de Ridder-Symoens (ed.), *A History of the University in Europe*, Cambridge.
- Nosek, B. A., Alter, G., Banks, G. C., Borsboom, D., Bowman, S. D., Breckler, S. J., ... Yarkoni, T. (2015). "Promoting an open research culture", *Science*, 348 (6242).
- O'Niell, J. (2014). *Antimicrobial Resistance: Tackling a crisis for the health and wealth of nations*, London.
- OECD (2019). *Antimicrobial Resistance Tackling the Burden in the European Union Briefing note for EU/EEA countries Contents*.
- Outterson, K., Powers, J. H., Daniel, G. W., & McClellan, M. B. (2015). "Repairing the broken market for antibiotic innovation", *Health Affairs*, 34 (2).
- Parascandola, J. (2001). "History of Salvarsan (Arsphenamine)", in *Encyclopedia of Life Sciences*, Chichester, UK.
- Pier, G. B. (2008). "On the Greatly Exaggerated Reports of the Death of Infectious Diseases", *Clinical Infectious Diseases*, 47 (8).
- Plackett, B. (2020). "Why big pharma has abandoned antibiotics", *Nature*, 586 (7830).
- Plotkin, S. (2014). "History of vaccination", *Proceedings of the National Academy of Sciences of the United States of America*, 111 (34).
- Premfors, R. (1987). "Utvärderingsverksamhet på central förvaltningsnivå", *Statsvetenskaplig Tidskrift*, 90 (4).
- Regeringen "Regeringens proposition (2009/10:149): En akademi i tiden – ökad frihet för universitet och högskolor", , Regeringens proposition (2010).
- Rider, S. (2013). "Higher Heteronomy: Thinking through Modern University

- Education", in S. Rider (ed.), *Transformations in Research, Higher Education and the Academic Market: The Breakdown of Scientific Thought*, Dordrecht.
- Rosenberg, G. (2002). "The Crisis of Consensus in Postwar Sweden", in N. Witoszek & L. Trägårdh (eds.), *Culture and Crisis: The Case of Germany and Sweden*, Oxford.
- Sadurskis, A. (2008). *Stiftelsehögskolereformen – en uppföljning*, Stockholm.
- Sandström, U. (1994). *Mellan politik och forskning: 1960-1992: Statens råd för byggnadsforskning*, Stockholm.
- Schacter, D. L. (1995). "Memory distortion: History and current status", in D. L. Schacter (ed.), *Memory distortion: How minds, brains, and societies reconstruct the past*, Cambridge.
- Schickore, J. (2018). "Scientific Discovery" in E. N. Zalta (ed by.) *Stanford Encyclopedia of Philosophy*, Stanford.
- Schilling, P. (2005). *Research as a source of strategic opportunity? Re-thinking research policy developments in the late 20th century*, Umeå University, Umeå.
- Schmidgen, H. (2011). "The Laboratory" in *European History Online*.
- Schmolck, H., Buffalo, E. A., & Squire, L. R. (2000). "Memory distortions develop over time: Recollections of the O.J. Simpson trial verdict after 15 and 32 months", *Psychological Science*, 11 (1).
- Schofer, E. & Meyer, J. W. (2016). "The Worldwide Expansion of Higher Education in the Twentieth Century:", *American Sociological Review*, 70 (6).
- Schulze-Cleven, T. & Olson, J. R. (2017). "Worlds of higher education transformed: toward varieties of academic capitalism", *Higher Education* 2017 73:6, 73 (6).
- Siraisi, N. (1991). "The Faculty of Medicine", in H. de Ridder-Symoens (ed.), *A History of the University in Europe*, Cambridge.
- Slaughter, S. & Leslie, L. L. (1997). *Academic Capitalism*, Baltimore.
- Sørensen, M. P., Haase, S., Granversen, E. K., Kalpazidou Schmidt, E., Mejlgaard, N., & Ryan, T. K. (2015). *Autonomi och kvalitet – ett uppföljningsprojekt om implementering och effekter av två högskolereformer i Sverige*, Stockholm.
- Sorokowski, P., Kulczycki, E., Sorokowska, A., & Pisanski, K. (2017). "Predatory journals recruit fake editor", *Nature News*, 543 (7646).
- Ståhle, B. (1992). *Forskningspolitik i Norden 1992: Om forskningsinsatser, prioriteringar och forskningspolitiska huvudlinjer i de nordiska länderna*, Copenhagen.
- Stephan, P. E. (2012). *How Economics Shapes Science*, Cambridge.
- Strömholm, S. (1994). *Den svenska högskolan*, Stockholm.
- Sundqvist, B. (2010). *Svenska universitet - lärdomsborgar eller politiska instrument?*, Hedemora.
- Sundström, G. (2003). *Stat på villovägar. Resultatstyrningens framväxt i ett historisk-institutionellt perspektiv*, Stockholm University, Stockholm Retrieved from <http://www.su.se/cmlink/stockholms-universitet-samhallsvetenskapliga-fakulteten/statsvetenskapliga-institutionen-nod/statsvetenskapliga-institutionen/forskning/vara-forskare/goran-sundstrom/goran-sundstrom-1.118500>.
- Teillant, A., Gandra, S., Barter, D., Morgan, D. J., & Laxminarayan, R. (2015). "Potential burden of antibiotic resistance on surgery and cancer chemotherapy antibiotic prophylaxis in the USA: a literature review and modelling study", *The*

- Lancet Infectious Diseases*, 15 (12).
- Trouiller, P., Olliaro, P., Torreele, E., Orbinski, J., Laing, R., & Ford, N. (2002). "Drug development for neglected diseases: A deficient market and a public-health policy failure", *Lancet*, 359 (9324).
- Trow, M. (1973). *Problems in the Transition from Elite to Mass Higher Education*, Berkeley.
- Turner, R. S. (1971). "The Growth of Professorial Research in Prussia, 1818 to 1848-Causes and Context", *Historical Studies in the Physical Sciences*, 3.
- Universitetskanslerämbetet (2021). *Universitet och högskolor – Årsrapport 2021*, Johanneshov.
- Uppsala University (2006). *Årsredovisning 2005*, Uppsala.
- Uppsala University (2011). *Årsredovisning 2010*, Uppsala.
- Utbildningsdepartementet "Högskolelag (1992:1434)", (1992).
- Utbildningsdepartementet "Uppdrag att inrätta nationella forskningsprogram", , Regeringsbeslut (2017).
- Utbildningsutskottet (1997). *Utbildningsutskottets betänkande*, "Anställningsskyddet för professorer," 1997 *Utbildningsutskottets Betänkande*, Stockholm.
- Verger, J. (1991). "Teachers", in H. de Ridder-Symoens (ed.), *A History of the University in Europe*, Cambridge.
- Vetenskapsrådet (2019). *Strategisk forskningsagenda: Nationella forskningsprogrammet om antibiotikaresistens*, Stockholm.
- Wainwright, M. (1990). *Miracle Cure: The Story of Penicillin and the Golden Age of Antibiotics*.
- Waluszewski, A. (2017)., February 15 "När samverkan gifts ihop med forskning och innovation blir det problematiskt", *Tidningen Curie*.
- Wennerås, C. & Wold, A. (1997). "Nepotism and sexism in peer-review", *Nature*, 387.
- Widmalm, S. (2013). "Innovation and Control: Performative Research Policy in Sweden", in S. Rider, Y. Hasselberg, & A. Waluszewski (eds.), *Transformations in Research, Higher Education and the Academic Market: The Breakdown of Scientific Thought*, Dordrecht.
- Wikgren, M., Gustavsson, T., & Gerdes Barriere, S. (2017). *De nya lärosätena i forskningssystemet - Forskningsförutsättningar och förhållande till Vetenskapsrådet*, Stockholm.
- World Health Organization (2017). *Antibacterial agents in clinical development – an analysis of the antibacterial clinical development pipeline, including tuberculosis*.
- Yarnell, A. (2005). *Salvarsan* *Chemical & Engineering News* [<http://pubsapp.acs.org/cen/coverstory/83/8325/8325salvarsan.html?>] (accessed: 11/12/2019).
- Ylijoki, O.-H. (2016). "Projectification and Conflicting Temporalities in Academic Knowledge Production", *Theory of Science*, 38 (1).
- Ylijoki, O.-H. & Mäntylä, H. (2003). "Conflicting Time Perspectives in Academic Work:", *Time & Society*, 12 (1).
- Zaffiri, L., Gardner, J., Toledo-Pereyra, L. H., & Toledo, L. H. (2012). "History of Antibiotics. From Salvarsan to Cephalosporins", *Journal of Investigative Surgery*, 25 (2).

Appendices

Appendix 1 - Intervjuguide:

1) 'University context': Projektet, relationer till andra grupper inom universitet, relationer till andra universitetsforskare

- **Hur etablerades** din forskningsverksamhet och ditt intresse för antibakteriell/antibiotikarelaterad forskning?

- **Sociala resurser: Växte någon speciell forskningsgruppering fram?** Hur mobiliserades? Hur många involverades? Hur kontinuerligt över tid? Vilken expertis var representerad? Vad karaktäriserade det övergripande målet med verksamheten/projekten och hur formulerades det? Hur såg det dagliga arbetet ut och vem gjorde vad? Förändring över tid?

- **Materiella resurser:** Vilka labb, utrustningar etc. var centrala för projektet? Lokaliserade var?

- **Kontinuitet över tid:** När ett projekt avslutats, hur togs erfarenheterna tillvara (förutom publicering)? Var projektdeltagarna i huvudsak fast anställda? Startades nya projekt på basis av tidigare?

- **Vilka andra forskargrupper/experten** inom universitetet var viktiga? Vilka, hur ofta träffades ni? Specifika materiella resurser av vikt?

- **Vilka nationella/internationella forskargrupper/experten** inom akademien var centrala? Vilka, på vilket sätt skedde interaktionen? Specifika materiella resurser av vikt?

- **Vad karaktäriserade relationen mellan kollegor inom gruppen** vad gäller problemlösande? (Mer samarbete eller mer konkurrens?) Förändring över tid?

- Vad karaktäriserade relationen mellan forskargrupper inom institutionen/fakulteten? (Mer samarbete eller mer konkurrens?) Förändring över tid?

- **På vilket sätt var projektet relaterad till administrativa/ledande funktioner** inom universitet? Stöd i form av sociala/materiella resurser? (Institutionsledning, Fakultetsledning, Övrig administration) På vilket sätt påverkade inverkade dessa funktioner i projektet, (underlättade, hindrade, påverkade inriktningen, eller enbart passiva)?

- **Ungefär hur stor del av er finansiering kom från institutionen/fakulteten?** Hur stor del av forskningsverksamheten, ungefär, garanterades av denna finansiering? Förändring över tid?

2) External research funding

- Vilka var det viktigaste externa finansiärerna? Vilka var dessa (råd, stiftelser etc.)?

- **Vilken roll spelade finansieringen från MFR/VR** för projektets realisering och verksamhet? För sociala resurser? För materiella resurser? (Enligt MFR/VR fick ni X i bidrag från MFR/VR för projekt Y år Z.) Hur stor del av hela projektbudgeten utgjorde detta? Vilka utgifter täckte detta? Vilka ev. andra finansiärer stöttade projektet?

- Hur stor del av er arbetstid la ni ner på att söka extern finansiering? Inkludera här både tid för praktiska uppgifter som sökandet efter finansiärer, det faktiska ansökansskrivandet, korrespondens, avrapportering mm samt tid som lades ner på att fundera kring frågor om finansiering. Vem i gruppen var det som utförde detta arbete?

- Hur påverkades möjligheten till extern finansiering över tid? Var funderingar kring externa medel en källa till oro för dig?

- Var möjligheten till extern forskning en faktor i valet av vad ni forskade om?

3) Pharmaceutical business R&D partners

- Hur skulle ni karaktärisera relationen till externa företag, som läkemedelsföretag, utrustningsföretag etc.?

- **Bedrevs konkreta projekt** tillsammans med någon/några av dessa parter?

- **Hur etablerades dessa?** (Officiella kanaler, gemensamma evenemang, tidigare kollegor eller studiekamrater etc.)

- **Sociala resurser: Hur bedrevs de?** (Forskningssamarbeten, industridoktorander, konsultprojekt?) Antal personer inblandade, representerande vilken expertis?

-**Materiella resurser:** Hade någon av parterna labb, utrustning etc. av central vikt för projektet.

- Vilka gemensamma mål respektive vilka olika intressen fanns i dessa samarbeten?

- **Relation forskningsprojekt – konkreta produkter/metoder.** På vilket sätt var projekten kopplade till konkreta produkter (läkemedel) respektive metoder? Som 'byggstenar' i tidig utveckling eller senare i 'drug development pipeline'.

- Påverkade möjligheten att bidra till utvecklingen av nya läkemedel/metoder valet av forskningsämne?

- Kom någon del av er finansiering från företag? Direkt eller indirekt?

Övrigt:

- Hade ni i forskargruppen några inkomstkällor förutom de vi tagit upp tidigare?
- Finns det några övriga faktorer som påverkade vad du eller ni forskade om?
- Finns det några andra personer eller organisationer, förutom de vi tidigare pratat om, som var viktiga för er forskning?

Appendix 2.a Logistic regressions for application approval odds for the bacterial MFR dataset adjusted for sex and year (Model 1)

	Odds Ratio	2.5%	97.5%	p-value
Intercept	4.71	1.73	12.83	0.002
Male	1.22	0.71	2.12	0.472
1981	0.63	0.21	1.93	0.423
1982	0.67	0.23	2.01	0.479
1983	0.51	0.18	1.44	0.202
1984	0.70	0.24	2.01	0.505
1985	0.65	0.23	1.83	0.414
1986	0.73	0.26	2.08	0.557
1987	0.49	0.18	1.35	0.168
1988	0.69	0.24	2.01	0.499
1989	0.65	0.23	1.85	0.422
1990	0.88	0.30	2.56	0.814

Significance: * <0.05 , ** <0.01 , *** <0.001

Appendix 2.b Logistic regressions for application approval odds for the bacterial MFR dataset adjusted for sex, year and status (Model 2)

	Odds Ratio	2.5%	97.5%	p-value	
Intercept	2.70	0.91	7.98	0.072	
Male	0.70	0.39	1.24	0.218	
1981	0.55	0.17	1.76	0.316	
1982	0.71	0.23	2.21	0.557	
1983	0.50	0.17	1.48	0.210	
1984	0.71	0.24	2.14	0.546	
1985	0.67	0.23	1.98	0.473	
1986	0.76	0.26	2.26	0.623	
1987	0.42	0.15	1.21	0.108	
1988	0.61	0.20	1.83	0.375	
1989	0.64	0.22	1.88	0.414	
1990	0.85	0.28	2.56	0.768	
Docent	2.24	1.36	3.69	0.002	**
Professor	6.97	3.95	12.30	0.000	***

Significance: * <0.05 , ** <0.01 , *** <0.001

Appendix 2.c Linear regressions for funding per approved project for the bacterial MFR dataset adjusted for sex and year (Model 1)

	Estimate	Std. Error	p-value
Intercept	152864	43054	0.000 ***
Male	96 550	27351	0.000 ***
1981	-36 287	48150	0.451
1982	-46 261	46425	0.319
1983	-33 621	46191	0.467
1984	-74 658	44605	0.095
1985	-88 350	43909	0.045 *
1986	-96 610	43689	0.027 *
1987	-62 869	44430	0.158
1988	-33 829	44817	0.451
1989	-78 179	44191	0.077
1990	-65 937	43404	0.129

Significance: * <0.05 , ** <0.01 , *** <0.001

Appendix 2.d Linear regressions for funding per approved project for the bacterial MFR dataset adjusted for sex, year, and status (Model 2)

	Estimate	Std. Error	p-value
Intercept	10 4706	46 086	0.024 *
Male	15 480	27 631	0.576
1981	-40 298	45 401	0.375
1982	-37 961	43 806	0.387
1983	-38 021	43 571	0.383
1984	-74 966	42 079	0.075
1985	-84 231	41 438	0.042 *
1986	-89 291	41 252	0.031 *
1987	-69 085	41 900	0.100
1988	-44 680	42 283	0.291
1989	-78 021	41 690	0.062
1990	-67 119	40 924	0.102
Docent	60 120	29 376	0.041 *
Professor	188 331	29 740	0.000 ***

Significance: *<0.05, **<0.01, ***<0.001

Appendix 2.e Logistic regressions for application approval odds for the full VR dataset adjusted for sex and year

	Odds Ratio	2.5%	97.5%	p-value
Intercept	0.44	0.39	0.50	0.000 ***
Male	1.27	1.17	1.37	0.000 ***
2006	1.18	0.99	1.41	0.058
2007	1.27	1.07	1.51	0.007 **
2008	1.01	0.84	1.21	0.930
2009	1.09	0.92	1.30	0.332
2010	0.77	0.64	0.92	0.005 **
2011	0.49	0.41	0.57	0.000 ***
2012	0.64	0.54	0.75	0.000 ***
2013	0.36	0.30	0.43	0.000 ***
2014	0.40	0.33	0.48	0.000 ***
2015	0.45	0.38	0.55	0.000 ***

Significance: * <0.05 , ** <0.01 , *** <0.001

Appendix 2.f Linear regressions for funding per approved project for the full VR dataset adjusted for sex and year

	Estimate	Std. Error	p-value
Intercept	368 577	39 437	0.000 ***
Male	90 269	24 645	0.000 ***
2006	27 817	50 813	0.584
2007	150 699	50 922	0.003 **
2008	217 960	53 588	0.000 ***
2009	192 161	50 986	0.000 ***
2010	404 540	54 799	0.000 ***
2011	504 957	51 358	0.000 ***
2012	788 687	52 070	0.000 ***
2013	1 256 215	57 234	0.000 ***
2014	839 160	58 798	0.000 ***
2015	744 807	58 804	0.000 ***

Significance: *<0.05, **<0.01, ***<0.001

Appendix 3 – List of Interviewees

Seniority ³⁴¹	Affiliation ³⁴²
Older	Lund
Older	Uppsala
Younger	Lund
Younger	Uppsala

³⁴¹ Seniority determined here by year of PhD defence, with Older interviewees defending before 1990 and Younger interviewees defending on or after 1990.

³⁴² Indicating affiliation at the time of receiving MFR or VR grant.

Acta Universitatis Upsaliensis
UPPSALA STUDIES IN ECONOMIC HISTORY
Editors: Anders Ögren and Ylva Hasselberg

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