Essays on Research Funding

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2 Abstract

This thesis is composed of three papers all regarding research funding. The first one, in close collaboration with Prof. Dr. Hendrik Hakenes, theoretically analyzes privately funded academic research being a mixture between academic and industry research. We develop a theoretical framework in which private research funding (PRF) transfers information on the value of a research project from the private sector into academia, in an incentive compatible way. Thereby, the introduction of private funding reduces the relative desirability of academia. Once, private research funds are obtained, a project leaves academia faster than without them. Besides, we are able to present different sequences research can be conducted as well as the optimal amount of private research funds, finding that it possibly exceed the aggregate bill in academia. In the end, we deduce some political implications about the funding of academic research.

The second paper empirically seeks to determine the type of research strategy that best responds to new conditions based on reformations of higher education systems. Also due to them, research funding has become an increasingly significant concern and the standards of efficient scholarship have risen. To this end, we examine access to public and private external funding and the compositions of university research budgets, which are determined by research focus. Moreover, we consider the relationship between public and private funding and find that they complement each other, independently of research strategy. This relationship is particularly strong if a pure strategy (either basic or applied) is chosen.

The last paper contributes to international mobility of researchers that is important because it enhances the benefits "for sending and receiving countries, as well as for the global economy"(Ivancheva and Gourova, 2011, p. 189), as it is "commonly believed to diffuse knowledge and, consequently, to support innovativeness and competitiveness"(Inzelt, 2011, p. 5). This issue, called brain circulation, has induced European countries in recent decades to develop their higher education and research funding systems to create conditions and research environments that attract both domestic and foreign scholars. However, the question remains as to whether this objective is met by all countries within the European Research Area (ERA). Because the ability to obtain external research funds is an important concern in this regard, we analyze whether foreign researchers in the ERA face the same access to public and private funding compared with their national colleagues. Unfortunately, we must conclude that there are differences regarding the allocation of research funds between national and foreign researchers. In particular, the Continental and Southern European countries discriminate against foreign researchers, whereas the Scandinavian countries treat both equally.

Keywords: Research Funding, University Finance, R&D

Zusammenfassung

Diese kumulative Dissertation besteht aus drei Teilen, die sich mit der Finanzierung bzw. Förderung von (universitärer) Forschung befassen. Den ersten Teil, der in Zusammenarbeit mit Prof. Dr. Hendrik Hakenes entstanden ist, bildet ein theoretisches Modell, welches drittmittelfinanzierte Forschung als Zwischenform zwischen universitärer und privater Forschung untersucht. In unserem Modellrahmen dienen die Drittmittel, die ausschließlich aus dem privaten Sektor stammen, als Qualitätssignal für die Vermarktbarkeit eines universitären Forschungsprojekts. Die Einwerbung von Drittmitteln induziert dabei, dass Forschungsprojekte früher den akademischen Sektor verlassen bzw. an die Industrie übergeben werden als ohne dieses Signal. Zudem können wir aus dem Modell heraus verschiedene Sequenzen, die ein Forschungsprojekt durchläuft, identifizieren und den optimalen Betrag an Drittmitteln bestimmen. Interessanterweise kann dieser das Gesamtbudget sogar übersteigen. Schlussendlich werden politische Implikationen für die Forschungsförderung abgeleitet.

Der zweite Teil, eine empirische Analyse, befasst sich mit der Frage, ob es eine Forschungsausrichtung (Grundlagenforschung, angewandte Forschung oder Mischformen) gibt, die besonders erfolgversprechend hinsichtlich der Einwerbung von Drittmitteln ist. Diese Art der Forschungsförderung gewinnt immer mehr an Bedeutung, nicht zuletzt angesichts der Reformen der Hochschulsysteme in der Europäischen Forschungsregion (ERA). Überdies wird der Erfolg eines Wissenschaftlers heutzutage auch an seiner Erfahrung im Umgang mit Drittmitteln festgemacht. Aus diesem Grund wird in diesem Forschungsansatz der Zugang zu öffentlichen und privaten Drittmiteln sowie die Zusammensetzung des individuellen Etats aus Universitäts- und Drittmitteln abhängig von der Forschungsausrichtung untersucht. Im Zuge der Analyse wird ferner der Zusammenhang zwischen öffentlichen und privaten Drittmitteln betrachtet wobei sich ein komplementäres Verhältnis beider, unabhängig von der Forschungsausrichtung, offenbart. Die Verbindung zwischen öffentlichen und privaten Drittmitteln ist jedoch besonders eng, wenn die Forschungsausrichtung stark fokussiert ist.

Der dritte Teil leistet einen Beitrag zur Literatur, die sich mit der internationalen Mobilität von Forschern beschäftigt. Der Argumentation folgend, dass diese Mobilität infolge von Wissenszirkulation positive Effekte für einzelne Länder bzw. die Weltwirtschaft im Allgemeinen hat, wird untersucht, ob die Länder in der Europäischen Forschungsregion (ERA) hinreichende Rahmenbedingungen geschaffen haben, die in- und fremdländischen Forschern denselben Zugang zu Drittmitteln ermöglichen und somit die Mobilität begünstigen. Bedauerlicherweise ist dies nicht der Fall, vielmehr sind große Unterschiede bei der Vergabe von Drittmittel (öffentlich und privat) zwischen in- und ausländischen Forschern erkennbar. Dies betrifft vor allem die kontinental- und südeuropäischen Länder.

Schlagworte: Forschungsförderung, Forschungsfinanzierung, Forschung & Entwicklung

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Part I

A Theory of private Research Funding

3 Introduction

Why are researchers in academia forced to finance projects, equipment or staff members with private outside finance? Why are they, that way, distracted from research and teaching? From a financial economics perspective, finance may act as a gatekeeper. Promising projects receive finance, projects with low value do not. That way, information enters the academic system from outside. But with this perspective, new questions come up. Should all research projects be financed privately, at least partially? And what is the optimal fraction of outside finance? Our paper addresses these questions with a theoretical model.

Therefore, we convert the view that is often used in models examining financial markets (see e.g. Tirole (2006)) into an approach regarding private research funding (PRF). In the light of asymmetric information, regardless whether we talk about research or financial markets, uncertainty about the valuation of projects may lead to inefficient outcomes. The question arises whether projects should be carried out anyway. Via incentive compatible contracts the problem of adverse selection is overcome or at least softened. We use this framing and apply it on research funding assuming that the private sector can gather information on potential marketable products. By asking the industry, researchers inside academia get to know if they pursue promising projects. So as to act as a credible signal, the information must be supported with private research funds.

This procedure is common practice. A striking example is the research conducted in the David H. Koch Institute for Integrative Cancer Research at the Massachusetts Institute of Technology (MIT) which historically pioneered research collaborations between academia and industry. We use the development of CML (Chronic myelogenous leukemia[1]) drugs for explaining our reasoning. A typical creation of new drugs starts inside the MIT and is finally transferred to industry. The whole process takes between 10 and 12 years and is highly complex. That is why we rather focus on the main steps and leave aside previous discoveries, potentially providing the basis for this development like the critical discovery about what causes CML made by Professor Dr. David Baltimore (MIT) in the 1980s. First, after gathering information on the need of a new drug, the researchers inside the MIT discover which protein is altered in CML. Afterwards, the chemical screen process begins in which 300.000 chemicals are tested to see which one kills the cancer cells. Thereby, small amounts of thousands of different chemicals are synthesized. The treated cancer cells are examined to see the effects of the chemicals.

[1] Cancer of the white blood cells.

The fourth stage contains the analysis of data on the experiments. By means of computer programmes, the most promising chemicals are determined. The fifth and sixth steps are carried out in the chemistry laboratory. In order to generate dose response curves, large batches of each of the promising chemical are synthesized and analogs of each chemical are made to measure their potencies. So far, these steps are assigned to be basic research leading to a discovery of potential drugs followed by the clinical trial, anon divided into 4 phases, to test each potential new treatment. The first phase measures the safety and the second the efficiency of the treatments. The third phase is rather organizational, whereas in the fourth the drugs are optimized. Finally, the findings are shared with the scientific community and the general public by journals, conferences and the World Wide Web and an approval from the U. S. Food and Drug Administration (FDA) is sought. After all, the new drug will be produced, advertised and placed on the market by pharmaceutical biotechnological firms like Novartis, Dendreon, or Bristol-Myers Squibb[2].

As we restrict our analysis up to private research funds, we omit public support which usually depends on social values being hardly convertible into monetary features. Public funding is mainly an issue inside academia if the granted scientific freedom leads to research that is not intended to provide implementable results that can be commercialized. This might happen because of the nonprofit-oriented character of academia yielding to the possibility that researchers are allowed to pursue a broader range of research (basic and applied, theoretical and experimental, etc.), respectively to trace various ideas. If rather concrete and applicable questions are investigated, like the CML drug, and the private sector is interested, it participates in terms of private research funds. This could be seen as a beneficial mixture between public and private effort just like (ideally) in a public-private partnership (PPP).

While the literature on R&D in general, and on PPP in particular, is immense (see, e. g., Maskin and Tirole (2007), Hart (2003), and Murray, Aghion, Dewatripont, Kolev, and Stern (2009)), hardly any work considers private research funding theoretically. We close this gap by extending the model of Aghion, Dewatripont, and Stein (2008). In their discrete-time model, Aghion, Dewatripont, and Stein assume that innovation occurs in a sequence of steps. Each step can be carried out in the private sector, where researchers are more determined, or in academia, where researchers demand lower wages because they appreciate academic freedom. With increasing steps of innovation, the product progresses towards marketability, so research becomes more urgent. A welfare maximizing policy maker (the dean, or rector, or director, in the following called the *research designer*) should then transfer the research line from academia to the private sector (in the following also called *industry*) in order not to risk the project success.

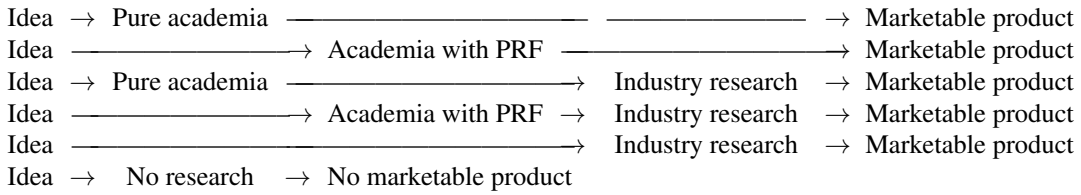
We consider a continuous-time version of this model. This is done for computational ease only, without changing any comparative statics. In order to endogenize research funding, we introduce a delegation problem: The research designer has neither information on the

[2]For further information, see http://ki.mit.edu/.

valuation of research projects nor the control over the researchers' strategy choice. To get an idea if the researchers work auspiciously, he could ask the private sector. Therefore, we add one modeling component, assuming that the private sector can gather information on the marketability of the final product – at a cost. This information is valuable for the research designer; hence, he wants to implement an incentive-compatible contract with the private sector to get the information truthfully. One way to do so is by asking the private firm to contribute to research funding, pledging part of the proceeds at the final date when the product becomes marketable. In equilibrium, the firm gathers the information on the product value, and invests if and only if the information is positive. Thus, the research designer pursues only those research lines that receive PRF – not only for monetary reasons but also because the research funds serve as a signal for promising research projects. In summary, the research designer has to decide with the help of the private sector which kind of research is welfare maximizing. In the end, there are three research designs: pure academia, privately funded academia, and industry research.

Our model produces a number of qualitative and quantitative results. Qualitatively, projects typically start in pure academia and are finally handed over to the private sector, where products reach marketability. Potentially, academia is leapfrogged or the private sector is not involved, but this order never changes. If there is PRF, it enters right at the beginning of the projects, when the initial idea is seized (see Figure 1).

Figure 1: Possible Sequences of Research Designs



However, not all collaborations work this way and it is imaginable that projects need some time to be concretized before the private sector is interested in the marketable value. Hence, the above sequence brings up the question whether it could be optimal to await until a project is partially developed to apply for PRF. Therefore, we soften our first assumption and state that parameters are unlikely to remain constant over time and we consider that the probability that a project fails inside academia decreases as a researcher gets more experienced. We finally obtain a slightly different design. In this regard it is not optimal to apply for PRF at the initial stage, but the project starts in pure academia, at an intermediate date t_c, the research designer forces the researcher to obtain private funding and at a later date, the project is (possibly) transferred to the private sector (see Figure 2).

Quantitatively, we can calculate the optimal date for completely switching to the private sector (t_{switch}) which depends, among other things, on the potential value (the more valu-

Figure 2: Additional Sequences of Research Designs

Idea → Pure academia → Academia with PRF — ——————— → Marketable product
Idea → Pure academia → Academia with PRF → Industry research → Marketable product

able a final product, the earlier a research line should be handed over to the private sector), on the wage differential between academia and the private sector (the higher the wage differential, the longer a research line should remain in academia) and on the differential of probabilities of failure between both sectors (the higher the differential, the earlier research should be transferred). Surprisingly, if an information on the marketable value is gathered and PRF enter into academia, a project is transferred earlier to the private sector. In that sense, information tells the research designer that the project should either be stopped completely, or in case of a positive information on the marketability, it switches earlier.

We can also calculate the optimal amount of private research funds, possibly even exceeding the academic budget, which itself does not depend on the potential value of the product but on the probability of marketability. Nevertheless, not all research projects are privately supported as there is an upper and a lower bound of the value such that either pure academic or pure private research is conducted from the initial stage to completion. Likewise it is possible that the final product is unlikely to be marketable. In this case, the research designer has the possibility to close the research line because it is impossible for the researcher to raise PRF due to an insufficient compensation for a cooperating firm.

The remainder of the paper is organized as follows. After giving an overview over related literature, we survey the most important stylized facts concerning research funding. In section 4, we introduce and solve the basic version of the model, with only an academic and a private sector. It is deduced from the model of Aghion, Dewatripont, and Stein (2008) but in a continuous version. We then add the possibility to get an information about the expected value of a research project, at a cost. Section 6 introduces research funding as an institutional design to transfer information from the private sector into academia. Section 7 concludes. Proofs are in the Appendix.

3.1 Related Literature

Our paper combines two strands of literature, innovation and finance. With regard to the latter, there are several papers focusing on the allocation of capital in the presence of asymmetric information. In lights of this, Stiglitz and Weiss (1981), and Meza and Webb (1987) investigate the required subsidies of entrepreneurs and Boadway and Keen (2006) conclude that the results depend on the expectations about the project return distributions.

In a sense, we jump on this train in order to implement this topic into R&D, but we introduce private research funds as a signal for auspicious research. In line with this, the work of Leland and Pyle (1977) observe investments in a project by an entrepreneur as a reliable signal for the quality of a firm. Holmström and Tirole (1997) also explore entrepreneurial finance, but they concentrate on the interaction of informed financiers with less informed investors in a moral hazard framework. Instead of moral hazard, we rather focus on adverse selection and a research designer who wants to balance the existing asymmetry of information. He fulfills the task of the financial intermediary balancing the incentive problems between borrowers and lenders considered in the monitoring framework of Diamond (1984) and Tirole (2006). In addition, Alam and Walton (1995) and Hubbard (1998) point out that the problem of asymmetric information yields not only to financing constraints between entrepreneurs and financiers like Akerlof (1970) elaborate, but particularly to financial restrictions in R&D.

We also contribute to a thread within innovation literature considering the differences between academic and private research which are mostly in line with our preliminary considerations. Sauermann and Stephan (2010) find significant academia-industry differences by broadly comparing the nature of science, the organizational characteristics, characteristics of individual scientists and the disclosing mechanisms. The first issue is also examined by Aghion, Dewatripont, and Stein (2008), Lacetera (2009b), and Sauermann and Stephan (2013) who argue that "firms focus on applied research with the goal of solving concrete problems valued in the market place", whereas academic research increases "the stock of knowledge by conducting basic research, i.e. research resulting in fundamental insights"(Sauermann and Stephan, 2013, p. 7).

The second dimension, the organizational characteristics, represents our core argument. In line with Aghion, Dewatripont, and Stein (2008), Sauermann and Stephan (2010), and Sauermann and Stephan (2013), we assume a fundamental tradeoff between academia and the private sector, respectively a tradeoff between academic freedom, defined as the granting of control rights to the researchers, versus focus. In detail, "academic norms allow researchers to freely choose projects based on personal interest [...] the commercial logic, in contrast, limits freedom and subordinates scientists' choices to the needs and requirements of their industrial employers"(Sauermann and Stephan, 2013, p. 8). Thus, the main difference to industrial research is that the researchers employed in the academic sector are free to establish new research lines and to experimentalize. However, we only consider implicitly the idea of academic freedom in the sense of delegation of authority to scientists. Aghion, Dewatripont, Hoxby, Mas-Colell, and Sapir (2009) yet take a step forward and stress the meaning of openness, the free flow of ideas across academic institutions, as a central attribute of academia. The recent paper of Hellmann and Perotti (2006) is a proposal for that intention. It also models research as a multi-stage process and endogenizes the choice between academic and private research. Furthermore, it contrasts the free flow of ideas in academia with the more controlled informational exchange that occurs in private firms.

The issue of scientific freedom brings about a further review of the characteristics of the individual scientist as considered by Aghion and Tirole (1997), Dasgupta and David (1994), Grossman and Hart (1986), Hart (1995), Hart and Moore (1990), Lacetera and Zirulia (2012), Roach and Sauermann (2010), and Sauermann and Stephan (2010). In accordance with them, we reconsider that scientists appreciate scientific freedom and value creative control. "In particular, scientists are assumed to share a "taste for science" and the desire for freedom in their choice of research"(Sauermann and Stephan, 2013, p. 10). Thereby, we follow the accepted thesis that the wage in the academic sector is less than in the private sector, where the researchers have to be compensated for the loss of creative freedom (see e.g. Sauermann and Stephan (2013), and Aghion, Dewatripont, and Stein (2008)). Hence, we focus rather on monetary arguments and patterns of finance than on academic freedom in terms of intellectual property rights (IPR) and on non-material motives, such as reputation as considered by Lacetera and Zirulia (2012).

The last dimension, namely the disclosing mechanisms, is left aside in our approach as we are rather interested in the development of scientific projects than in publishing and patenting. The first is mainly assigned to the academic sector because "applied research loses much of its commercial value if openly disclosed in the form of publications"(Sauermann and Stephan, 2010, p. 8). The second distinguishes the private sector as "knowledge resulting from basic research does not meet the criteria for patentability"(Sauermann and Stephan, 2010, p. 8). Lacetera (2009a) examines the choice to commercialize research made by academic researchers and compares their behavior with industrial scholars. Crespi, D'Este, Fontana, and Geuna (2011) show that academic patenting complements or substitutes publishing dependent on the degree of output. Contrary, we analyze the interaction between academia and the private sector. Besides, we differ from Lacetera (2009b) who argues that firms outsource research projects to academia to commit a valuable research project before completion such that academia conducts commissioned research.

Another related papers deal with the subject of asymmetric information in R&D in a different way. While we focus on private research funds as a mechanism to overcome asymmetric information with regard to uncertain values of research projects, this function is assumed by Technology Transfer Offices considered by Macho-Stadler, Pérez-Castrillo, and Veugelers (2007). They conclude that the reputation of Technology Transfer Offices reduces this asymmetric information. Takalo and Tanayama (2010) study a similar idea of research funding in the presence of asymmetric information which can be eliminated by subsidies serving as signals. Opposed, they observe the distinction of private and public funding with financing restrictions. They argue that under certain conditions, public R&D subsidies reduce the asymmetric information by dint of reducing financing constraints of firms.

Overall, we abstract away from any job-designs, priority rules, broader institutional views of the role of academia like Dasgupta and David (1994), and incentive schemes which are already implemented in research institutions in reality. The latter issue is considered by

Geuna and Martin (2003) and Auranen and Nieminen (2010) who examine the advantages and disadvantages of performance-based funding in comparison with other approaches to funding. Moreover, Aghion, Dewatripont, Hoxby, Mas-Colell, and Sapir (2009) discover in a yet another approach that university governance in terms of autonomy and competition affects inventive research output in a positive way. Alternatively, Banal-Estañol and Macho-Stadler (2010) propose a framework to analyze the effects of scientific and commercial incentives in R&D organizations. They show that commercialization incentives influence the choice of research projects and deduce an optimal incentive scheme respective to the researchers' characteristics. Macho-Stadler and Pérez-Castrillo (2010) as well as Lacetera (2003) describe the ways academic knowledge is transferred to industry and how incentives can be offered. While Macho-Stadler and Pérez-Castrillo (2010) regard licensing agreements and spin offs, Lacetera (2003) discusses spillovers between the academic and the private sector. Finally, Choi (1993) develops a model of sequential innovations with a variety of research lines and compares two alternative systems of enforcing patent law to provide proper incentives for R&D.

At last and continuative to our approach, there is some literature treating the consequences of the different kinds of research. Murray, Aghion, Dewatripont, Kolev, and Stern (2009) corroborate the risk of decreasing innovation by detecting that restrictions of academic freedom reduce the variety in basic research. Particularly, openness and academic freedom may increase the overall flow of research output in basic as well as in applied research. Another approach of Aghion, Dewatripont, Hoxby, Mas-Colell, and Sapir (2009) investigates the correlation of autonomy and research output of universities and assesses a positive relation. The authors add by way of explanation that even greater funding is likely ineffective as measured by research output, if there exist no careful and balanced commitment to openness as well as to freedom (see Murray, 2007).

3.2 Stylized Facts

In the past three decades, both R&D expenditures and research funding have increased nearly all over the world, especially in the OECD area (Vincent-Lancrin, 2006, p. 2). Private research and higher education research (in the sense of academic research) alike have gained in importance.

Actually, higher education R&D has grown more rapidly in absolute and relative terms than in any other sector, the expenditures have tripled and the number of researchers has more than doubled between 1981 and 2008 (Vincent-Lancrin, 2010, p. 4). Despite the public prominence in the financing structure, more and more funding is provided by private sources. Indeed, the government performs 80% of basic research and still allocates the bulk of the funds for academic research (72% in 2008), but its aggregate share is decreasing (-6% between 1981 and 2006). Meanwhile, the share of the private sector in academic research funding has doubled since 1981 but is still at a relatively low level.

Vincent-Lancrin predicts that, should these trends continue, we will see academic research half privately and half publicly funded within the OECD given the different capitalization of the business and academic sectors[3].

However, as opposed to higher education R&D, the lion's share of research is still carried out and financed by the private sector. Between 1981 and 2008, the share of R&D performed by the business sector has yet increased from 65.4% to 70% of the total R&D effort in the OECD area (Vincent-Lancrin, 2010, p. 2).

With this general information in mind, we present some stylized facts. The first 2 facts motivate our modeling choices. The other can be related to our empirical hypotheses. Having said that, please note that the available data is relatively scarce, hence the following "facts" should be treated with some caution.

Fact 1 *C. p., the expenditures on research in the private sector exceed the ones in the academic sector.*

This fact is mainly driven by the divergent financial compensation of the researchers, but also by different endowments. However, we will concentrate on the first. As argued by Sauermann and Stephan (2013) and in line with Aghion, Dewatripont, and Stein (2008), the prime reason for the gap between academic and private wages dues to different characteristics of workplaces. "Industry may be able to pay higher wages because of its focus on applied research with higher expected returns" as it is only interested in "knowledge that complements existing firm assets and increases profit"(Sauermann and Stephan (2013)). Furthermore, it seeks "to maximize financial returns from research, which typically requires that scientists limit disclosure and forego some of the non-financial rewards offered by academia" and therefore it may has "to share some of the financial returns from research with their employees, resulting in higher wages in industry than in academia"Sauermann and Stephan (2013). Walker, Vignoles, and Collins (2010) study this fact by comparing the salaries of higher education academics in the UK with those of other comparable professionals. Their findings coincide with the estimation of UK and U. S. academic wages by Stevens (2004), namely that academic employees earn less than graduates working in the non-academic sector.

In order to give a first evidence, we present some examples taken from the "Bureau of Labor Statistics[4]. For instance, academic political scientists earn just about two-thirds of the wage of private employed researchers. In 2012, a political researcher earned an average of $69.060 in academia, but $107.340 in the private sector. Employed mathematicians earned $79.830 in academia versus $122.440 in the private sector in 2012. Biological scientists are serving as another example. In 2012 they got $65.130 in the academic and

[3]For details, see OECD (2008).

[4]www.bls.gov/data

$90.600 in the private research sector on average. In contrast, there are some research areas that possess a small wage discrepancy. Consistently, a life scientist working in an U. S. university earned in 2012 on average $69.540, whereas wages in the amount of $80.980 are paid averaged in U. S. private sector research.

Fact 2 *C. p., private research is more likely to be marketable.*

This is also associated with the nature of research conducted by the private sector. As previously discussed in Section 3.1, we assume that "academic researchers are more heavily engaged in basic research than their colleagues in industry, who tend to work on applied questions"(Sauermann and Stephan, 2010, p. 8). This leads to large direct commercial values rather than to fundamental insights. Hence, because of the profit-orientated character of private research, basic research projects as less restricted to commercial success exist entirely in academia. Besides, because of the provided scientific freedom inside academia, researchers are able to test different ideas, resulting in broader but simultaneously more jeopardous research as they are not forced to consider a close issue.

We are able to evidence this feature by the amount of patents announced in the member states of the Patent Cooperation Treaty (PCT). In 2008, the business sector accounted for approximately 84% of total PCT filings. However, the share of the business sector is diverse, ranging from 94.2% in Sweden to 40.9% in South Africa. Front-runner among these firms was the Chinese company Huawei Technology, employing approximately 42 000 R&D personnel, with the highest number of PCT filings (1 737), while Panasonic Corporation and Philips were ranked second and third.

Besides, the Bayh-Dole Act of 1980 enabled academic researchers to pursue ownership of an invention. As a consequence, academic research has undergone a change, and more and more ideas have been patented. The university sector in the PCT member states accounted for a significant share of total PCT filings of about 6%. U. S. universities dominated the list of top PCT applicants. The University of California, occupying 10 700 research employees, filed 345 PCT applications, hence twice as much as the following MIT. In this respect, the most effective university patented 25% less per R&D employee than Huawei Technology. In comparison with the total amount of patent filings announced by the business sector, the quantity of academic patents seems to be just a drop in a bucket [5].

The typical disclosure mechanism inside academia is still international publishing and thus does not lead to a marketable, although social value. If scientific articles are pulled up as a measure for the valuation of an innovation, it is accordingly possible to distinguish between and classify different fields of research. In total, the number of scientific articles

[5] See World Intellectual Property Organization (2009).

being published increased by a high degree of 40% between 1988 and 2008 to an amount of about 700 000 within the OECD area.[6] 31% thereof are ascribable to clinical medical, 15% to biomedical, 12% to physical, and 10% to chemical articles. Together with other "hard" sciences and engineering they represent the bulk of academic research articles. The remaining fields of research, such as psychology, social and health sciences, and professional fields accounting for about 10% of the OECD article output.

Fact 3 *C. p., a higher marketable value of a research project is accompanied by either an increasing amount of private research funds or by a raised fraction of private research funding of the academic budget.*

Traditionally, the output generated by academic and private researchers differs widely, especially if basic research is conducted inside academia. On the one hand there is the academic mission enhancing the stock of public knowledge whereas firms are only interested in specific knowledge leading to higher profits. However, as universities substantially care about private research funding as new funding source, we observe a shift from basic to applied research in universities. On the other hand, the private sector engages in basic research in order to increase the "ability to absorb external knowledge, [to] provide a map for downstream R&D , or [to] result in unexpected commercial applications"(Sauermann and Stephan, 2013, p. 7). In this regard, industry-university collaborations are increasingly important as firms outsource research projects to academia "especially for the performance of more general-purpose research"(Lacetera, 2009b, p. 565) and if there is a "discrepancy between scientific and economic value of the projects"(Banal-Estañol, Macho-Stadler, and Pérez-Castrillo, 2011, p. 6). This "allows a firm to commit not to terminate or alter a scientifically valuable project before completion"(Lacetera, 2009b, p. 565).

The other way round, academia typically does not conduct commissioned research but potentially research the industry is interested in. In order to signalize this interest and furthermore to secure usage or patent rights, the industry participates in terms of research funds. Hence, if a project predicts to increase the profit exceedingly, it is worth to invest in the academic project to a great extent. Consequently we should observe high fractions of private research funds in fields examining primarily applied research as its output is most valuable for firms.

Taking into account the statistics from the U. S. academic research sector, this reasoning can be confirmed. One can notice that research funds for life sciences and engineering exceed the funds for social science, psychology, mathematical and physical sciences.

Particularly, the departments of engineering, mainly chemical, aeronautical-astronautical and mechanical engineering had an amount at their disposal of $820 million. In other

[6] Similarly, the number of newly published academic books has increased.

words 8.2% of the R&D expenditures have been privately funded in 2011. In contrast, psychology in public U. S. universities had to get along with just a fraction of $16.2 million, which is up to a share of only 1.4% of the total expenditures[7]. A reasonable statement for that phenomenon will also be executed by our model.

The first 2 stylized facts enter into our set of assumptions, the latter corresponds to results of our model. We will refer to these facts within the model, and later in the conclusion.

4 Framework

Like Aghion, Dewatripont, and Stein (2008), we consider a step-by-step development of a valuable product (the CML drug, for instance) in which discoveries generated in one stage serve as essential inputs into the next. The starting point is a basic idea for a project at date 0. This project then passes through a number of stages, being refined at each stage. If one stage is successful, the project continues, otherwise it fails. In contrast to Aghion, Dewatripont, and Stein, we consider a continuous number of T stages. Hence at each date $t \in [0;\ T)$, if research is carried out successfully for dt periods, the next stage at date $t + dt$ is reached. At the final stage T, the project can be sold. With probability q, it is worth V, otherwise it is worthless (for example, because the drug is never admitted to the market).

Each of the required steps to complete a research project can be carried out in two different ways, in *academia* or in the *private sector*. As the main difference, researchers enjoy academic freedom in academia, but are forced to predefined and promising research strategies in the private sector. To fix ideas, assume that in each logical second, there is a variety of research strategies (theoretical vs. empirical, exploratory vs. constructive, ...). We suppose that a project can fail anyway with probability λ_p. On top of that, there is a probability of failure in academia because of the possibility that the wrong strategy is chosen, so $\lambda_a > \lambda_p$. This assumption is in line with stylized fact 2.

Besides, we suppose that researchers value creative control, i. e., their academic freedom. Therefore, researchers in the private sector must be compensated for the fact that they cannot choose their preferred strategy. If the competitive wage in academia is w_a, the wage in the private sector must be $w_p > w_a$. This assumption is based on stylized fact 1.

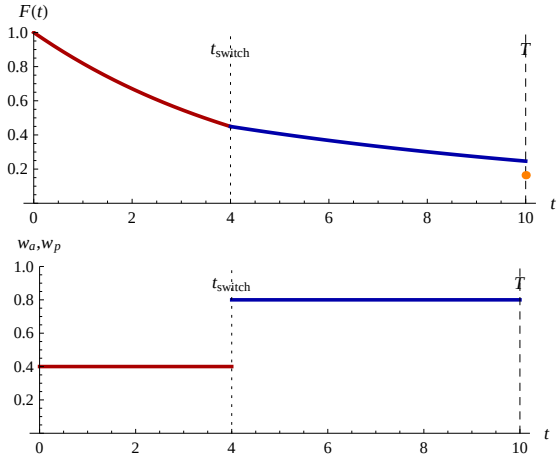
Examining the model in continuous time, a researcher earns $dt\, w_a$ for working in academia for dt periods, and $dt\, w_p$ for working in the private sector. In academia, the project fails with probability $\lambda_a\, dt$; in the private sector, it fails with probability $\lambda_p\, \mathrm{dt}$. Accordingly, after time t has elapsed, a project in the academic sector has failed with probability

[7] For further details, see National Science Foundation (2011).

$F_a(t) = 1 - e^{-\lambda_a t}$. The according density function is $f_a(t) = \lambda_a e^{-\lambda_a t}$, and the instantaneous failure rate is $f_a(t)/(1 - F_a(t)) = \lambda_a$. A project in the private sector has failed with probability $F_p(t) = 1 - e^{-\lambda_p t}$, and the density function is $f_p(t) = \lambda_p e^{-\lambda_p t}$.

Figure 3 shows the probability that the project is still alive at some date t. The final date is $T = 10$. Before t_{switch} (which will later be endogenized), research is carried out in academia, hence the probability declines fast (upper picture), but wages are low (lower picture). After t_{switch}, the project is continued in the private sector. The probability declines slower (upper picture), but wages are higher (lower picture). The orange point at date T marks the final probability of success. It lies below the curve of the survival probability, because at the final date, the product may turn out to be worthless.

Figure 3: Survival Probabilities and Wages



4.1 The Basic Tradeoff between Academia and Private Research

Consider now a social planner (the research designer) who wants to maximize the expected payoff of a research project. In order to do this, he needs to plan at which time to conduct research in academia, at which time to switch to the private sector, and possibly switch back to academia. Each research stage can possibly be carried out in academia or in the private sector. However, we can show that optimally, one switches at most once, and always from academia to the private sector.

Remark 1 *If research is optimally carried out privately at some date, it remains there until it is finished.*

The proof is in the Appendix. As a consequence, there is a single switching date t_{switch} at which the project is handed over to private research. This result is the continuous-time equivalent of Aghion, Dewatripont, and Stein (2008, Lemma 1). Now given a switching date t_{switch}, the probability that the product reaches marketability is $(1 - F_a(t_{\text{switch}}))(1 - F_p(T - t_{\text{switch}}))$. Before date t_{switch}, it fails with instantaneous probability λ_a. Once it reaches t_{switch}, the project is handed over to the private sector and fails with a lower probability λ_p. Hence, the expected value itself is $(1 - F_a(t_{\text{switch}}))(1 - F_p(T - t_{\text{switch}}))\, q\, V$, because the product is marketable in the end only with probability q, in which case it yields a value of V. The expected aggregate wages for research conditioned on the non-failure of the project are $(1 - F_a(t_{\text{switch}}))\, w_a\, dt$ in the academic and $(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\, w_p\, dt$ in the private sector. Therefore, the expected payoff consists of $q\, V - w_p\,(T - t_{\text{switch}}) - w_a\, t_{\text{switch}}$, weighted with the probability that the project reaches T. However, even if the project fails in between the initial and the final stage, some wages must be paid. The aggregate depends on the moment of failure t. Now combining all terms, the expected payoff from the project is

$$\begin{aligned}\Pi &= q\,(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\, V \\ &\quad - \int_0^{t_{\text{switch}}} (1 - F_a(t))\, w_a\, dt - \int_{t_{\text{switch}}}^{T} (1 - F_a(t_{\text{switch}}))\,(1 - F_p(t - t_{\text{switch}}))\, w_p\, dt \\ &= q\, e^{-t_{\text{switch}}\,\lambda - (T - t_{\text{switch}})\,\lambda_p}\, V - \frac{w_a}{\lambda_a}\,(1 - e^{-t_{\text{switch}}\,\lambda_a}) - \frac{w_p}{\lambda_p}\, e^{-t_{\text{switch}}\,\lambda_a}\,(1 - e^{-(T - t_{\text{switch}})\,\lambda_p}).\end{aligned} \tag{1}$$

Using the first order condition, $\partial\Pi/\partial t_{\text{switch}} = 0$, the payoff-maximizing switching date is

$$t^*_{\text{switch}} = T - \frac{1}{\lambda_p} \log\Big[\frac{\lambda_a - \lambda_p}{w_p\,\lambda_a - w_a\,\lambda_p}\,(w_p + \lambda_p\, q\, V)\Big]. \tag{2}$$

Due our assumptions $w_p > w_a$ and $\lambda_a > \lambda_p$, some properties follow immediately (with proof in the Appendix).

Remark 2 *The duration of the time in private research $T - t_{switch}$ does not depend on the total development length T. Second, the higher the expected value of the final product $q\,V$, the earlier one should switch to the private sector. Third, t_{switch} depends negatively on the wage w_a and the probability of failure λ_a inside academia, and positively on the private wage w_p and the probability of failure λ_p inside the private sector.*

The intuition for the first result goes as follows. When a project is very far from completion, the cost of losing the project is comparably low. Consequently, it is cheaper to pay the low academic wages. Later, when a project is closer to completion, it should no longer be put at risk. Hence, one should then switch to the private sector. So to speak, the project must beef up before it is taken over by the private sector. Now if, c. p., the aggregate duration of development is longer, the time until the project has beefed up enough

is accordingly longer. The time spend in the private sector is not affected, though. This comparative static of the second result will be important in the following sections. Of course, if the project is more valuable, it should not be put at risk. The third result is quite intuitive: The higher the academic wage w_a and the probability of failure λ_a, the earlier the project should be transferred to private sector research. The higher the private wage, the later one should switch because private sector research becomes relatively more expensive. The relation between the probability of failure inside the private sector λ_p and the switching date is ambiguous at first sight as it crucially depends on the parameter constellation. But on closer examination we find that more jeopardous research inside the private sector leads to a later transfer provided that the project is transferred anyway. [8].

We can now calculate the aggregate expected return for optimal t^*_{switch}.

$$\Pi = \left(w_p + \lambda_p\, q\, V\right)^{\frac{\lambda_a}{\lambda_p}} \frac{e^{-\lambda_a T}}{\lambda_a} \left(\frac{\lambda_a - \lambda_p}{w_p\, \lambda_a - w_a\, \lambda_p}\right)^{\frac{\lambda_a - \lambda_p}{\lambda_p}} - \frac{w_a}{\lambda_a}. \tag{3}$$

Obviously, the expected payoff increases more than proportionally in the expected final value ($q\, V$). This is due to an adjustment of the switching date t_{switch} and accordingly a lower aggregated probability of failure if $q\, V$ is high.

However, there is no need that a project passes both, academic and private sector. Possibly, it is optimal to start the project in the private sector right away. Formally,

$$\begin{aligned} 0 \geq t_{\text{switch}} = T - \frac{1}{\lambda_p} \log\left[\frac{\lambda_p - \lambda_a}{w_a\, \lambda_p - w_p\, \lambda_a}\left(w_p + \lambda_p\, q\, V\right)\right] \iff \\ q\, V \geq \frac{1}{\lambda_p} \frac{e^{\lambda_p T}(w_p \lambda_a - w_a \lambda_p) + w_p(\lambda_p - \lambda_a)}{\lambda_a - \lambda_p}. \end{aligned} \tag{4}$$

Because a switch *to* academia cannot occur (Remark 1), this inequality implies that the complete research is carried out privately. This happens if V, q or both are large and the final project has a great market value. To the other extreme, it may be optimal to start *and* finish a project in academia. Formally,

$$\begin{aligned} T \leq t_{\text{switch}} = T - \frac{1}{\lambda_p} \log\left[\frac{\lambda_p - \lambda_a}{w_a\, \lambda_p - w_p\, \lambda_a}\left(w_p + \lambda_p\, q\, V\right)\right] \iff \\ 1 \leq \frac{\lambda_p - \lambda_a}{w_a\, \lambda_p - w_p\, \lambda_a}\left(w_p + \lambda_p\, q\, V\right), \\ q\, V \leq \frac{w_p - w_a}{\lambda_a - \lambda_p}. \end{aligned} \tag{5}$$

This case occurs if the expected final market value $q\, V$ is low. There may be two reasons. First, the probability of a positive information on the marketability (q) is low and the

[8] The proofs of Remark 2 and the argumentation for the last result are shown in the Appendix.

project might be classed as rather abstract. Consequently, it is unlikely that the private sector can benefit from the project in order to sell the outcome. Second, the applicable value itself is rather small (V). In this case we could think of a minor improvement of an already existing invention such that the advantages deceed the additional cost in relation to the failure markup.

We need to consider one more constraint. If V is very low, the optimal strategy will be to not pursue any research at all. The expected wage bill would exceed the expected reward from finishing the project. Both expected aggregate costs and expected final value depend on the research design. Hence, the optimal t^*_{switch} must be plugged into the expected profit (1) and it must be checked whether the result is positive. The different conditions depending on whether the project is carried out only in academia, only in the private sector, or switches in between, are given at the beginning of the Appendix.

5 Information Acquisition

Until now, we have assumed that in the very end, the product is marketable with probability $q < 1$. With probability $1 - q$, all effort and costs are sunk. Consequently, it would be valuable to get an early information on the later value of the product. We now assume that a firm can spend c in order to find out whether the value of the product will be high (V, with probability q) or low (value of 0). If it is high, the switching date t_{switch} may react. If it is low, the project will be canceled completely and no more wages will be paid.[9]

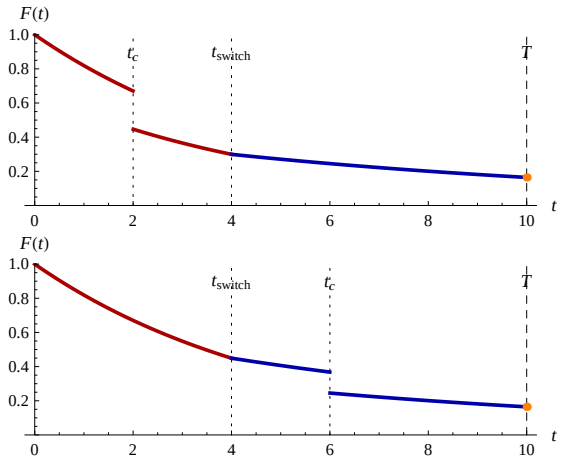
Following Jonbloed (2008), who mentions that "the growing complexity of our society strengthens the case for relying on markets to make decisions", we argue that this information will typically come from the corporate sector, which may know better how to possibly market the product, in comparison to a university professor in academia. We will first assume that gathering the information is observable and verifiable to the research designer. That way, we find the optimal research strategy, given the possibility of information acquisition. In a second subsection, we will weaken this assumption and assume that an outsider must be incentivized to gather and report the information truthfully. At that point, research funding becomes relevant: in order to create incentives, the outsider must be invested in the research project ("skin in the game").

Observable Information Acquisition Let t_c denote the date at which the research designer collects the information at cost c. Possibly, this date can be before t_{switch} (when

[9]This may sound very unrealistic, because typically in academia researchers cannot be sacked, and research strategies cannot be dictated. However, if a researcher finds out that his project will never be successful, he will discard the old research line for a new one. All following wage costs must thus be attributed to another project.

the project is still in academia), at t_{switch} (when the project is just transferred to the private sector), or after t_{switch} (when the project is already in the private sector). When the information is negative, the project is stopped immediately, otherwise it is continued. The following Figure 4 shows the survival probabilities for $t_c < t_{\text{switch}}$ (above) and for $t_c > t_{\text{switch}}$ (below). In both pictures, the survival probability drops by the factor q at the date t_c, but there is no further drop at the final date T.

Figure 4: Survival Probabilities

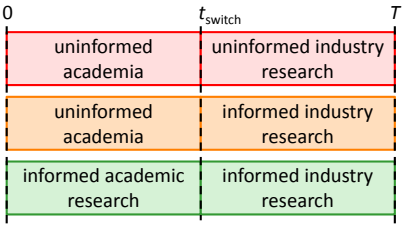


We now proceed in the following steps. While we for now only deeply discuss the cases in which there is a transfer to the private sector, we firstly concentrate on the first picture (case $t_c \leq t_{\text{switch}}$) and show that it is never optimal to have an interior information date t_c. Either the information is collected right at the start ($t_c = 0$) or at the switching date ($t_c = t_{\text{switch}}$), but never in between. Second, we focus on the second picture (case $t_c \geq t_{\text{switch}}$) and show that an interior information date is never optimal. If the information has not yet been collected at the switching date, it will never be collected. In other words, there are just three different possible sequences of research strategies[10].

Case $t_c \leq t_{\text{switch}}$. For the case $t_c \leq t_{\text{switch}}$, we construct the expected payoff. Having waited until t_c, the cost c are spent to gather the information if the research project is still alive (probability $1 - F_a(t_c)$). The result is either a negative information (with probability $1 - q$), in which case the research line is closed. Or, the information is positive (with probability q), in which case the project is carried on in academia until date t_{switch} (which may now differ from the original switching date). However, in case of non-failure, wages must be paid inside academia until the information date and with probability q from this

[10] At the end of Section 5, all regimes are summarized.

Figure 5: Possible Regimes



date on to the transfer to the private sector. Remember, the project might even fail despite the positive information. Therefore, the research line is still alive at date t_{switch} with probability $q\,(1 - F_a(t_{\text{switch}}))\,(1 - F_p(t - t_{\text{switch}}))$. From this time on, everything is as before. Consequently, the aggregate expected payoff is

$$\begin{aligned}\Pi = {} & q\,(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\,V - (1 - F_a(t_c))\,c \\ & - \int_0^{t_c} (1 - F_a(t))\,w_a\,dt - q \int_{t_c}^{t_{\text{switch}}} (1 - F_a(t))\,w_a\,dt \\ & - q \int_{t_{\text{switch}}}^{T} (1 - F_a(t_{\text{switch}}))\,(1 - F_p(t - t_{\text{switch}}))\,w_p\,dt \end{aligned} \tag{6}$$

The derivative with respect to t_c is

$$\begin{aligned}\frac{\partial \Pi}{\partial t_c} &= f_a(t_c)\,c - (1 - F_a(t_c))\,w_a + q\,(1 - F_a(t_c))\,w_a \\ &= (\lambda_a\,c - (1 - q)\,w_a)\,e^{-\lambda_a\,t_c}. \end{aligned} \tag{7}$$

This term is positive if and only if $\lambda_a\,c > (1 - q)\,w_a$, or equivalently

$$c > (1 - q)\,w_a/\lambda_a. \tag{8}$$

In other words, if the weighted cost of information exceeds the cost saving in case of negative information, the information should be gathered later in order to increase the expected payoff. Otherwise, the information date should be accelerated. Interestingly, t_c does not enter into the condition at all. Hence, we have shown that there is no interior solution: either $t_c = 0$, the information is collected immediately (if condition (8) does not hold), or $t_c = t_{\text{switch}}$, the information is collected when the project is switched to the industry (if condition (8) does hold). This result even holds if the project is not transferred to industry, hence if condition (5) is fulfilled.

Besides, it is substantiated by our initial example. Only after identifying if there is a need for a new CML drug, the research is initiated at the MIT. Conducting research without any information would potentially lead to an expensive invention of a new drug although a former one works quite well such that the market does not accept the new one.

Case $t_c \geq t_{\text{switch}}$. If $t_c > t_{\text{switch}}$, the expected payoff changes only slightly. With probability $(1 - F_a(t_{\text{switch}}))\ (1 - F_p(t_c - t_{\text{switch}}))$ the project survives in academia, the information date t_c inside the private sector is reached and the cost c is spent. Either a positive or a negative information is gathered. Therefore, the academic wage (with probability $(1 - F_a(t_{\text{switch}}))$) until the project is transferred and the private wage (with probability $(1 - F_a(t_{\text{switch}}))\,(1 - F_p(t_c - t_{\text{switch}}))$ until the information date have to be paid if the project does not fail in between. Once a positive signal is received with probability q, the project will be pursued inside the private sector and the wage payment continues until the final stage T in case of non-failure. Thus, the aggregate expected payoff is composed of

$$\begin{aligned}\Pi = {} & q\,(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\,V - (1 - F_a(t_{\text{switch}}))(1 - F_p(t_c - t_{\text{switch}}))\,c \\ & - \int_0^{t_{\text{switch}}} (1 - F_a(t))\,w_a\,dt - \int_{t_{\text{switch}}}^{t_c} (1 - F_a(t_{\text{switch}}))\,(1 - F_p(t - t_{\text{switch}})\,w_p\,dt \\ & - q \int_{t_c}^{T} (1 - F_a(t_{\text{switch}}))\,(1 - F_p(t - t_{\text{switch}}))\,w_p\,dt \end{aligned} \tag{9}$$

The derivative with respect to t_c is

$$\begin{aligned}\frac{\partial \Pi}{\partial t_c} &= (1 - F_a(t_{\text{switch}}))\,f_p(t_c - t_{\text{switch}})\,c - (1 - F_a(t_{\text{switch}}))(1 - F_p(t_c - t_{\text{switch}}))\,w_p \\ &\quad + q\,(1 - F_a(t_{\text{switch}}))(1 - F_p(t_c - t_{\text{switch}}))\,w_p \\ &= (\lambda_p\,c - (1 - q)\,w_p)\,e^{t_{\text{switch}}(\lambda_p - \lambda_a) - t_c\lambda_p}. \end{aligned} \tag{10}$$

This term is positive if and only if $\lambda_p\,c > (1 - q)\,w_p$. Again, there is no interior solution. As a mathematical consequence, only the limiting cases $t_c = t_{\text{switch}}$ and $t_c = T$ are possible. But on the other hand, $t_c = T$ means that the information is gathered only at the very last innovation step. This implies that there are no benefits from gathering the information: it costs c, but the result would become obvious in the next logical second anyhow. Therefore, $t_c = T$ is dominated by not gathering the information at all. Hence, we are left with three cases, $t_c = 0$, $t_c = t_{\text{switch}}$ and $t_c = \infty$ (no information at all).

Switching Dates and Expected Profits. We handle the cases in chronological order. If the information is gathered right away, the expected profit is similar to (7),

$$\begin{aligned}\Pi = {} & q\,(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\,V - c \\ & - q \int_0^{t_{\text{switch}}} (1 - F_a(t))\,w_a\,dt \\ & - q \int_{t_{\text{switch}}}^{T} (1 - F_a(t_{\text{switch}}))\,(1 - F_p(t - t_{\text{switch}}))\,w_p\,dt \end{aligned} \tag{11}$$

The expected profit still depends on the switching date t_{switch}, which is endogenous. The first order condition with respect to t_{switch} yields

$$t^*_{\text{switch}} = T - \frac{1}{\lambda_p} \log\Big[\frac{\lambda_a - \lambda_p}{w_p\,\lambda_a - w_a\,\lambda_p}\,(w_p + \lambda_p\,V)\Big]. \tag{12}$$

This term is identical to (2), with the only difference that the complete potential value V enters, instead of the expected value $q\,V$. Consequently, the switching date *with* information is earlier than the switching in the absence of information on the project's viability. Substituting t^*_{switch} into Π yields the expected profit,

$$\Pi^* = e^{-\lambda_a\,T}\,q\,\frac{w_p+\lambda_p\,V}{\lambda_a}\,\Big(\frac{w_p\,\lambda_a - w_a\,\lambda_p}{(\lambda_a-\lambda_p)(w_p+\lambda_p\,V)}\Big)^{1-\lambda_a/\lambda_p} - q\,\frac{w_a}{\lambda_a} - c. \tag{13}$$

Now turn to the intermediate case, $t_c = t_{\text{switch}}$. The according expected payoff is

$$\begin{aligned}\Pi = {} & q\,(1-F_a(t_{\text{switch}}))\,(1-F_p(T-t_{\text{switch}}))\,V - (1-F_a(t_{\text{switch}}))\,c \\ & - \int_0^{t_{\text{switch}}} (1-F_a(t))\,w_a\,dt \\ & - q\int_{t_{\text{switch}}}^{T} (1-F_a(t_{\text{switch}}))\,(1-F_p(t-t_{\text{switch}}))\,w_p\,dt\end{aligned} \tag{14}$$

The first order condition yields the optimal information, respectively switching date

$$t^*_{\text{switch}} = T - \frac{1}{\lambda_p}\log\Big[\frac{\lambda_a-\lambda_p}{w_p\,\lambda_a - (w_a - c\,\lambda_a)\,\lambda_p/q}\,(w_p+\lambda_p\,V)\Big]. \tag{15}$$

The endogenous expected profit is then

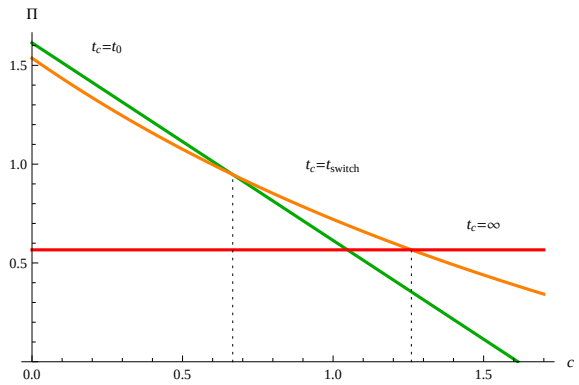
$$\Pi^* = e^{-\lambda_a\,T}\,q\,\frac{w_p+\lambda_p\,V}{\lambda_a}\,\Big(\frac{q\,w_p\,\lambda_a - w_a\,\lambda_p + c\,\lambda_a\,\lambda_p}{q\,(\lambda_a-\lambda_p)(w_p+\lambda_p\,V)}\Big)^{1-\lambda_a/\lambda_p} - \frac{w_a}{\lambda_a}. \tag{16}$$

The final case, $t_c = \infty$, has no information gathering at all. Consequently, the expected profit is exactly identical to (3).

Comparison of Profits. Figure 6 shows expected profits, depending on the switching costs c. The green curve stands for expected profits under immediate information acquisition. It is a straight line with slope -1, this follows immediately from (13). If information costs c are small, it is obviously optimal to get the information as early as possible. The amber curve stands for information acquisition at the switching date. It is not a straight line; this is due to the fact that the switching date is endogenous and not constant; it depends on c. Finally, the red curve stands for expected profits if no information is acquired. In that case, the marketability of the product becomes apparent only when the final stage is reached. This curve is a constant. Importantly, each of these regimes can be optimal.

Optimality of Regimes. We first calculate the transition from early information ($t_c = 0$) to intermediate information ($t_c = t_{\text{switch}}$). This can be done by comparing the expected profits (13) and (16). Some algebra yields that it is better to switch early if and only if $c \le (1-q)\,w_a/\lambda_a$, which is identical to (8). This is hardly surprising, because already

Figure 6: Comparison of Expected Profits



Parameters are $w_a = 0.4$, $w_p = 0.8$, $\lambda_a = 0.2$, $\lambda_p = 0.1$, $V = 20$, $T = 10$, and $q = 2/3$. We will use these parameters also in later figures and examples. The green line stands for immediate information acquisition ($t_c = 0$), amber stands for information acquisition when the project switches into the private sector ($t_c = t_{\text{switch}}$) and red stands for no information acquisition at all ($t_c = \infty$).

(8) was the condition for when it is better so get the information earlier rather than later. In the numerical example, the transition is at $c = (1 - 2/3)\, 0.4/0.2 = 2/3$.

Now turn to the transition from intermediate information ($t_c = t_{\text{switch}}$) to no information at all. We need to compare (16) with (3). The inequality cannot be solved for c explicitly (nor for any other parameter). We get an implicit inequality: no information acquisition is better if

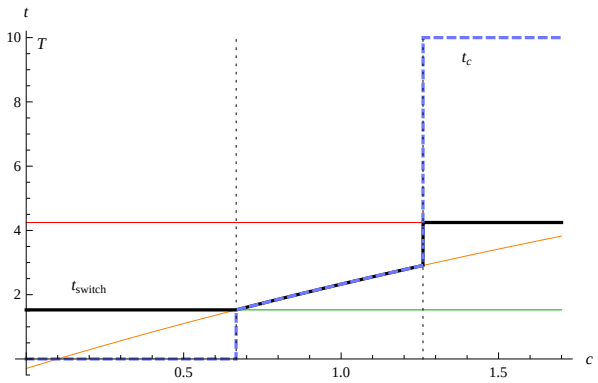
$$\begin{aligned} & q(w_p + \lambda_p V)\Big(\frac{q(\lambda_a - \lambda_p)(w_p + \lambda_p V)}{q\, w_p\, \lambda_a - w_a\, \lambda_p + c\, \lambda_a\, \lambda_p}\Big)^{\frac{\lambda_a - \lambda_p}{\lambda_p}} \\ & \quad \leq (w_p + q\, \lambda_p V)^{\frac{\lambda_a}{\lambda_p}} \Big(\frac{\lambda_a - \lambda_p}{w_p\, \lambda_a - w_a\, \lambda_a}\Big)^{\frac{\lambda_a - \lambda_p}{\lambda_p}}. \end{aligned} \tag{17}$$

In the numerical example, the transition is at $c = 121/96 \approx 1.26$. One more property is notable: The total project duration T completely drops out of the comparison.

The Switching Date t_{switch}. The date when the project is switched from academia to the private sector is endogenous, and it especially depends on the degree of information that the research planner has about the viability of the project. Let us therefore analyze this date in some more depth. In the different regimes, we have already calculated the switching dates in (2), (12), and (15). The following figure 7 shows these switching dates, depending on c.

The switching date in the absence of information is equal to the red line, where the research planner chooses not to buy the information. Hence, the figure suggests a number of properties. We summarize them in the following remark (with proof in the appendix).

Figure 7: Switching Dates and Informations Dates



Parameters are as in Figure 6. The green line shows the switching date under immediate information acquisition ($t_c = 0$, which is optimal only for small c), amber stands for information acquisition at the switching date ($t_c = t_{\text{switch}}$, optimal for intermediate level of c) and red stands for no information acquisition at all (optimal for large c). The thick black curve follows the optimal switching date t_{switch} in the according regime. The dashed blue curve follows the information date t_c. Clearly, for small c, we have $t_c = 0$, for intermediate c, we have $t_c = t_{\text{switch}}$, and for larger c, we have no information until the project ends. The cost c is then never spent.

Remark 3 *The switching date t_{switch} with information acquisition is always earlier than that without information. If $t_{switch} = t_c$, the project switches later than under immediate information acquisition ($t_c = 0$).*

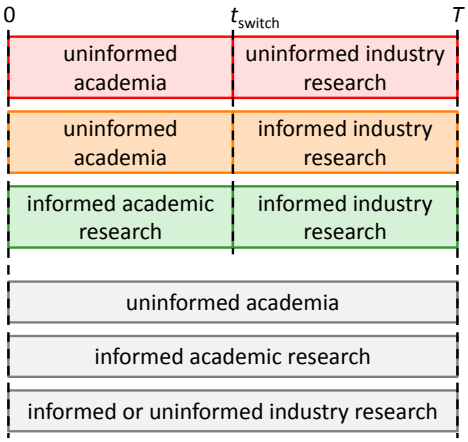
One might have thought that by bringing information from the private sector into academia, academia always loses one of its disadvantages, and hence the project switches at a later date. But no! Information tells the research designer that the project should either be stopped completely, or that it is valuable, in which case the project switches *earlier*.

Besides, some comparative statics are immediately apparent. As mentioned in the previous section, a higher potential value V and a higher academic wage w_a lead to earlier switching to the private sector. Not very surprising, higher information cost c as well as a larger aggregate research time T entail later switching. Like in the case without a qualified information, the duration of the time in private research $T - t_{\text{switch}}$ does not depend on the total development length T.

Overall, we have detected 5 different scenarios if we expect a research project to start inside academia: In general, a project can be started and completed inside academia. Otherwise, it can be conducted in academia and the private sector. In both cases, the information can be gathered right away just in the second the idea is seized, and can thus be developed with qualified information in all stages. Alternatively, the whole idea is processed without any information and either only academia or both sectors suffer from

uncertainty about the marketable value The interim solution is that the information date is identical with the transfer to the private sector. Hence, inside academia the project is carried out without information, whereas the private sector benefits from informed agents. Finally, the project might fail in between or is stopped if qV is too small, c is too high or a negative information is gathered (with probability $(1-q)$). The following Figure 8 summarizes the different regimes.

Figure 8: Summary of Regimes



6 Implementation – Private Research Funding

We now want to convert these possible sequences into a model with research funding. For this reason, we weaken the assumption of an observable and verifiable information and suppose more realistically that the outsider must be incentivized to gather and report the information. As a consequence, the research designer (principal) will have to design a mechanism to get the information. He needs to design a contract such that the outsider has sufficient incentives to participate, to gather the information at cost c, and to report the information truthfully.

In Remark 3 we have shown that the information is optimally generated either right away ($t_c = 0$) or at the switching date ($t_c = t_{\text{switch}}$). In the second case, one needs not think about incentivizing the firm to acquire the information: the research designer can sell the project to the firm. In that case, the firm who owns the project will optimally choose to get the information and spends c. Hence, the only remaining case is that of $t_c = 0$ and the according t^*_{switch} derived from equation (12).

In principle, the way the contract is written might influence the optimal dates t_c respectively t_{switch}. Since there is no delegation cost connected with a research funding contract,

t_c and t_{switch} are unaffected. Consequently, one financing contract looks as follows. At date $t_c = 0$, the firm must invest an endogenous amount I into the project (research funding). In return, the research designer promises the firm an endogenous fraction γ of the final return V. For example, if the final product leads to a patent, the research designer could grant the firm the permission to use the patent for free. By this, financial returns can be captured singularly without additional costs and other firms are excluded from benefiting directly from the project's inherent knowledge (see Sauermann and Stephan (2013)). One could also think of other concessions like cash-flow rights or property rights.

There are two inequalities that must hold, both will bind in equilibrium. First, the firm must be willing to gather the information. If time t_c is reached and the firm spends c, it will invest I with probability q (only if the information is positive). The project will then be successful with probability $(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))$, in which case the firm will collect $\gamma\, V$. If, our of equilibrium, the firm does *not* gather the information and always spends I, it gets $\gamma\, V$ with probability $q\,(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))$. Hence, incentive compatibility requires

$$\begin{aligned} &q\left[(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\,\gamma\, V - I\right] - c \geq \\ &\quad q\left[(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\,\gamma\, V\right] - I, \end{aligned} \tag{18}$$

which is equivalent to $I \geq \frac{c}{1-q}$. Second, the firm must be willing to participate in the first place. In other words, the firm must be discouraged from always withholding research funds and thus sending the negative signal. The participation constraint requires

$$q\left[(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\,\gamma\, V - I\right] - c \geq 0. \tag{19}$$

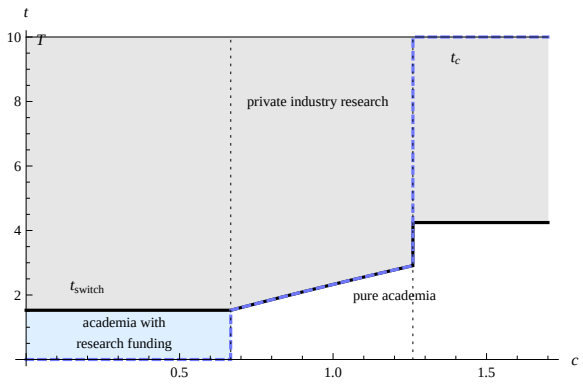
In equilibrium, assuming that the research designer holds all market power, he will choose γ and I such that both inequalities will bind. Solving (18) and (19) yields the optimal amounts

$$\begin{aligned} I &= \frac{c}{1-q} \quad \text{and} \\ \gamma &= \frac{c}{q\,(1-q)\,(1 - F_a(t_{\text{switch}}))\,(1 - F_p(T - t_{\text{switch}}))\,V} \\ &= e^{t_{\text{switch}}(\lambda_a - \lambda_p) + T\,\lambda_p}\,\frac{c}{q(1-q)V}. \end{aligned} \tag{20}$$

These equations only apply if there is research funding, hence if any information is gathered. Otherwise, the project is turned private or stays in academia without any information.

Now comes the key part of the paper. If the information comes from private firms, and it is acquired in an incentive compatible way by making the firm fund the research, then the different regimes from the previous section can be re-interpreted. The following Figure 9 contains only few changes from Figure 7.

Figure 9: Switching Dates and Informations Dates



Parameters are as in Figure 6. The figure is very comparable to figure 7.

For low levels of c, the research planner wants to get the information right away ($t_c = 0$), but he does not yet want to switch to the private sector entirely. In the numerical example, for $c < 2/3$, the project remains in academia until $t = t_{\text{switch}} \approx 1.53$. Hence, the academia in this case is not pure academia, but is funded with private money, at least partially.

For higher levels of c, the research planner does not want the information while the project is in academia. Consequently, researchers in this case are *not* forced to obtain private money.

Comparative Statics. At this point some comparative statics are evident. If V goes up, the required γ decreases. Accordingly, the fraction of V does not need to be as high as before to compensate the firm for the investment of I. Increasing cost c result in a higher I as well as in a higher γ. This is based on the fact that the information cost reduce the expected payoff of the firm. To be profitable, the firm is forced to invest a higher I in the project and hence demands a higher fraction of the potential value γ. We have also shown that I is an increasing function in q. Surprisingly, the value V itself has no direct influence on the absolute amount of I. Hence, we are able to state the following remark (with proof in the appendix).

Remark 4 *An increasing amount of research funding comes along with an increasing probability of marketability q.*

Besides, there is an interesting phenomenon. For $q \to 0$ respectively $q \to 1$ the fraction γ becomes infinitely large. The same applies to I if $q \to 1$. As they stand alone, these extreme results must be redescribed. In reality, γ cannot ever exceed 100% as well as the research funds will not account for an infinite amount. However, we are able to justify

these relations. For example, if $q \to 1$, the project is very likely to be highly marketable. Hence, the incentives for the firm stating a high-quality project are high. To deter the firm from this behavior, a large I as well as a large γ is needed. For $q \to 0$, the firm will only invest the minimum, namely c. In return, the required reward must be infinitely high. Since this is impossible because no marketable output is generated, there will be no research funding at all.

Anyhow, as private research funding depends crucially on the research design, we have to consider it in a broader setting. That is why we get to the question of major importance that is left aside until now: What is the relation of the amount of research funding, I, to the aggregate bill in academia? Inside academia, we have only the expected expenditures within one project, so we can compare research funding to them. The total budget in academia is

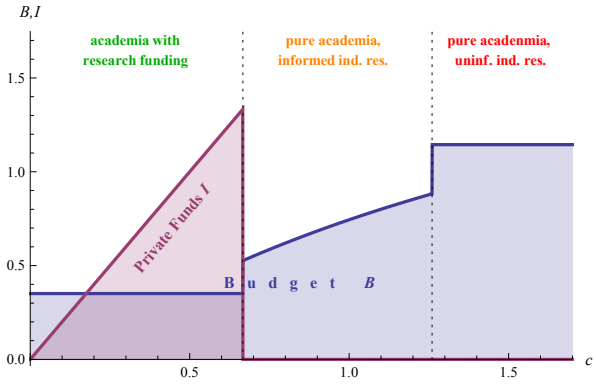
$$B = q \int_0^{t_{\text{switch}}} (1 - F_a(t))\, w_a\, dt = \frac{q\,(w_a - e^{-t_{\text{switch}}\,\lambda_a} w_a)}{\lambda_a}. \tag{21}$$

at least if there is research funding (otherwise, the q drops out). As a consequence, we can set also t_{switch} to the optimal value in the regime with research funding, as given by (12).

$$B = q\,\frac{w_a}{\lambda_a}\left[1 - e^{-\lambda_a\,T}\left(\frac{(\lambda_a - \lambda_p)(w_p + \lambda_p\,V)}{w_p\,\lambda_a - w_a\,\lambda_p}\right)^{\lambda_a/\lambda_p}\right]. \tag{22}$$

Furthermore, expected revenues from research funding are $q\,I = q\,I/(1-q)$, if there is research funding at all, i. e., for $c \le (1-q)\,w_a/\lambda_a$. Figure 10 shows the budget and the volume of private funding for our numerical example.

Figure 10: Budget B and Private Funding I



Parameters are as in Figure 6. The purple area shows the volume of private funds in academia. The blue area shows the total (expected) academic budget.

Some facts are visible right away. First, at the point $c = (1-q)\,w_a/\lambda_a = 0.67$, it becomes optimal not to have any private funding in academia, hence the funding drops to zero. At

the same point, the expected academic budget B jumps up. This is due to the fact that there is no information, hence the researcher must be paid no matter whether the product will be marketable or not. At $c \approx 1.26$, it is optimal to do without the information even in the private sector. Here, the academic budget jumps up again: it is now optimal to keep the project in academia for longer.

Second, the private funding can even exceed the total academic budget. This simply implies that it is optimal to collect more money from the industry than necessary to run the project. This case occurs if it is very expensive for a firm to gather the information. Hence, it must be incentivized more deeply to spend this cost and the required return of the final value must be extremely high. In turn, the research funds serving as a credible signal surpass the effective budget. Conceivably in this regard is a completely new product. Then, simply monitoring the market is insufficient and expensive market analyses have to be done. The surplus arose from the research funds can then be spent on continuative or other projects in academia, or it can be interpreted as overhead costs (academic administration, ...). Proposition 1 gives a short overview.

Proposition 1 *Depending on the cost of information, there are* 3 *different scenarios. If the cost is relatively low, the amount of private research funds is low even in terms of the academic budget. An increase of the cost results in higher research funds which may indeed exceed the academic budget. For high* c*, there is no funding at all.*

Finally, we are also able to refer conclusively to Fact 3 where we stated that a higher marketable value of a research project is accompanied by either an increasing amount of private research funds or by a raised fraction of private research funding of the academic budget. In Remark 4, we have already shown that a higher probability of marketability leads to a higher amount of private support. Additionally, as proved in the Appendix, the fraction of private research funds is positively associated with the potential value V. The following remark shows that this result holds in general.

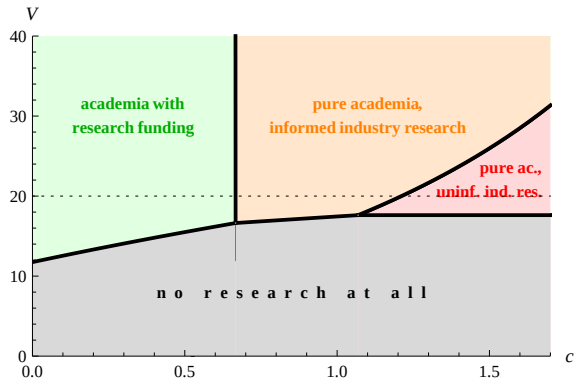
Remark 5 *With an increasing potential value* V *of the final product, private research funding increases as a fraction of the academic budget.*

This remark is quite intuitive. If the potential value V increases, it should be switched to the private sector earlier in order not to risk success. Academia spends less time on the project, and the academic budget shrinks. Hence, as the amount of private research funds is independent of V, the fraction of research funds increases as V rises. By combining Remarks 2, 4, and 5, we get to the following Proposition 1 which is perfectly in line with Fact 3.

Proposition 2 *An increasing expected value of the final product ($q\,V$) comes along with either an increased fraction of research funding of the academic budget and/or an increased absolute amount of private research funds.*

For completeness, we need to check whether expected profits from the research project are positive at all. This is tedious work with many different possible cases. Therefore, instead of giving the conditions explicitly, we deliver a plot for our numerical example. We vary V to look at different parameter constellations. Figure 11 shows the result. Two properties are evident. First, of course, if V is low, it does not pay to start the project at all. There is no single value for this minimum V; rather, it depends on the next-best research strategy. In academia with research funding (green area), the cut-off value is comparably low. Second, we see that the border between academia with research funding (green area) and pure academia (amber area) does not depend on V. We already know this, as the border is at the point $c = (1-q)\,w_a/\lambda_a$ (here, $c = 0.67$). Finally, we see that, as V grows, it is optimal to get the information at least in the private sector (orange area, in comparison to red).

Figure 11: Regimes for Different Parameters



Parameters are as in Figure 6. The figure shows the different possible regimes. Green stands for "privately funded academia, later private research," as before. Amber stands for "pure academia, later informed private research", and red stands for "pure academia, later uninformed research." Gray stands for the case where V is so low that it does not pay to even start the research project. The dashed line stands for $V = 20$, the parameter choice from Figure 6. Hence, at this line, we again find the switching points $c = 0.67$ and $c = 1.26$.

6.1 Modification

One result is striking, and seems very strong. Either a project is started with research funding right away ($t_c = 0$ for low levels of c), or it remains in pure academia until it is switched to the private sector. Until now, something that is not possible in the model is

a project that starts in pure academia, then obtains research funding, and finally switches into the private sector completely. These first results are inherently consistent and seem plausible if we think of the invention of a CML drug. Uninformed and consequently privately funded research would not make any sense in this case. However, as not all research projects directly dependent on the market needs, they usually need some time to be concretized before the private sector is interested in them. In order to generalize the model, we soften our assumption that all parameters are constant over time arguing that there are indeed many reasons why parameters change dynamically. Let us give a number of examples.

The researcher in the academic sector may get more experienced over time. In that case, the probability to fail $\lambda_a(t)$ may decrease over time: $\lambda_a'(t) < 0$. The same may be true for the private researcher. However, the private researcher may gain experience only once he starts on the project. In that case, λ_p would be a function not of t, but of $t - t_{\text{switch}}$. In addition, there may be a general increase in knowledge, independent from the researcher's personal experience, leading to a decrease of λ_a and λ_p.

However, the probabilities to fail may also increase over time. One potential reason might be that the different steps of innovation are not homogenous, but require very different research inputs. For example, to develop a new engine, one starts with computer simulations, then mechatronic technicians construct a basic configuration. After testing it rudimentally, it is developed concretely, and installed and adapted for different motor vehicles. Finally, a production manager tries to find a production method on a larger scale. There is no reason to assume that the probability of failure is the same for all steps.

Wages may also evolve over time. Again, there may be a macroeconomic evolution of wages. More experiences researchers may demand higher wages. Furthermore, different researchers may be necessary for the different research steps. Also, remember that the wage bill is the only cost factor for the research project. This implies that other costs of doing research (laboratories, instruments, ...) are implicitly comprised in the wage bill. These costs may also differ between research steps. In general, these costs may sink over time. This holds for both the academic and the private sector.

Furthermore, the precision of the information may evolve over time. Far from the final date of completion, it may be difficult to judge the chances for financial success. Shortly before completion, this judgment may have become easier. This effect may be expressed by an increasing precision of the information over time, or by a decreasing cost c of getting the information.

Summing up, none of the model parameters are likely constant over time. Therefore, the question of the robustness of results with respect to a model extension is permissible. For simplicity, let us concentrate on one parameter, and assume that λ_a is a function of time, hence we write $\lambda_a(t)$. Assume that the project is at date t, and the decision is whether the information should be gathered right now, or after another logical second at date $t + dt$.

The value of the remaining project at date $t + dt$, net of any costs, is named v. Hence, if the information is gathered right away, the aggregate value is

$$-c - q\, w_a\, dt + e^{-\lambda_a(t)\, dt}\, q\, v,$$

consisting of the information cost c, the wage payment for the time span dt (which only needs to be paid with probability q), and the value v (weighted with the probability with which the project does not fail until $t + dt$). If the information is gathered at date $t + dt$ instead, the aggregate value is

$$-e^{-\lambda_a(t)\, dt}\, c - w_a\, dt + e^{-\lambda_a(t)\, dt}\, q\, v,$$

taking into account that the cost c must be spent only if the project has not failed yet, and the wage must be spent independent from the information outcome. The research planner is indifferent if both are equal, thus if

$$c = (1 - q)\, w_a\, \frac{1}{1 - e^{-\lambda_a(t)\, dt}}\, dt.$$

Taking into account that $dt \to 0$, L'Hôpital's rule yields

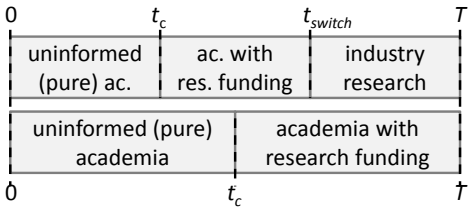
$$c = (1 - q)\frac{w_a}{\lambda_a(t)}, \quad \text{or} \quad \lambda_a(t) = (1 - q)\frac{w_a}{c}.$$

There are some immediate consequences. Assume that $\lambda_a(t)$ is increasing. Then, if it is not optimal to get the information at some date t, it is neither optimal to get it at some later date before t_{switch}. That implies that the information should be acquired right at the beginning ($t_c = 0$), or not before switching ($t_c = t_{\text{switch}}$). Nothing changes in comparison to the case with constant λ_a.

Now assume that $\lambda_a(t)$ is decreasing. Then, at time t_c with $\lambda_a(t_c) = (1 - q)\, w_a/c$, it is better to get the information immediately rather than in the next second, or any other future date. Hence, if it is optimal to get the information, then it is optimal to get it at this date t_c. In that case, the project starts in pure academia. At date t_c, the research planner forces the researcher to obtain private funding. The project is continued only if the researcher is successful. At some other date (possibly), a private firm takes over the project. In comparison to Figure 8, there are two new regimes.

Some comparative statics follow immediately. A higher information cost c leads to a later date t_c of private funding. A higher academic wage w_a leads to an earlier date t_c, and a higher success probability q leads to a later date t_c of private funding. These results lend themselves to interpretation. If the cost in the academic sector w_a are high, (early) private funding is optimal. Hence, expensive experiments should optimally be funded by private money from early on, as opposed to cheap theoretical research. Furthermore, for example if a researcher has a reputation to start projects with a high success probability q, he should not be bothered to acquire private funding .

Figure 12: Additional Regimes



7 Conclusions

Academia has a central feature which causes the main advantage compared to the private sector: scientific freedom. Researchers working within academia have the possibility to unfold themselves in creative scientific projects. This in turn decreases the potential to control their research agenda choices and choose the ways in which they allow others to build on their research discoveries (see Stern, 2004). In this paper, we develop a theoretical framework in which private research funding (PRF) transfers information on the marketable value of a research project from the private sector into academia, in an incentive compatible way. We have placed the model in the context of prior work of Aghion, Dewatripont, and Stein (2008), but focused rather on monetary arguments than on academic freedom in terms of intellectual property rights. As a consequence, this paper has provided predictions about the optimal sequence of research designs, about the optimal duration of a project within the designs, and about the optimal amount of research funds.

Projects typically start in pure academia and are finally handed over to the private sector, where products reach marketability. Potentially, academia is leapfrogged or the private sector is not involved. However, if both sectors occur, this order never changes. If private research funds enter, they reduce the relative desirability of academia because they tell the research designer that a project is marketable and consequently should switch earlier than without private funding in order to prevent the project from failing. When private funds enter into the academic system depends crucially on the design of academic research which is implicitly divided into 2 ways by us.

Our first results show that projects are privately funded only right from the start. This is perfectly in line with our initial example regarding the development of a CML drug at the MIT. If we interpret this kind of research as market oriented and extremely applied, this sequence is the most promising one and stands to reason. An uninformed research without a credible signal from the private sector that the drug is marketable, respectively that there is a need for it, would potentially lead to expensive and worthless research. Hence, a later date for inviting private money is neither possible within the model nor plausible if we think of such a research strategy. Including all other cases (no research

funds, no academic research, no private research) and following our argumentation in style of Figure 8 there is a total of six conceivable scenarios .

If we modify our model and allow parameters to change, we get an argument for why projects should not start with private research funds right away. If a project needs some time to be made concrete, is relatively jeopardous, or a researcher needs to get experienced, it is optimal to conduct the project initially without private support. This type of research, possibly rather basic or experimental, is in any case not as market oriented as the above mentioned research. Therefore, the optimal sequence presented in Figure 12 changes slightly.

As we abstract from any capital constraints inside academia and the private sector and focus only on the signal effect of PRF, we find that the amount of private research funds can even exceed the academic budget. If it is very expensive for the private sector to gather the information on the marketability, it must be compensated with higher returns of the final product for sharing the information truthfully. In turn, the research funds surpass the budget and act in this way as a credible signal. Contrary, the absolute amount of private support does not depend on the potential value of the product, but the switching date t_{switch} is accelerated with an increasing value. The private sector does not finance research lines of limited value at all. It indirectly finances research lines of medium marketability.

In addition to the effects on the patterns of finance, the expected value ($q\,V$) impacts the amount of private research funds as well as the required return. An increasing probability of marketability is attended by an increasing amount of research funds and a higher potential value V leads to a higher share of private research funds in the academic budget. This is consistent with our stylized Fact 3 we assessed. By providing data of funding in different fields of research, we suggested that the relative amount of funds is positively correlated with the particular expected valuation of projects.

By dint of the model, we can now explain, why some research projects raise more research funds than others. That is to say a question of incentive compatibility. Because of profit-orientation, a firm only provides research funds if it is compensated for this effort to an adequate extent, which is assured in event of high monetary expectations. Besides, the higher this effort is, the higher has to be the compensation. Hence, the approached applied research fields like medical or physical sciences, which produce obviously a high level of marketable output, are able to raise the vast bulk of research funds and possess the major fractions of research funds regarding their total budget. Consistently, we detect that fields of less profitable research show fewer research fund fractions.

As a consequence, our results, mainly Proposition 1 and Proposition 2 have strong implications for the organization of research. A possible policy maker should have in mind that basic research in terms of either improbably marketable projects should almost always be subsidized by the government sector. The higher the marketability, the higher is the amount of acquirable research funds and less dependent is the researcher of public

subsidies. Nevertheless, research projects incapable to gain PRF should not always be left in the lurch. These projects are primarily of basic character and therefore very important for subsequent research. Even though a quick marketable result does often not succeed directly, a mass of new research lines could arise from them. More market oriented research is traditionally privately supported to a greater extent or completely done in the private sector. So, it is first and foremost basic research (but definitely not solely) the policy maker should focus on regarding on the allocation of public funds. An alternative solution could be to invest the potential surplus of private research funds into (at least at first sight) non-market oriented research.

In summary, if basic research suffers from financial problems due to the fact that the private sector cannot be incentivized to invest, also applied research is eventually hurt. In that case, the diversity of research would be reduced due to the fact that there would be only few (if at all) incentives to carry out basic or risky research. More market oriented and specialized projects would be carried out. Potentially, some research lines and at worst whole fields of research could become extinct.

8 Appendix

Calculation of the minimal V: In Section 4, we argue that for very low V it might be the best strategy to not pursue any research at all. Therefore, we give lower limits for V, such that the project should be started in the first place. The algebraic expression depends on the research design. First, consider pure academic research, hence $t_{\text{switch}} = T$. We need to check whether (1) remains positive with $t_{\text{switch}} = T$, obtaining

$$V \geq \frac{(e^{\lambda_a T} - 1)\, w_a}{\lambda_a\, q}$$

No consider pure private research, hence $t_{\text{switch}} = 0$. Then solving (1) for V,

$$V \geq \frac{(e^{\lambda_p T} - 1)\, w_p}{\lambda_p\, q}$$

must hold, otherwise the project never starts. If there is switching ($0 < t_{\text{switch}} < T$), then

$$V \geq \frac{e^{T\,\lambda_a} w_a \big(\frac{(\lambda_a - \lambda_p)(w_p + q\,\lambda_p\, V)}{w_p\,\lambda_a - w_a\,\lambda_p}\big)^{1-\frac{\lambda_a}{\lambda_p}} - w_p}{q\,\lambda_p},$$

which is the last of the three conditions. As there is no single value for this minimum V, it depends on the next-best research strategy. ■

Proof of Remark 1: Assume the project in stage t, so the next stage is $t + dt$. Further suppose that v is the aggregated value of the remaining project, including the potential final V, and net of wages from $t + dt$ onwards. Hence, we concentrate on the period between t and $t + dt$ only. If research is carried out in the private sector, the aggregate value is $(1 - \lambda_p\, dt)v - dt\, w_p$. If carried out in academia, the according value is $(1 - \lambda_a\, dt)v - dt\, w_a$. Hence, there is a critical $\overline{v}$ such that research is better carried out in academia if and only if $v \geq \overline{v}$, given by

$$(1 - \lambda_p\, dt)\overline{v} - dt\, w_p = (1 - \lambda_a\, dt)\overline{v} - dt\, w_a \Rightarrow \overline{v} = \frac{w_p - w_a}{\lambda_a - \lambda_p}. \tag{23}$$

Now over time, v increases, because the time span $T - t$ decreases, such that less wages need to be paid until completion of the project. Consequently, if the research designer prefers private research at some stage, he prefers private research even more at a later stage. ■

Proof of Remark 2: The optimal switching date t_{switch} depends on several circumstances inside academia and the private sector. In order to describe the influences on it, we take the derivatives of t_{switch} with respect to the determining factors. This yields

$$\frac{\partial\, t_{\text{switch}}}{\partial\, q} = -\frac{V}{w_p + q\, \lambda_p\, V} < 0 \tag{24}$$

$$\frac{\partial\, t_{\text{switch}}}{\partial\, V} = -\frac{q}{w_p + q\, \lambda_p\, V} < 0 \tag{25}$$

$$\frac{\partial\, t_{\text{switch}}}{\partial\, w_a} = \frac{1}{w_a\, \lambda_p - w_p\, \lambda_a} < 0 \tag{26}$$

$$\frac{\partial\, t_{\text{switch}}}{\partial\, \lambda_a} = \frac{w_a - w_p}{(\lambda_a - \lambda_p)(w_p\, \lambda_a - w_a\, \lambda_p)} < 0 \tag{27}$$

$$\frac{\partial\, t_{\text{switch}}}{\partial\, w_p} = \frac{w_a + q\, \lambda_a\, V}{(w_p + q\, \lambda_p\, V)(w_p\, \lambda_a - w_a\, \lambda_p)} > 0 \tag{28}$$

$$\frac{\partial\, t_{\text{switch}}}{\partial\, \lambda_p} = \frac{-1 + \frac{w_p}{w_p + q\, \lambda_p\, V\, \lambda_p} + \lambda_a(\frac{1}{\lambda_a - \lambda_p} + \frac{w_p}{w_a\, \lambda_p - w_p\, \lambda_a}) + \log\left[\frac{(\lambda_a - \lambda_p)(w_p + q\, \lambda_p\, V)}{w_p\, \lambda_a - w_a\, \lambda_p}\right]}{\lambda_p^2}. \tag{29}$$

The signs of all comparative statics are immediately obvious, bar the last (29). We now show that the sign is positive provided that there is a transfer to the private sector anyhow. (29) implies that

$$-\frac{2\, w_p\, \lambda_a - w_a\, \lambda_p}{w_p\, \lambda_a - w_a\, \lambda_p} < \frac{(2\, \lambda_a - \lambda_p)w_p + q\, \lambda_a\, \lambda_p\, V}{(w_p + q\, \lambda_p\, V)(\lambda_a - \lambda_p)} + \log\Big[\frac{(\lambda_a - \lambda_p)(w_p + q\, \lambda_p\, V)}{w_p\, \lambda_a - w_a\, \lambda_p}\Big]. \tag{30}$$

Since the left-hand side is always negative, we need to prove that the right-hand side is positive. The first term (the fraction) in the right-hand side is positive, and the log is positive if the numerator is larger than the denominator. We check,

$$(\lambda_a - \lambda_p)(w_p + q\,\lambda_p\,V) > w_p\,\lambda_a - w_a\,\lambda_p \iff$$
$$q\,V > \frac{w_p - w_a}{\lambda_a - \lambda_p}. \tag{31}$$

This is the reversal of condition (5) where we stated that the project will never switch to the private sector because of an undersized expected market value. Hence, it stays inside academia and λ_p does not enter at all. In contrast, if (31) is fulfilled, a project is transferred to private sector. In this case, $\frac{\partial\, t_{\text{switch}}}{\partial\, \lambda_p} > 0$ and an increasing probability of failure inside the private sector leads to later switching. ■

Proof of Remark 3: In order to make a statement about the optimal switching dates with and without information, we must distinguish between the 3 different cases. First, the change of t_{switch} if the information is gathered immediately ($tc = 0$). By comparing (2) and (12) we get

$$T - \log\Big[\frac{\lambda_a - \lambda_p}{w_p\,\lambda_a - w_a\,\lambda_p}\,(w_p + q\,\lambda_p\,V)\Big] - \Big(T - \log\Big[\frac{\lambda_a - \lambda_p}{w_p\,\lambda_a - w_a\,\lambda_p}\,(w_p + \lambda_p\,V)\Big]\Big)$$
$$= \frac{1}{\lambda_p}\Big(\log\Big[\frac{(\lambda_a - \lambda_p)(w_p + \lambda_p\,V)}{w_p\,\lambda_a - w_a\,\lambda_p}\Big] - \log\Big[\frac{(\lambda_a - \lambda_p)(w_p + q\,\lambda_p\,V)}{w_p\,\lambda_a - w_a\,\lambda_p}\Big]\Big) > 0$$

Thus, the switching is accelerated.
Second, we match (2) and (15) ($t_c = t_{\text{switch}}$):

$$T - \log\Big[\frac{\lambda_a - \lambda_p}{w_p\,\lambda_a - w_a\,\lambda_p}\,(w_p + q\,\lambda_p\,V)\Big] - \Big(T - \log\Big[\frac{q(\lambda_a - \lambda_p)}{q\,w_p\,\lambda_a - w_a\,\lambda_p + c\,\lambda_a\,\lambda_p}\,(w_p + \lambda_p\,V)\Big]\Big)$$
$$= \frac{1}{\lambda_p}\Big(\log\Big[\frac{q(\lambda_a - \lambda_p)(w_p + \lambda_p\,V)}{q\,w_p\,\lambda_a - w_a\,\lambda_p + c\,\lambda_a\,\lambda_p}\Big] - \log\Big[\frac{(\lambda_a - \lambda_p)(w_p + q\,\lambda_p\,V)}{w_p\,\lambda_a - w_a\,\lambda_p}\Big]\Big) > 0$$

Again, the transfer is earlier than without any information, but later than with $t_c = 0$ as c is limited to $(1 - q)\,w_p/\lambda_p$ (see (10)):

$$\frac{1}{\lambda_p}\Big(\log\Big[\frac{q(\lambda_a - \lambda_p)(w_p + \lambda_p\,V)}{q\,w_p\,\lambda_a - w_a\,\lambda_p + c\,\lambda_a\,\lambda_p}\Big] - \log\Big[\frac{(\lambda_a - \lambda_p)(w_p + \lambda_p\,V)}{w_p\,\lambda_a - w_a\,\lambda_p}\Big]\Big) > 0$$

In the last case ($t_c = \infty$), there is no information at all. Hence, t_{switch} remains unchanged. ■

Proof of Remark 4: Taking the derivative of I as computed in (18) with respect to c yields

$$\frac{\partial I}{\partial q} = \frac{c}{(1 - q)^2} > 0.$$

■

Proof of Proposition 1: In order to examine whether one term exceeds the other, we need to compare the academic budget and the amount of research funds. Remember, if there is private research funding, it is received right away ($t_c = 0$). Hence, inserting $t_c = 0$ and the corresponding t_{switch} in (21) yields

$$B = q\,\frac{w_a}{\lambda_a}\left[1 - e^{-\lambda_a T}\Big(\frac{(\lambda_a - \lambda_p)(w_p + \lambda_p V)}{w_p\,\lambda_a - w_a\,\lambda_p}\Big)^{\lambda_a/\lambda_p}\right]$$

The private research funds as given by (20) are

$$I = \frac{c}{1-q}.$$

Since we derived from (8) the maximal c for which the information is gathered at date $t_c = 0$, we can rearrange the formula to

$$I = \frac{w_a}{\lambda_a}.$$

Finally, we match both terms against each other

$$q\Big(1 - e^{-T\,\lambda_a}\big(\frac{(\lambda_a - \lambda_p)(w_p + \lambda_p V)}{w_p\,\lambda_a - w_a\,\lambda_p}\Big)^{\frac{\lambda_a}{\lambda_p}} \lesseqgtr 1,$$

finding that private research funds increase with c and indeed may exceed the academic budget. However, conditioned by (8), private research funds cannot increase to infinity, they are limited to

$$\frac{1}{q\Big(1 - e^{-T\,\lambda_a}\big(\frac{(\lambda_a-\lambda_p)(w_p+\lambda_p V)}{w_p\,\lambda_a - w_a\,\lambda_p}\Big)^{\frac{\lambda_a}{\lambda_p}}}$$

times the academic budget. Otherwise, it would be totoo expensive to gather the information and there will be no private financial support. In the numerical example, the maximum multiplier is ≈ 5.7. ■

Proof of Remark 5: Inserting the optimal switching date from equation (12) and taking the derivative of B with respect to V yields

$$\frac{\partial B}{\partial V} = -q\,\frac{e^{-T\,\lambda_a}\,w_a\,\big(\frac{q(\lambda_a-\lambda_p)(w_p+V\,\lambda_p)}{w_p\,\lambda_a - w_a\,\lambda_p}\big)^{\frac{\lambda_a}{\lambda_p}}}{w_p + \lambda_p\,V},$$

which is negative. However, if the information is gathered right away research funding is

$$I = \frac{c}{1-q},$$

independent on V. As a direct consequence, research funding as a fraction of the academic budget is an increasing function, provided that the project is transferred. ■

Part II

Raising Research Funds: Does the Research Strategy matter?

9 Introduction

The requirements for successful researchers have changed dramatically in recent decades. In the past, researchers demonstrated success by producing high quality publications, citations or inventions. Thus, "bringing research results to market has not been of prime concern to academic institutions"(Muscio, Quaglione, and Vallanti, 2013, p. 63). Today, in a time of internationalization and shortages of public funds, researchers must manage various scientific partnerships beyond national boundaries and acquire external funds because "there is increasing political pressures on universities to raise research funding from industry and contribute actively to economic development"(Muscio, Quaglione, and Vallanti, 2013, p. 63). This emphasis "put on universities to produce research that is valuable for industry and to establish closer linkages with the business community in order to widen the chances of establishing collaborations"(Muscio, Quaglione, and Vallanti, 2013, p. 63) is omnipresent. Thus, the so-called third mission of universities has gained ground.

Hence, the relationship between universities and industry has become more substantial, as academia has increasingly contributed to wealth creation, economic growth (Florida (1995), Romer (1993), Leonard-Barton (1995)) and industrial innovation. Consequently, the academic sector as a knowledge generating institution is increasingly relevant to the private sector. In this regard, universities not only concentrate on acquiring new knowledge but also on more practical objectives related to established social and economic targets (Laredo (2007)) without sacrificing the nature of academic research. This creates an advantage for both sides: academia acts as an input source for the private sector and enlarges its external funding options. However, the latter benefit is not always intrinsically motivated. In particular, the recent expectation that universities apply for private funds is mainly driven by policy makers. Several European governments, primarily a result of the Maastricht criteria (Sörlin (2007)), changed their funding systems and introduced direct allocating institutions to optimize "the efficiency of research funds and increase the accountability of universities as well as the pressure to reduce their costs"(Muscio, Quaglione, and Vallanti (2013)). Accordingly, not only private but also public competitive funding is involved. As Muscio, Quaglione, and Vallanti (2013) argue, "this intervention has taken different forms in different countries, but is being driven by similar overall targets, which are promoting a contractual-oriented approach to university research funding, aimed at indirect control of the behavior of universities through the introduction of

(quasi-market) financial incentive schemes". On a related note, external public funding sources must not be forgotten. Because of "the widening and ever more diverse interest in research [...] funding [sic] become the preoccupation of government [...] and the EU"(Sörlin, 2007, p. 1).

These developments are seen in recent figures, which show that, although most of the academic budget continues to be provided by governments, a stepwise decrease can be observed (for example, in the USA, Japan, Germany, and France)[11]. While governmental funds account for 60% to 90% of total funds, it is increasingly necessary to enter into markets to tap new resources. "The largest part of university budgets is based on "negotiated budgets" and "funding formulas" (based on the size of staff or the number of students enrolled), but universities also compete for research funding on the basis of peer-reviewed project proposals against a set of objectives. [...] Other sources of university funding such as industry funding is becoming increasingly important for [...] universities' budgets"(Muscio, Quaglione, and Vallanti, 2013, p. 64).

In light of these arguments, we examine whether the choice of research strategy influences the ability to acquire external funding. This is a crucial point, in view of all the renewals, progress, and changes in the funding environment, including not only new funding sources but also dramatic shifts in the amounts of funds allocated. Moreover, we more closely examine the composition of the budget in the light of the aforementioned research focus. Finally, we derive some policy implications for researchers and the academic sector in general: which research strategy should be pursued? Is a diversified research focus more promising for raising research funds, or should a researcher concentrate on one field?

To answer these questions, we survey highly regarded economists, sociologists, and political scientists, distinguishing solely between private and public funds in general. Surprisingly, our results differ somewhat from our preliminary expectations. We present significant evidence that a precisely defined research focus positively affects the prospect of being funded. If research can be described as pure basic or pure applied, the link between the success rates of applications submitted to public and private institutions is highly significant, while a more diversified research orientation has a weaker but still significant effect on this complementarity. Additionally, we show that the research strategy chosen has a significant bearing on the composition of the research budget, whereas it is comparatively less important in accessing research funds.

In this sense, our approach differs from that of earlier studies in various ways. We conduct an econometric analysis based on exceptional micro data on individual researchers primarily in the European Union. By means of these researchers, we test our hypotheses with reference to the influence of research strategy on a researcher's ability to obtain funds and the amount of funding obtained. In the course of this research, we examine

[11] For further details, see OECD (2010).

differences between public and private external funds and define the relationship between them via application success rates.

The paper is organized as follows. Section 9.1 provides an overview of research related to the present paper, while Section 9.2 deduces our hypotheses from the theoretical background of such research. Section 10 presents our empirical results with respect to the determinants of industry funding of universities, including a description of our data, descriptive statistics, the methodology employed, and Logit and Tobit regressions. Section 11 addresses specific implications and concludes.

9.1 Related Literature

Admittedly, a large body of literature focuses on "the issue of the positive direct and indirect effects of public R&D on firms' productivity and private R&D"(Muscio, Quaglione, and Vallanti, 2013, p. 65). Additionally, schools have begun to theoretically and empirically examine the allocation and linkage between public and private research funding. However, while most of these studies have focused on the relationship between different types of research funds, we expand the analysis and examine which aspects influence the awarding of external funds. We analyze in detail whether certain research strategies[12] yield better prospects in obtaining the one or the other kind of funding and whether granted external funds of different types are complements or substitutes.

Within the strand of theoretical literature that focuses on the relationship between public and private research funds, several papers examine questions similar to ours. For example, David, Hall, and Toole (2000) ask whether public R&D spending is complementary to or substitutive of private R&D; David and Hall (2000) study public and private funding as potential complements, and García-Quevedo (2004) consider the relationship between public funding of R&D and private R&D expenditures, using a meta-regression.

David, Hall, and Toole (2000) presents a summary of econometric studies based on time series and cross-sectional data from various approaches collected over the past 35 years. David, Hall, and Toole considers the multiplicity of studies on this question and the inherent problem of comparability between them. The authors conclude that findings regarding the relationship between public and private R&D are ambiguous and provide suggestions to enhance future empirical research. Overall, complementarity appears to be appreciably more incumbent than substitutability, a finding that accords with our preliminary considerations and results.

In the same year, David and Hall further studied the effects of complementarity, using a simplified two-sector model. In contrast to our study, which mainly focuses on research,

[12] Basic, applied or both.

these authors argue that the degree of complementarity depends on the dimensions of the government R&D sector, the elasticity of scientists' labor supply, or the characteristics of the marginal product R&D curve, whereas our study explains different degrees of complementarity by way of distinct research strategies. However, David and Hall (2000) highlight that complementarities among public and private research funds may originate from the learning and training effects of publicly subsidized R&D activities employed by the private sector, cost-saving opportunities for the industry, and the signaling of future product demand by the public sector .

Another strand of the literature focuses on the possible advantages and disadvantages of a policy that forces universities to tap alternative funding sources, a type of policy that has been subject to controversy. Some observers argue that there is great need of more private funding and thus greater commercialization of research, while others point to the negative consequences of excessive emphasis on applicability and marketability at the cost of the core competency of academia. Among those taking the former position are Perkmann and Walsh (2008) and Gulbrandsen and Smeby (2005), who reason that academia and industry are likely to benefit from collaboration and that private sector participation in academia supports scientific output. In contrast, Thursby and Thursby (2011) argue that cooperation between academia and industry has several negative effects on the activities of universities. Calvert (2006) and Geuna (2001) go one step further and postulate that a shift toward private funding negatively affects the generation and dissemination of scientific knowledge. This argument is also present in Strehl, Reisinger, and Kalatschan (2007), an international report on funding systems and their effects on higher education systems. The authors conclude that, due to decreased government funding and repeated tapping of alternative funding opportunities, basic research has been neglected, and research quality has decreased.

Among all the studies that have examined the relationship between different sources of external funding, two most closely resemble our approach. Similarly to Grimpe (2010), we argue that many studies typically fail to contrast their findings with the variety of funding opportunities available to public science. Thus, in line with the author, we analyze and compare different funding sources. While we focus on a sample of approximately 3,800 European researchers, Grimpe (2010) considers a sample of more than 1,000 scientists at universities and public research institutes in Germany. His paper focuses on the Sixth Framework Programme for Research and Technological Development (FP6), finding that participation substitutes for other grant programs, which are complementary to each other.

The analysis of Muscio, Quaglione, and Vallanti (2013) not only matches our recent approach, but its origin is similar to our previous study (see Friedrici and Hakenes (2014b)), a theoretical investigation of private research funds. This work is based on Aghion, Dewatripont, and Stein (2008), who argue that government funding provides universities with vital resources needed to conduct research activities, the results of which can be transferred to industry. While we implemented private research funds as a tool to overcome information asymmetries that exist between the academic and private sector, so that such

funding acts as a kind of signal of the marketability of research, Aghion, Dewatripont, and Stein (2008) omit external funding and develop a model that defines when and under what conditions a research project is transferred from academia to industry. That study has an affinity with Tanayama (2010), who examines the effect of asymmetric information on the quality of research projects, arguing that direct public research funds can reduce asymmetric information. She also concludes that research funds can serve as a signal to industry, leading to lower financing constraints.

In addition, Muscio, Quaglione, and Vallanti (2013), using financial data for Italian academic researchers in the engineering and physical sciences, study the impact of different forms of public funding on the ability of universities to raise private funds. The researchers empirically examine whether financial pressures placed on universities motivate more university-industry interactions and has a substitution effect or leads to increased access to external funding, thus occasioning a complementarity effect. In line with these authors, we conclude that publicly funded research conducted in universities strategically complements private sources of funding. Thus, following Muscio, Quaglione, and Vallanti, public funding may incentivize university-industry interactions. Furthermore, the authors argue that a reduction in public research funds eventually leads to decreasing opportunities for additional external funding.

Finally, we must acknowledge that information cascades may also account for relationships between public and private funds[13]. Welch (1992) examines the cascade effect in financial markets, arguing that "when IPO[14] shares are sold sequentially, later potential investors can learn from the purchasing decisions of earlier investors. This can lead rapidly to "cascades" in which subsequent investors optimally ignore their private information and imitate earlier investors". Equally, one could pursue this line of argument under our approach. In particular, first funding decisions may affect later financiers. Concretely, early financiers will or will not fund a research project based on the requirements it fulfills. A subsequent financier will consider this decision and follow it or not. We call such a sequence a cascade whenever a subsequent financier relies on the decision of the first financier in making a financing decision. In the end, we set this argument aside because information cascades cannot explain why some funds are granted, while others are rejected. Furthermore, we possess indirect information on the quality of the research conducted due to the repertory of the survey[15].

9.2 Theoretical Background and Motivation

In examining external funding, we must first distinguish between public and private funds. Although both types of funds imply an additional source of capital for the researcher, the

[13] For a discussion of information cascades, see, e.g., D'Arcy and Oh (1997).
[14] Initial Public Offering.
[15] see Section 10.1

application process, the motivation, and even the conditions for funding differ widely. However, there is one factor that both types of funding share: they are only awarded if the projects have potential. While researchers receive public funds if, among other reasons, their projects have useful social, economic, or other external effects (see Weinberg (1962)), private funds are mainly awarded in cases of marketability or at least applicability. Following Aghion, Dewatripont, and Stein (2008) and Lacetera (2009b) we argue that firms focus on applied research with the goal of solving specific issues. Hence, from the perspective of a manager of a firm, he invests money in a project to realize future monetary gains with the help of research results obtained through the project. This is possible if an idea or proposal is achievable (optimally in the short run) within his firm. However, basic research "is commonly thought to refer to research that is directed solely toward acquiring new knowledge rather than any more practical objective"(Calvert, 2006, p. 199). Specifically, research "is often thought to produce a certain type of knowledge, and it is epistemological criteria that may seem the most intuitively obvious to use in defining it. The most common epistemological features [...] associated with basic research were unpredictability and generality"(Calvert, 2006, p. 204). Hence, public institutions are ultimately interested in funding basic research because of the potential value of such research to society (see Calvert (2002)). By contrast, a manager is not interested in general or unpredictable solutions. He is interested in a specific approach corresponding to his problem. Furthermore, because of the minor direct commercial value of basic research, it must be publicly supported (see e.g. Sauermann and Stephan (2013)).

In this regard, another definition refers to the goal of basic research. "What is significant about the intentional definition of "basic research" is that if the intentions behind the research are to produce something that will result in an application, no matter how fundamental the research may be in an epistemological sense, the research will no longer be classified as basic"(Calvert, 2006, p. 204). As a result, a manager will rarely invest in basic research because he "would not be able to capture the returns" unless "the results of basic research would eventually feed into industry and produce substantial economic benefits [...]"(Calvert, 2006, p. 206).

In view of such arguments, one must anticipate that the composition of the budget changes, depending on the justifications given for research. Such arguments lead us to expect that research strategy is important and has a significant impact on the ability to obtain funding and the extent of such funding. Consequently, we arrive at our intuitive Hypothesis One:

H1: The fraction of the research budget provided by private sources increases with the applicability of a research project.

Thus far, we have discussed the overall funding situation broadly and considered both funding sources separately. However, in reality, funding as well as application decisions are highly complex. This is likely the case because of continuous changes in the research landscape and the ongoing appearance of new funding possibilities. Traditionally, basic

researchers have applied only for public funds because "governments are ultimately interested in funding basic research because of the benefits that it is perceived to bring to society"(Calvert and Martin, 2001, p. 15). In any case, public sources cannot be tapped infinitely. "As science grows, its demands on our society's resources grow. It seems inevitable that science's demands will eventually be limited by what society can allocate to it"(Weinberg, 1962, p. 159). Currently, in view of the existing requirements imposed on researchers and restricted public budgets, private resources can be tapped. "The creation of new channels of university-industry collaboration has gained strategic relevance to universities primarily because of their potential as sources of external funding"(Muscio, Quaglione, and Vallanti, 2013, p. 63).

The question that arises for researchers facing multiple funding opportunities is where and how to apply for funding successfully. Thus, "the existing relationship between government funding and the funding raised by universities through [...] scientific activities to order"(Muscio, Quaglione, and Vallanti, 2013, p. 63) should be factored into the decision. Concretely, due to "the nature of the relationship between public and private funding to universities, government and industry funding for research within universities can be strategic substitutes or complements"(Muscio, Quaglione, and Vallanti, 2013, p. 63). Similarly, Blume-Kohout, Kumar, and Sood (2009) argue that "there could be a negative (substitution) effect, either due to crowding out of private investment or because researchers could stop seeking other sources of funding once they receive federal funding. On the other hand, federal R&D funding could also have a positive impact due to complementarity or signaling effects". The authors mirror Connolly (1997), who argues that external funding may serve as a signal of university quality because "external sponsors wish to allocate funding to those universities that do the highest quality research"(Muscio, Quaglione, and Vallanti, 2013, p. 65).

Consistent with the strand of the literature that traces the relationship between public and private funding of university research to the issue of complementarity between public and private R&D (see e.g. Muscio, Quaglione, and Vallanti (2013)), we suppose that the two types external funds are complements.

Accordingly, we obtain our next hypothesis:

H2: A positive evaluation of a researcher (in the sense of existing research funding) increases the probability of raising additional research funds.

In this context, we must acknowledge that we would prefer to focus on quasi-complementarity rather than complementarity because there is no pure quality variable in the dataset. Additionally, the survey was exclusively administered to selected researchers, many of whom are highly ranked in their research fields and thus exhibit strong potential. Thus, despite the absence of a distinct quality characteristic, we can examine the relationship between different external funding sources.

For convenience, we narrow our focus to cases of private funds complementing public funds. However, the argument presented below could be used to approach the process from the opposite perspective.

Recognizing this, we return to our expectation that public and private research funding are complements. Such complementarity "would imply that universities need government funding to increase [...] their external fundraising options"(Muscio, Quaglione, and Vallanti, 2013, p. 65)[16]. If we proceed on this assumption, we deduce that qualified researchers who obtain public research funds are well positioned to raise private funds. However, whether the latter transpires depends equally on other factors, in particular, the researcher's research focus, as described above. This is intuitive because, as we argued in the first part of Section 9.2, firms are not interested in general or unpredictable solutions. Rather, they have a stake in research that is "less risky and more short-term"(Calvert, 2006, p. 211) in nature. To tap different sources of funding, researchers should behave strategically. Calvert and Martin (2001) argue that "increased pressures for instrumentality in research" influences researchers in how they present their research. In this context, Calvert (2006) argues that scholars try "to make their work appear more applied to gain funding and resources. By changing the way they portray their research activities, scientists are engaging in boundary work". Additionally, the author confesses that "[...] it is difficult to tell if many [...] scientists were guilty of this 'applied hypocrisy' or whether their work actually did have both basic and applied elements to it, and that it is easy to make their research appear either basic or applied or both, depending on the circumstances"(Calvert, 2006, p. 210).

However, regardless of whether desired elements are only emphasized or overemphasized, this approach to obtaining funding is subject to a condition: rudimentary applied aspects must be included. Otherwise, this approach fails. Furthermore, if a researcher works almost exclusively on basic research, there is little chance of obtaining private funds, although it is not impossible. On the contrary, the more applied aspects that can be emphasized, the greater is the opportunity to obtain further funding. As we have demonstrated, this also holds if public funds complement private funds. Basic aspects must be signaled to obtain further public funding. The more funding the researcher is able to amass , the more likely he is to win additional funding. Calvert (2006) refers to this performance as "tailoring". While she focuses on basic research and the possibilities of accessing private funding sources, we claim that these methods could also be adopted by researchers whose work is applied.

Based on this line of argument, we arrive at our third hypothesis:

H3: The degree of complementary between public and private funding increases with the degree of research diversity of a researcher, particularly with a deepened combination of basic and applied elements.

[16]See also Mansfield (1995), Dechenaux, Thursby, and Thursby (2011), Jensen, Thursby, and Thursby (2010), and Perkmann and Walsh (2008).

In the following chapters, we will refer to and revise these hypotheses.

10 Empirical Analysis

10.1 Data Source and Description

Our empirical analysis is based on data from 2010 and 2011, drawn from the Academic Careers Observatory of the Max Weber Programme, which conducted three separate surveys of economists, sociologists, and political scientists. All participants were asked to complete an online questionnaire on research funding in the social sciences in Europe to obtain knowledge of their funding experiences. The sample of economists consisted of top European economists[17] and members of the European Economic Association (EEA). The sample of sociologists included authors in the Top 10 journals in sociology[18] and members of the European Sociological Association (ESA). The sample of political scientists was composed of authors in the Top 10 journals in political science[19] and members of the European Consortium for Political Research (ECPR). Overall, out of a sample of $3,802$ respondents, nearly 63 % were economists, approximately 20% were sociologists, and approximately 17 % were political scientists.

The multiscientific dataset of researchers in 70 countries and residents of more than 50 countries includes information on personal characteristics (e.g., age, gender, nationality) and institutional characteristics (e.g., position, employer, tenured employment). In addition, we recorded the change in the Human Development Index (HDI) from 2009 to 2010[20], used to develop our research design, which takes advantage of several potential correlates of the structure of internal and external financing.

Our main focus of attention is the scientific characteristics revealed in the survey, enabling us to gain insight into the compositions of budgets, the fractions and amounts of budgets provided by the institutions themselves and by private and public investors, and the research strategies of the scholars. To address our research questions, we aggregated several variables. We summarized the percentages of national public, regional public, European Research Council (ERC), and Framework Programme grants under the category "fraction public funds". The shares of national and regional private grants and grants from consultancies and prizes were categorized as "fraction private funds". Most of the information regarding fractions of specific funding was taken directly from the survey. If values were missing from this primary source, the fractions were calculated by means of

[17] Based on RePEc (Repository of Papers in Economics).
[18] Based on ISI Web of Knowledge.
[19] Based on ISI Web of Knowledge.
[20] For further details, see United Nations Development Programme (2011).

annual budgets in absolute terms. Thus, we obtained information on three different fractions of funds (public, private, and own institution). If a researcher receives no funding at all, he is assigned a value of 0 in all three cases. Similarly, the variables "annual amount public funds", "annual amount private funds", and "annual total amount" were created. Additionally, we reconditioned the variables on "average application success rate public" and "average application success rate private" by aggregating the distinct success probabilities stated by the participants.

Another modification of the original dataset concerns the classification of research strategies. Five variables related to research focus (empirical, theoretical, numerical, experimental, and other[21]). The respondents were asked to quantify their research strategy, and the levels "never" (recoded as 1), "sometimes" (recoded as 2), "mostly" (recoded as 3), and "exclusively" (recoded as 4) were placed at their disposal. To gain a more general view of strategic direction, we created a new variable called "research strategy". Specifically, we rearranged the four remaining work descriptions in accordance with the variable research strategy, using the classifications "pure applied", "applied-oriented", "balanced", "basic-oriented", and "pure basic". Therefore, in an intermediate step, we classified the work descriptions "theoretical" and "numerical" as basic research and the strategies "empirical" and "experimental" as applied research[22]. In particular, we added the different levels of "theoretical" and "numerical" work descriptions and subtracted the sum of the levels of "empirical" and "experimental" work descriptions. If both manifestations coincide (so that there is no discrepancy), the researcher is balanced in his research strategy (conducts both basic and applied research). If the result is greater than 2, the researcher works pure basic and in-between basic-orientated. If the result is less than -2, the research can be described as pure applied and as among the applied-orientated researchers. Therefore, the quantity of the solitary sum is immaterial, and only the difference provides some indication of the orientation of the researcher. The resulting characteristics are used as dummy variables in the regressions to highlight the specific effects of the strategy on the dependent variables.

We confined our analysis to the employer university because these researchers are the focus of our research interest. Furthermore, it must be emphasized that only EEA Members are included because we can assume that all researchers have the same needs with respect to networking. As we expect differences in requirements, legal regulations, and accessibility to research funding, we used country dummies to control for country-specific differences. In so doing, we account for the differential development of higher education sectors and for both the economic and political status quos, which may lead to diverse degrees of dependence on external funding and conditions for funding allocation . For instance, the Anglo-Saxon system, adopted by the UK, Ireland, and the Netherlands, is

[21] Because of a small number of responses, we did not include this variable.

[22] Of course, this categorization must be viewed as relative, as scholars in the social sciences do not work as applied researchers, as engineers do, for example.

characterized by transparent ex ante and ex post evaluation procedures and a large number of independent funding agencies allocating financial support to meet specific needs at different career stages. In contrast, Continental Europe's higher education systems show a high level of centralization due to many factors, for example, that funding decisions are less independent[23].

Finally, we checked for any inconsistences (e.g., total fractions not equal to 100%).

A detailed description of the data set can be found in Table 8 in Section 12.

10.2 Descriptive Statistics

Table 1 presents descriptive statistics of the variables used in the analysis. The dependent variables are the fractions and the amounts of external funding raised by researchers commissioned by public and private institutions and average application success rates. Public funds are granted by national and regional institutions and the ERC. Private grants come primarily from national and regional firms. Hybrid funding sources are considered neither by the survey nor by us. Not all the grants are subject to specific conditions (they include all research funds, regardless of whether there exists a contract or a funding scheme).

At first glance, large differences between the characteristics of the response variables are evident. While the mean of the fraction of public funds is nearly 58%, the mean of the fraction of private funds is only 13%. The amounts of external funds from these different sources are widely separated. On average, 60.349 euros are awarded to researchers by public institutions, while 7.255 euros are awarded on average by private institutions. In contrast, the average application success rates are only slightly different between public and private funding sources, averaging 54% and 52%, respectively.

The explanatory variables are indicators of the individual characteristics of the researcher (such as gender, age, position, years since graduation, and whether the researcher is a national or a foreigner at his university) and work experience-related characteristics (such as one's average application success rate for public funding, average application success rate for private funding, work time spent on research, work time spent on fundraising, the rated impact of external funding on the researcher's career, and work environment). Finally, we included the percentage change in the Human Development Index (HDI) to control for the external circumstances of researchers' locations.

The independent variable of greatest interest is "research strategy", as it is fundamental to all our research questions, given our approach. Concretely, we wish to examine whether scientific orientation indeed influences a researcher's ability to obtain funding and the corresponding amount. To gain initial insight into whether the research strategy affects

[23] See Marimon (2008).

Table 1: Descriptive Statistics on the survey respondents

Variable	Obs	Mean	Std. Dev.	Min	Max
public funding (d)	828	.82	.39	0	1
private funding (d)	828	.40	.49	0	1
fraction public funds	828	57.92	37.86	0	100
fraction private funds	828	13.11	24.15	0	100
annual amount public funds	828	60349	289071	0	4500000
annual amount private funds	828	7255	33662	0	525000
annual budget own institution	828	10862	63124	0	1500000
average application success rate public	686	53.79	31.92	0	100
average application success rate private	326	51.86	38.44	0	100
research strategy	743	2.25	1.16	0	4
gender (d)	828	.36	.48	0	1
age	828	43.64	11.14	22	77
tenured (d)	828	.59	.49	0	1
position	821	4.44	1.66	1	6
years from graduation	803	3.35	1.24	1	5
foreigner/national (d)	828	.28	.45	0	1
work environment	828	2.58	.64	0	3
working time research	828	45.01	20.02	2	100
working time fund raising	828	7.02	7.16	0	60
rated impact of external funding on career[1]	730	2.34	.77	1	3
HDI growth	828	.309	.117	-.11	.87

(d) indicates dummy variables

[1] Respondents assessed the impact of external research funding on their future careers. We interpreted this as taking external funds seriously.

the fractions of the research budget provided by private and public sources, we present the following graphs. The first graph (Figure 13) illustrates the fraction of public funds, depending on type of research. The second graph (Figure 14) depicts the fraction of private funds, depending on research strategy.

Figure 13: Fraction of public funds by research strategy

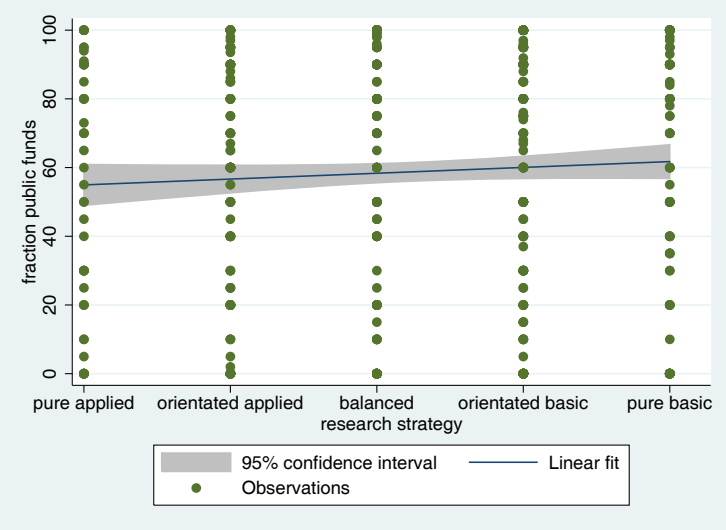
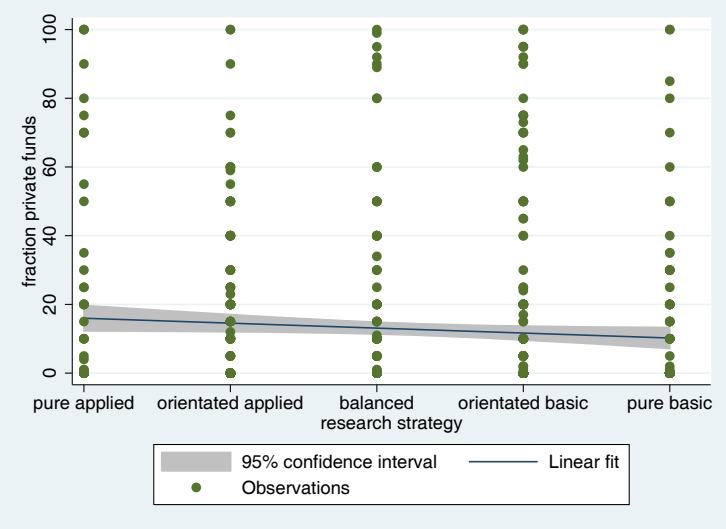


Figure 14: Fraction of private funds by research strategy



The scatter plots illustrate - disregarding all other characteristics - that the more basic is a researcher's orientation, the larger is the fraction of public funds and, correspondingly, the smaller is the fraction of private funds. To validate this finding, we conduct a first univariate analysis, namely, the Spearman rank correlation test, presented in Table 2.

Table 2: Spearman rank correlation

Characteristics	**research strategy**
fraction public funds	0.056
	(0.130)
fraction private funds	-0.094***
	(0.010)
Observations	743

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

* p-values in parentheses

Spearman's rank correlation coefficients and the corresponding p-values (in parentheses), used to test the hypothesis that the research strategy and the fractions of funding provided by public and private sources are independent, validate the descriptive statistics shown in Figure 13 and Figure 14. While there is a distinct negative and highly significant trend from applied to basic research in the fraction of private funds, the correlation between research strategy and the fraction of public funds is positive and insignificant. Because personal and work characteristics may have a bearing on the composition of the budget, we will extend our analysis to a multivariate regression in section 10.4.2.

10.3 Methodology and empirical specifications

Our approach to estimating the structural parameters of our model of interscientific budget structure rests on the idea that different types of research have different implications for the sources of external financing. We analyze whether the research strategy adopted is informative with respect to a researcher's ability to raise external research funds and the composition of research budgets. Therefore, we run several empirical regressions.

To begin, we examine whether the research strategy influences access to external research funding via a Logit regression. We then examine the influence of research focus on the fractions of funds from the two external funding sources (public and private), employing a Tobit regression. Finally, we estimate the correlation between public and private research funds to determine whether the different types of funding are substitutes or complements and whether success in obtaining research funds positively or negatively influences the probability of raising additional funds.

For purposes of comparison, we estimate different models using the same sample. Additionally, to validate our results, we exploit bootstrapped standard errors based on $1,000$ replications.

With respect to endogeneity, reverse causality may be a problem. The absence of a panel data set or adequate instrument variables does not allow for such tests. However, it is

unlikely that a researcher orients himself towards a certain strategy only because of a specific funding possibility, especially in the short term. An arbitrary indication for this reasoning is given in Section 12.1. There, we restrict the sample up to researchers who never applied for private funds and show that the results estimated in Section 10.4 still hold.

10.4 Empirical results

10.4.1 The research strategy and its impact on access to external funding

As outlined above, before addressing the composition of the budget, we investigate whether the research strategy adopted influences a researcher's ability to obtain external research funds. Given the binary nature of the dependent variables "public funding" and "private funding", we use a Logit regression to predict the relationship[24].

Table 3 reports the estimation results for the Logit model, in which public funding is the dependent variable. "0" is assigned to respondents who receive no public funds, and "1" is assigned to those who are publicly supported (they may receive private funds, but the relationship between access to private funds and research strategy will be shown in the next table). Our focus is not on allocations of funding of specific organizations but on the general relationship. We emphasize that the marginal effects and t-statistics based on Logit standard errors (in parentheses) and bootstrapped standard errors (in brackets) (to account for asymptotic normality) are presented[25]. Column (1) refers to estimation without any control variables, column (2) refers to individual related variables, and column (3) refers to work- and experience-related variables. Finally, column (4) merges all control variables and includes the country dummies.

Overall, we find a positive relationship between the explanatory variable, research strategy, and public funding. Nevertheless, the relationship is only highly significant (at the 5% level) in the case of applied-oriented research. In other words, involvement of slightly basic research increases the probability of obtaining public funding by approximately 16%. Surprisingly, investing more in basic research is less worthwhile. A further step toward basic-orientated or balanced research yields a 12% increase in funding probability, an increase that is marginally significant (10%) only if we control for all related factors. By contrast, a holistic focus on basic research is without value, even if all control variables are included.

Additionally, other variables have significant effects on whether research is publicly funded. As expected, time spent fundraising plays a role in access to public funding, with a margin

[24] Detailed tables are presented in Section 12.

[25] The marginal effects yielded by the two methods fully coincide.

Table 3: Multivariate determinants of public funding

research strategy	**(1)**	**(2)**	**(3)**	**(4)**
applied-oriented	.1454**	.1537**	.1646**	.1600**
	(2.09)	(2.17)	(2.37)	(2.36)
	[1.86]	[2.01]	[2.14]	[2.13]
balanced	.0837	.0919	.1226*	.1201*
	(1.20)	(1.30)	(1.79)	(1.80)
	[1.08]	[1.21]	[1.64]	[1.65]
basic-oriented	.0963	.1049	.1293*	.1170*
	(1.40)	(1.48)	(1.91)	(1.74)
	[1.29]	[1.40]	[1.74]	[1.56]
pure basic	.0689	.0700	.0770	.0677
	(0.93)	(0.93)	(1.05)	(0.94)
	[0.86]	[0.90]	[0.99]	[0.85]
Constant	1.157***	.2626	-.4247	-2.202*
	(3.35)	(0.38)	(0.46)	(1.69)
	[2.97]	[0.36]	[0.44]	[1.62]
Observations	538	538	538	538
McFadden's R^2	0.012	0.039	0.143	0.181

Country dummies and all variables presented in Table 8 are included in (4).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Logit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

that is significant at the 10% level. Investing 1% more time in the application process and in all related fundraising actions increases the probability of public funding by approximately 0.4%. Furthermore, the variable, average application success rate, is significant at the 1% level, indicating that successful fundraising in the present has a positive (approximately 0.3%) effect on future funding prospects.

Table 4 shows the estimation results for the Logit model, in which private funding is the dependent variable. Again, "0" is assigned to respondents who receive no private funds, and "1" is assigned to those who are privately supported. Our focus, again, is not on the allocation of private funds of specific organizations. We provide the marginal effects and t-statistics based on Logit standard errors and bootstrapped standard errors. Column (1) refers to the estimation without any control variables, column (2) refers to individual related variables, and column (3) refers to work- and experience related variables, while column (4) merges all control variables and additionally includes country dummies[26].

We find a negative correlation between a basic research orientation and access to private

[26]This summary also applies to all subsequent regressions

Table 4: Multivariate determinants of private funding

research strategy	**(1)**	**(2)**	**(3)**	**(4)**
applied-oriented	-.1026	-.1053	-.1220	-.1149
	(1.05)	(1.10)	(1.29)	(1.17)
	[1.00]	[1.03]	[1.20]	[0.99]
balanced	-.2273**	-.2340**	-.2100**	-.2056**
	(2.34)	(2.48)	(2.26)	(2.16)
	[2.16]	[2.33]	[2.29]	[1.86]
basic-oriented	-.2708***	-.2870***	-.2342***	-.2209**
	(2.88)	(3.08)	(2.61)	(2.33)
	[2.73]	[2.83]	[2.35]	[1.94]
pure basic	-.1992*	-.1990*	-.2424**	-.2226**
	(1.86)	(1.91)	(2.36)	(2.11)
	[1.71]	[1.74]	[2.18]	[1.71]
Constant	1.609***	.8481	1.117	1.591
	(2.94)	(0.98)	(1.03)	(1.03)
	[2.68]	[0.94]	[0.98]	[0.87]
Observations	263	263	263	263
McFadden's R^2	0.025	0.046	0.153	0.167

Country dummies and all variables presented in Table 8 are included in (4).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Logit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

funding, with an effect that is significant (up to the 1% level) in all cases except one. Only a move to slightly more basic research does not negatively affect funding probability. Put simply, the more basic research is, the more difficult it is to access private funding. Concretely, the probability of being funded by a private organization decreases by approximately 20.6% if a researcher's research orientation is balanced, by 22.1% if the researcher chooses a basic-orientated strategy, and by 22.3% if the researcher adopts a pure basic strategy. In this regard, it is intriguing that a further shift to a more basic research orientation does not worsen access to private funding. The probabilities are consistently lower, independently of the degree of basic research.

Additionally, time spent on research influences the probability of being privately funded. Surprisingly, the relationship is negative and significant at the 5% level, although the effect is very small. More time invested in research entails a 0.3% reduction in the probability of receiving private funding. At first glance, this may appear counterintuitive. However, referring to the Section 9.2, an explanation is evident. We argued that firms are generally uninterested in lengthy (that is, not readily applicable) research projects. Thus, the less time a research project requires, the more likely it is to receive external financing

from firms. As expected, the success rate of all applications for public funds plays an important role. Specifically, it is significant at the 1% level. Thus, as in the first regression, a researcher who has received or continues to receive funding now obtains private funding in the future with a 0.4% higher probability.

In summary, it can be stated that an applied-oriented research strategy appears to be the most promising strategy in terms of access to both forms of external funding. On the one hand, there is no significant decrease in the probability of private funding compared with purely applied research. On the other hand, a marginal shift toward basic research significantly improves the probability of public funding. Interestingly, time spent fundraising appears to have an impact solely on the public side, while time spent on research itself appears to only impact the private side. Hence, the application procedure and all related activities are crucial to the allocation of public funds and should be conducted accurately.

10.4.2 The research strategy and its impact on the fraction of external funds

In a second step, we analyze the composition of the budget. Figure 13 and Figure 14 are examined in a multivariate setting. As the dependent variables (shares of the budget that come from public and private external sources) are censored to a minimum of 0% and a maximum of 100%, we apply two-limit Tobit regressions. The results, shown in Table 5 and Table 6, strengthen the implications of the above univariate Spearman regressions. See the Tobit model for the fraction of public funds.

The results for the Tobit model, including the Tobit standard errors and bootstrapped standard errors, are summarized in Table 5. In contrast to access to public research funds, the choice of research strategy has a significant influence on the fraction of public funds. Consequently, the research strategy adopted is associated (up to the 1% level of significance) with the composition of the budget. Changing the strategy from pure applied to applied-oriented leads to a 23.4% higher fraction of public funds. Each additional move toward pure basic research increases the share of the external public budget by approximately 20.8, 18.7, and 15.5%, respectively. Of course, this tendency could be due to a reduction of the fraction of external private funds (an issue examined in the following table). Nevertheless, the magnitudes of the marginal effects are striking.

With respect to the control variables, we find similarities to the Logit regression. Work time spent fundraising and the average application success rate have significant effects on the share of public funds (at the 5 and 1% levels, respectively) . On closer examination, the first variable increases the share of public funds by approximately 0.5%, and the second variable raises the fraction of public funds by 0.4%. Therefore, it is somewhat profitable to invest additional time in applying for research funding.

As promised, we now more closely examine the effects of research focus on the fraction of private research funds, as seen in Table 6.

Table 5: Multivariate determinants of the fraction of public funds

research strategy	**(1)**	**(2)**	**(3)**	**(4)**
applied-oriented	15.48**	15.83**	16.51***	15.67***
	(2.43)	(2.47)	(2.80)	(2.63)
	[2.55]	[2.58]	[2.78]	[2.48]
balanced	19.93***	20.44***	21.24***	20.79***
	(3.33)	(3.39)	(3.79)	(3.67)
	[3.30]	[3.38]	[3.62]	[3.29]
basic-oriented	17.66***	18.01***	20.06***	18.69***
	(2.96)	(2.97)	(3.60)	(3.28)
	[3.05]	[2.92]	[3.40]	[2.89]
pure basic	15.92**	16.57***	16.52***	15.51***
	(2.48)	(2.57)	(2.77)	(2.58)
	[2.58]	[2.49]	[2.71]	[2.41]
Constant	38.22***	24.92*	-15.64	-41.44**
	(4.82)	(1.76)	(1.00)	(2.00)
	[4.91]	[1.60]	[1.01]	[2.05]
Observations	538	538	538	538
McFadden's R^2	0.003	0.004	0.023	0.026

Country dummies and all variables presented in Table 8 are included in (4).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Tobit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

Table 6 shows that not only the decision regarding whether a researcher obtains private research funds (see the Logit regression presented in Table 4) but also the share of private research funds depend significantly on research strategy. Accordingly, research strategy has a considerable effect (up to the 1% level of significance) on the composition of the budget. The fraction of private funds declines by approximately 19% if applied-orientated research, rather than pure applied research, is conducted. An additional tendency toward basic research does not extend this effect. If the researcher chooses a balanced (basic-orientated or pure basic) strategy, the private fraction of the budget is 23.2% (20.6% or 20%) less compared with pure applied research. Hence, interestingly, the decline is stable and independent of the proportion of basic research. Once a researcher has shifted to fundamental research, the fraction of private funding does not change.

Moreover, the success rate of all applications for private funds has a significant (at the 1% level) influence on the share of private research funds. Specifically, a researcher who has received or continues to receive positive funding decisions has on average a 0.3% higher share of private funds. It is particularly noteworthy that some personal characteristics affect the private fraction if we include all control variables. Thus, foreign researchers are

Table 6: Multivariate determinants of the fraction of private funds

research strategy	**(1)**	**(2)**	**(3)**	**(4)**
applied-oriented	-14.92**	-16.38**	-19.21***	-19.03***
	(1.96)	(2.17)	(2.61)	(2.62)
	[1.90]	[2.13]	[2.42]	[2.26]
balanced	-19.88***	-20.85***	-23.61***	-23.16***
	(2.72)	(2.88)	(3.30)	(3.28)
	[2.53]	[2.79]	[2.99]	[2.77]
basic-oriented	-18.26**	-20.74***	-19.91***	-20.61***
	(2.53)	(2.87)	(2.80)	(2.89)
	[2.26]	[2.66]	[2.46]	[2.41]
pure basic	-16.47**	-16.32**	-21.12***	-20.04***
	(2.10)	(2.08)	(2.79)	(2.66)
	[1.96]	[2.06]	[2.46]	[2.25]
Constant	36.57***	39.08**	20.09	43.62*
	(4.19)	(2.46)	(1.06)	(1.68)
	[3.77]	[2.38]	[1.09]	[1.49]
Observations	263	263	263	263
McFadden's R^2	0.005	0.010	0.023	0.031

Country dummies and all variables presented in Table 8 are included in (4).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Tobit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

characterized by a 7.0% lower private fraction than national researchers (significant at the 10% level). This could be due to weaker networks or recent changes in residence. Finally, the fraction of private research funds decreases by approximately 4.8% (which is significant at the 5% level) with the attainment of an advanced academic position. Researchers at the beginning of their careers, by contrast, can obtain a higher fraction of private funds, possibly due to a smaller total budget und consequently a higher share of external funds allocated to young researchers.

We feel partially vindicated with respect to hypothesis 1. Indeed, the fraction of the budget attributable to external private donors is highest when pure applied research is pursued. In addition, however, it is noteworthy that a stepwise orientation toward basic research does not result in a linear decrease in the private funding share. The heaviest losses are observable when a balanced strategy is undertaken, losses that are due, of course, to a higher share of public funds. This finding in turn raises the question of why this phenomenon is not observed in the case of pure basic research. As one would expect, basic research is primarily publicly supported. However, compared with pure applied research, the fraction of public funds is indeed significantly higher. Even so, it shows the

smallest effect of all remaining research strategies.

10.4.3 The relationship between public and private research funds

A question that arises from the first multivariate regression is how external funds relate to each other. Are they complementary or substitutive? We have shown that an applied research focus increases the fraction of private funds and decreases the fraction of public funds. Of course, these fractions of academic budgets cannot be used to examine the relationship, as together they amount to 100% of a university's budget. Therefore, we use alternative variables, namely, the application success rates of external funding, to depict the relationship via a Tobit model[27].

The estimation results for the Tobit model with respect to the average application success rate of public research funds are presented in Table 7. Column (1) refers to the estimation of the success rate in general, pursuant to hypothesis 2. Moreover, to test hypothesis 3, all other columns show the estimation results for the different categories of research strategy. The upper part of the table presents the outcome without any control variables, while the bottom part includes individual-, work-, and experience-related variables and country dummies. Again, t-statistics based on both Tobit standard errors and bootstrapped standard errors for the general regression are also shown[28].

To reassess hypothesis 2, we first examine column (1), which shows the influence of the application success rate for private funding on the application success rate for public funding. We find a positive correlation that is significant at the 1% level. For a 1% increase in the average application success rate for private research funds, there is a 0.3% increase in the predicted value of the average application success rate for public research funds. This is an important finding, as it provides evidence for hypothesis 2. Indeed, the probability of additional funding increases - if only slightly - with external funding in the present. We can draw this conclusion without making any assumption regarding the sequence of support (that is, private or public) because the result holds regardless of the sequence. Apart from the fact that simultaneous application for both types of funding is implausible, the grants themselves are highly unlikely to occur concurrently.

Unlike in the previous regression, the work environment is found to positively affect private funding, with a marginal effect that is significant at the 5% level. In other words, more focused and integrated research entails a 9.8% higher average success probability in obtaining public funds. This could be due to established reputations, efficient networks, the division of responsibilities, or other similar reasons.

[27] Theoretically, this could have been done by estimating the effects on the amounts of public and private funds, but the survey provides less information on specific amounts.

[28] Unfortunately, the number of observations within the five categories is too small to run a bootstrapped regression.

Table 7: Multivariate determinants of the relationship between public and private application success rates

Characteristics	**full sample**	**pure applied**	**applied-oriented**	**balanced**	**basic-oriented**	**pure basic**
without control variables						
average application success rate private	.299*** (6.24) [5.57]	.655*** (7.14)	.398*** (4.32)	.120 (1.13)	0.201** (2.26)	0.495*** (4.91)
McFadden's R^2	0.015	0.087	0.031	0.002	0.007	0.042
control variables included						
average application success rate private	.251*** (5.03) [4.51]	1.699*** (8.27)	.297** (2.29)	.145 (1.39)	.077 (0.79)	.506*** (5.51)
Observations	250	23	48	64	75	40
McFadden's R^2	0.028	0.324	0.064	0.036	0.051	0.117

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

t-statistics based on Tobit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

The remaining columns pertain to hypothesis 3, namely, that there exist different degrees of complementarity, depending on the diversification of research strategies. This hypothesis is both confirmed and rejected . We acknowledge that these results should be treated with caution, given the small number of observations. As can be observed, the complementarity is variously severe among the different categories. Contrary to our opinion, the complementarity is most pronounced in cases of pure strategies. The significance and the margins are largest if a researcher conducts either pure basic or pure applied projects. Whereas pure basic and pure applied research are both statistically significant at the 1% level, the latter implies a 1.7% and the former implies a 0.5% increase in the average application success rate for public funds if the average application success rate increases by 1%. These results are highly unexpected. After examining access to both funding sources by means of a Logit regression (see Table 3 and Table 4), we would expect either a negative relationship or no relationship. However, the signaling effect of existing funding appears to be conclusive if there is a sharp focus on either basic or applied research. On the contrary, if a researcher is balanced in his or her orientation, employing different research strategies, the private application success rate influences the application success rate for public funds. An orientation toward applied research enhances the relationship significantly, but the effect is not as large as in extreme cases. A 1% increase in the private application success rate induces a 0.3% rise in the probability of obtaining public funding.

Contrary to expectations, focusing on a definite research strategy improves one's chances of being reviewed positively by external funding donors. A combination of fundamental or basic and applied research (here called balanced) leads to a large diversity of outcomes rather than reducing the probability of success. Additionally, such a combination does not significantly influence the application success rate positively.

11 Discussion and Conclusions

"Knowledge is considered to be a primary resource for wealth creation and economic growth and intellectual capital a crucial resource of economic advantage in the knowledge economy"(Muscio, Quaglione, and Vallanti, 2013, p. 64). This knowledge is traditionally created in universities where publicly conducted research has "rested with the national, or federal, government"(Sörlin, 2007, p. 1). However, the "funding of research and higher education has become an increasingly important concern"(Sörlin, 2007, p. 1). Therefore, the new academic funding rationale and the promotion of external orientation of academic research have raised several theoretical and policy questions regarding the future role of universities and their future funding options. While we focus on researchers and leave aside the new requirements of universities, we try to fill a void in the economics literature.

In summary, we obtain striking results, some of which are intuitive and expected, while others are surprising. Nevertheless, all the results are indicative of a promising choice

of strategy for obtaining funding within the social sciences. First and foremost, access to research funding appears to be easiest, given an applied focus involving marginal basic elements. Compared with a pure applied research focus, the probability of obtaining private funding is just as strong, whereas the probability of obtaining public funding is significantly enhanced. Conducting basic research to a greater extent reduces the probability of obtaining private funding and yields only a minor advantage in obtaining public funding.

With respect to fractions of external funds, we obtain slightly different results. An orientation toward basic research leads to higher fractions of public funding up to an increase of approximately 31.2 percentage points. Thus, a pure basic strategy is as worthwhile as an applied-oriented strategy. In contrast, a deviation from a pure applied strategy causes a substantial decrease in the share of private funding (approximately 20%), regardless of whether basic research now constitutes a marginal part of overall research or all of it . For this reason, we take hypothesis 1 as partially demonstrated and establish that the fraction of the budget attributable to external private donors is largest when pure applied research is conducted. Indeed, we also observe smaller fractions of private funding when researchers mix strategies or conduct pure basic research. However, we did not expect these effects to decline non-linearly. The minimal fraction of private funding is associated with a balanced strategy, which in turn exhibits the highest fraction of public research funds. Thus, a pure basic strategy does not attract the largest fraction of public support.

Hypothesis 2 is confirmed by the significant positive correlation between the application success rates for private and public funding. Hence, a positive previous evaluation - regardless of whether it occurred publicly or privately - enhances the chances of raising additional research funds. In accordance with Muscio, Quaglione, and Vallanti (2013) we state that public and private funds are strategically complementary. Although this relation is minor in an economic sense (approximately 0.3%), it is statistically significant, and we use it to more closely examine the linkages between the success rates among the five research strategies. The strongest connection is observed when a researcher conducts either pure applied or pure basic research. Focusing on a specific research strategy improves the researcher's chances of being positively reviewed by external funding donors, whereas scientific diversification is neither detrimental nor particularly advantageous. Thus, we arrive at the conclusion that the degree of complementarity is u-shaped and that it is worthwhile to focus on a specific strategy to exploit the close connections between strategy and funding.

All our results provide a clear answer to our major question raised in the title: Does research strategy matter in raising research funds? Yes, it does. While we do not wish to judge whether basic or applied research is more promising (the needs are too diverse), a sharp focus on one or the other appears to enhance fulfillment of the new requirements researchers face in obtaining funding. Thus, focusing intently on core competencies rather than on a wide variety of strategies fosters a higher probability of being successfully evaluated and funded.

12 Appendix

Table 8: Description of the variables used in the regressions

Variable	Description	Data Source
public funding (d)	0 if there is no public funding, 1 if there is any	Survey (adapted)
private funding (d)	0 if there is no private funding, 1 if there is any	Survey (adapted)
fraction public funds	aggregated fraction of different public funding sources	Survey (adapted)
fraction private funds	aggregated fraction of different private funding sources	Survey (adapted)
annual amount public funds	aggregated amounts of different public funding sources	Survey (adapted)
annual amount private funds	aggregated amounts of different private funding sources	Survey (adapted)
annual budget own institution	amount of the budget available by the own institution	Survey
average application success rate public	aggregated and averaged fraction of positive funding decisions (public)	Survey (adapted)
average application success rate private	aggregated and averaged fraction of positive funding decisions (private)	Survey (adapted)
research strategy	0 if pure applied, 1 if applied-orientated, 2 if balanced, 3 if basic-orientated, 4 if pure basic	Survey (adapted)
gender (d)	0 if male, 1 if female	Survey
age		Survey
tenured (d)	0 if non-tenured, 1 if tenured	Survey (adapted)
position	1 if PhD, 2 if PostDoc, 3 if Researcher, 4 if Assistant Professor, 5 if Associative Professor, 6 if Full Professor	Survey
years from graduation		Survey
foreigner/national (d)	0 if national, 1 if foreigner	Survey (adapted)
work environment	sporadic, single or intergrated research	Survey
working time research	fraction of the working time spend on research	Survey
working time fund raising	fraction of the working time spend on fund raising	Survey
rated impact of external funding on career	assessed importance of external research funding on future career, 1 if no, 2 if marginal, 3 if yes	Survey
HDI growth	change in the Human Development Index from 2009 to 2010	Human Development Report
countries	Austria, Belgium, Brazil, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, UK, USA	Survey

Table 9: Multivariate determinants of public funding (detailed)

Characteristics	**(2)**	**(3)**	**(4)**
applied-oriented research	.1537**	.1646**	.1600**
	(2.17)	(2.37)	(2.36)
	[2.01]	[2.14]	[2.13]
balanced research	.0919	.1226*	.1201*
	(1.30)	(1.79)	(1.80)
	[1.21]	[1.64]	[1.65]
basic-oriented research	.1049	.1293*	.1170*
	(1.48)	(1.91)	(1.74)
	[1.40]	[1.74]	[1.56]
pure basic research	.0700	.0770	.0677
	(0.93)	(1.05)	(0.94)
	[0.90]	[0.99]	[0.85]
gender (d)	.0158		.0048
	(0.48)		(0.15)
	[0.45]		[0.15]
age	-.0025		-.0018
	(1.02)		(0.77)
	[0.96]		[0.66]
tenured (d)	.0173		.0049
	(0.41)		(0.12)
	[0.37]		[0.13]
foreigner/national (d)	.0178		.0476
	(0.50)		(1.34)
	[0.47]		[1.17]
position	.0201		.0187
	(1.15)		(1.07)
	[1.09]		[0.99]
years from graduation	.0315		.0308
	(1.19)		(1.23)
	[1.19]		[1.10]
annual budget own institution		4.37e-07	3.50e-07
		(0.69)	(0.57)
		[0.71]	[0.56]
work environment		-.0112	-.0094
		(0.43)	(0.35)
		[0.40]	[0.34]
working time research		-.0004	.0005

Characteristics	(2)	(3)	(4)
		(0.59)	(0.63)
		[0.56]	[0.60]
working time fund raising		.0041*	.0043*
		(1.67)	(1.73)
		[1.37]	[1.34]
average application success rate public		.0036***	.0033***
		(7.14)	(7.03)
		[5.75]	[5.64]
rated impact of external funding on career		-.0128	-.0002
		(0.62)	(0.01)
		[0.64]	[0.01]
HDI growth		.1357	.1151
		(1.01)	(0.79)
		[0.91]	[0.68]
Constant	.2626	-.4247	-2.202*
	(0.38)	(0.46)	(1.69)
	[0.36]	[0.44]	[1.62]
Observations	538	538	538
McFadden's R^2	0.039	0.143	0.181

(d) indicates dummy variables

Country dummies are included in (4).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

t-statistics based on Logit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

Table 10: Multivariate determinants of private funding (detailed)

Characteristics	(2)	(3)	(4)
applied-oriented research	- .1053	-.1220	-.1149
	(1.10)	(1.29)	(1.17)
	[1.03]	[1.20]	[0.99]
balanced research	-.2340**	-.2099**	-.2056**
	(2.48)	(2.26)	(2.16)
	[2.33]	[2.29]	[1.86]
basic-oriented research	-.2870***	-.2342***	-.2209**
	(3.08)	(2.61)	(2.33)
	[2.83]	[2.35]	[1.94]
pure basic research	-.1990*	-.2424**	-.2226**
	(1.91)	(2.36)	(2.11)
	[1.74]	[2.18]	[1.71]

Characteristics	**(2)**	**(3)**	**(4)**
gender (d)	.0659		.0192
	(1.02)		(0.31)
	[0.94]		[0.26]
age	.0017		.0018
	(0.35)		(0.41)
	[0.34]		[0.33]
tenured (d)	.0740		.0455
	(0.93)		(0.60)
	[0.89]		[0.50]
foreigner/national (d)	-.0501		-.0957
	(0.74)		(1.35)
	[0.70]		[1.15]
position	.0026		-.0379
	(0.08)		(1.10)
	[0.07]		[0.93]
years from graduation	.0144		.0047
	(0.28)		(0.10)
	[0.27]		[0.07]
annual budget own institution		1.46e-07	3.55e-07
		(0.35)	(0.37)
		[0.16]	[0.16]
work environment		-.0124	-.0173
		(0.25)	(0.32)
		[0.23]	[0.26]
working time research		-.0031**	-.0033**
		(2.30)	(2.15)
		[2.11]	[1.75]
working time fund raising		.0021	.0021
		(0.49)	(0.47)
		[0.44]	[0.42]
average application success rate private		.0040***	.0042***
		(6.86)	(6.62)
		[5.98]	[5.65]
rated impact of external funding on career		-.0332	-.0384
		(0.88)	(0.96)
		[0.90]	[0.81]
HDI growth		.5077	.4895
		(1.56)	(1.40)
		[1.47]	[1.23]

Characteristics	**(2)**	**(3)**	**(4)**
Constant	.8481	1.117	1.591
	(0.98)	(1.03)	(1.03)
	[0.94]	[0.98]	[0.87]
Observations	263	263	263
McFadden's R^2	0.046	0.153	0.167

(d) indicates dummy variables
Country dummies are included in (4).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Logit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

Table 11: Multivariate determinants of the fraction of public funds (detailed)

Characteristics	**(2)**	**(3)**	**(4)**
applied-oriented research	15.83**	16.51***	15.67***
	(2.47)	(2.80)	(2.63)
	[2.58]	[2.78]	[2.8]
balanced research	20.44***	21.24***	20.79***
	(3.39)	(3.79)	(3.67)
	[3.38]	[3.62]	[3.29]
basic-oriented research	18.01***	20.06***	18.69***
	(2.97)	(3.60)	(3.28)
	[2.92]	[3.40]	[2.89]
pure basic research	16.57***	16.52***	15.51***
	(2.57)	(2.77)	(2.58)
	[2.49]	[2.71]	[2.41]
gender (d)	3.218		-.4449
	(0.95)		(0.14)
	[0.92]		[0.13]
age	-.0152		.0766
	(0.06)		(0.32)
	[0.06]		[0.32]
tenured (d)	0.9637		-.4642
	(0.22)		(0.12)
	[0.22]		[0.12]
foreigner/national (d)	3.704		5.461
	(1.04)		(1.53)
	[1.04]		[1.42]
position	-.5746		-.0127

Characteristics	**(2)**	**(3)**	**(4)**
	(0.30)		(0.01)
	[0.27]		[0.01]
years from graduation	2.642		2.618
	(0.95)		(1.00)
	[0.92]		[1.02]
annual budget own institution		3.95e-06	-7.20e-07
		(0.21)	(0.04)
		[0.07]	[0.01]
work environment		-2.975	-2.915
		(1.18)	(1.11)
		[1.14]	[1.05]
working time research		.0849	.1394
		(1.10)	(1.64)
		[1.03]	[1.57]
working time fund raising		.4497**	.4644**
		(2.07)	(2.11)
		[1.84]	[1.91]
average application success rate public		.4113***	.4109***
		(9.87)	(9.82)
		[8.57]	[8.61]
rated impact of external funding on career		3.342*	3.444
		(1.69)	(1.63)
		[1.77]	[1.49]
HDI growth		16.26	17.27
		(1.25)	(1.27)
		[1.15]	[1.16]
Constant	24.92*	-15.64	-41.44**
	(1.76)	(1.00)	(2.00)
	[1.60]	[1.01]	[2.05]
Observations	538	538	538
McFadden's R^2	0.004	0.023	0.026

(d) indicates dummy variables

Country dummies are included in (4).

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

t-statistics based on Logit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

Table 12: Multivariate determinants of the fraction of private funds (detailed)

Characteristics	**(2)**	**(3)**	**(4)**
applied-oriented research	-16.38**	-19.21***	-19.03***
	(2.17)	(2.61)	(2.62)
	[2.13]	[2.42]	[2.26]
balanced research	-20.85***	-23.61***	-23.16***
	(2.88)	(3.30)	(3.28)
	[2.79]	[2.99]	[2.77]
basic-oriented research	-20.74***	-19.91***	-20.61***
	(2.87)	(2.80)	(2.89)
	[2.66]	[2.46]	[2.41]
pure basic research	-16.32**	- 21.12***	-20.04***
	(2.08)	(2.79)	(2.66)
	[2.06]	[2.46]	[2.25]
gender (d)	7.450**		5.360
	(2.07)		(1.55)
	[1.89]		[1.41]
age	.1479		.1855
	(0.56)		(0.73)
	[0.56]		[0.63]
tenured (d)	1.400		.1864
	(0.30)		(0.04)
	[0.29]		[0.04]
foreigner/national (d)	-4.075		-7.014*
	(1.04)		(1.66)
	[1.05]		[1.48]
position	-3.316*		-4.801**
	(1.69)		(2.44)
	[1.40]		[2.12]
years from graduation	1.937		1.446
	(0.67)		(0.52)
	[0.64]		[0.47]
annual budget own institution		-1.87e-05	-1.45e-05
		(1.22)	(0.95)
		[0.36]	[0.34]
work environment		-1.249	-.9721
		(0.44)	(0.33)
		[0.43]	[0.30]

Characteristics	(2)	(3)	(4)
working time research		-.0296	-.1270
´		(0.36)	(1.42)
		[0.32]	[1.30]
working time fund raising		.2817	.1377
		(1.14)	(0.55)
		[1.05]	[0.57]
average application success rate private		.2340***	.2560***
		(5.77)	(6.34)
		[5.73]	[5.91]
rated impact of external funding on career		-.1892	-.6405
		(0.09)	(0.28)
		[0.09]	[0.26]
HDI growth		10.81	5.648
		(0.58)	(0.29)
		[0.58]	[0.28]
Constant	39.08**	20.09	43.62*
	(2.46)	(1.06)	(1.68)
	[2.38]	[1.09]	[1.49]
Observations	263	263	263
McFadden's R^2	0.010	0.023	0.031

(d) indicates dummy variables
Country dummies are included in (4).
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Logit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

Table 13: Multivariate determinants of the relationship between public and private application success rates (detailed)

Characteristics	with control variables
average application success rate private	.2512***
	(5.03)
	[4.51]
applied-oriented research	-15.02*
	(1.94)
	[1.84]
balanced research	-17.41**
	(2.34)
	[2.12]
basic-oriented research	-13.46*

Characteristics	with control variables
	(1.81)
	[1.68]
pure basic research	-13.35*
	(1.66)
	[1.66]
gender (d)	.9598
	(0.22)
	[0.18]
age	-.0993
	(0.32)
	[0.30]
tenured (d)	4.693
	(0.85)
	[0.78]
foreigner/national (d)	6.567
	(1.27)
	[1.14]
position	2.791
	(1.14)
	[1.00]
years from graduation	-.5963
	(0.17)
	[0.17]
annual budget own institution	-1.14e-05
	(0.60)
	[0.26]
work environment	7.667**
	(2.13)
	[2.14]
working time research	.1606
´	(1.45)
	[1.42]
working time fund raising	.0125
	(0.04)
	[0.04]
rated impact of external funding on career	-2.791
	(0.99)
	[0.96]
HDI growth	-1.430

Characteristics	with control variables
	(0.06)
	[0.06]
Constant	17.11
	(0.69)
	[0.62]
Observations	250
McFadden's R^2	0.028

(d) indicates dummy variables
Country dummies are included.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Tobit standard errors are in parentheses; t-statistics based on bootstrapped standard errors are in brackets.

12.1 Robustness

As argued in Section 10.3 we now present the estimation results for the Logit and Tobit regression based on the subsample. Although the marginal effects exceed the ones estimated in Section 10.4, the algebraic sign as well as the levels of significance remain relatively stable.

Table 14: Test for endogeneity

Characteristics	acess to public funding	fraction of public funds
applied-oriented research	.2000*	22.90**
	(1.91)	(2.56)
balanced research	.1895*	30.55***
	(1.84)	(3.64)
basic-oriented research	.2053**	26.51***
	(2.04)	(3.10)
pure basic research	.2043*	26.30***
	(1.93)	(3.00)
Constant	.6705	-23.34
	(0.28)	(0.75)
Observations	228	259
McFadden's R^2	0.323	0.039

All control variables and country dummies are included.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
t-statistics based on Logit/Tobit standard errors are in parentheses.

Part III

Liberty, Equality, Fraternity? How accessible are Research Funds in Europe?

13 Introduction

As a result of the continued opening and coalescing of European countries, higher education systems have recently undergone wide-ranging transformations, imposing new challenges on academics and additional requirements in evaluating scientific researchers' performance. Today, international competition for research funds demands that academics have a large degree of cross-border labor mobility, well-conceived research and network strategies and, of course, considerable scientific output. Thus, academic success is no longer solely based on publications and citations but is also based on researchers' fundraising abilities and experience. However, are the conditions for prosperous external research funding the same throughout the European Research Area (ERA)? Furthermore, do all researchers face the same access to external funding, or do foreign researchers suffer from an unbalanced allocation of funding compared with their native-born colleagues, who may benefit from being better acquainted with local research systems, the native language and potential funding sources? Although we find a negative answer for the first question by highlighting the main differences between various funding systems in the ERA, we focus our attention on the second question in this study and must answer it in the negative also.

The issue of equal opportunity regarding the allocation of research funds is of vital significance not only because of our research questions but also because of the shortage of non-competitive public money. Specifically, as a result of political pressure (Maastricht criteria), the lack of competitiveness and the quest for recognition in the scientific community, a great number of European countries have reformed their funding systems and implemented a system of institutions to which funds are directly allocated to improve "the efficiency of research funds and increase the accountability of universities as well as the pressure to reduce their costs" (Muscio, Quaglione, and Vallanti, 2013, p. 64). These reforms have been constructed and conducted differently in different countries, but all are driven by similar general objectives, "which are promoting a contractual-oriented approach to university research funding, aimed at indirect control of the behavior of universities through the introduction of (quasi-market) financial incentive schemes"(Muscio, Quaglione, and Vallanti, 2013, p. 64). Moreover, sufficient and fairly allocated external

funding determines how attractive a country is to outstanding scholars, in addition to projecting its approach to science to the rest of the world. Therefore, a country should design its research environment and funding optimally.

In this study, we concentrate on the probabilities of external funding (and are not interested in the concrete amounts of financial support, which is frequently based on the needs of particular projects) to compare the chances of securing funding for foreign and national scholars in the social sciences. In doing so, we briefly examine the situation at the European level and find a significant discrepancy that is biased against foreign researchers. Scholars remaining in their home countries are up to 10.5% more likely to secure funding. This first result elicits so much interest that we wish to analyze whether it holds for all regions in the ERA or whether some of these regions manage this issue in a more balanced way. Indeed, clustering the countries into 4 groups (Western European; Northern European; Continental and Southern European; and Central, Eastern and Southeastern European) reveals substantial differences among countries. Whereas certain countries feature no discrimination against foreigners (such as the Western European countries), others place them at a competitive disadvantage for external funds (mainly the Continental and Southern European countries) to various degrees. This phenomenon is the result of the different organizational structures and development levels of higher education systems. Certainly, all countries in the ERA are making efforts to improve their competitiveness and openness, but they could and should "reform their research systems according to their own strengths and national specificities"[29] based on the diversity of their institutional paths and governance structures. Some states have already accomplished their objectives, whereas others are still pursuing their goals. At this point, we emphasize that we do not want these latter countries to feel pilloried. Instead, we wish to provide some political implications and learn from the best-performing countries. Therefore, we go into further detail by examining which group of foreigners is potentially most adversely affected (if indeed) and which group is treated equally compared with nationals. We placed foreigners into two groups: related countries (belonging to the same country group) and distant countries (from outside of the country grouping). Surprisingly, countries from different regions address the two groups of foreigners in markedly different ways. Western European countries disadvantage only distant foreigners in terms of private funding, and Northern European countries do the same with related foreign scholars as to public funding. Meanwhile, although the Central, Eastern and Southeastern European countries (CESE) show no discriminatory treatment in general, the Continental and Southern European group disadvantages both types of foreigners in terms of public funding. Therefore, both the Northern European and the Continental and Southern European groups must reconsider the role of public funding, which is the primary external funding source for social sciences.

We are able to showcase these remarkable results, which would not be possible without

[29] European Research Area Progress Report (2013).

the exceptional microdata on individual researchers provided by the Max Weber Programme. To the best of our knowledge, these microdata differ from those employed by earlier research in several ways. By conducting an econometric analysis based on the foreign status of researchers, we are the first to explore access to specific funding sources in different countries with data from active scholars. Moreover, this outstanding dataset allows us to compare the funding possibilities within the ERA through a cross-regional analysis. Moreover, precise consequences may be drawn due to the distinction between groups of foreigners. On the one hand, researchers themselves may consider carefully where to move and where to apply for external funding (depending on their nationality and country of residence). On the other hand, this approach encourages countries to think outside the box and improve their national conditions by learning from countries that perform better.

The remainder of the paper is organized as follows. Section 13.1 provides a short overview of the related literature, and in Section 13.2, we formulate our hypotheses on the allocation of research funding based on a description of the systems of exemplary countries. Section 14 presents the data description, the descriptive statistics and the methodology before we address the empirical results for the general European case and for the country clusters. Section 15 summarizes and elaborates the political implications of our research. We present the results of our robustness checks, including estimations based on an alternative clustering, are presented in Section 16.1.

13.1 Related Literature

My paper, which analyzes a specific characteristic, i.e., access to external research funding for foreign researchers, fills a void between two strands of literature. In one strand, much research has focused on academic mobility in general and in Europe, in particular. The other strand has examined systems of higher education and research funding.

The first strand, which focuses on the international mobility of researchers, is broadly discussed by Inzelt (2011), Ivancheva and Gourova (2011), Ackers (2009), and Grigolo, Lietaert, and Marimon (2010). In accordance with these studies, we infer that the mobility of researchers is increasingly important in Europe. This development is crucial ”as people convey knowledge between organisations and countries, brain circulation may lead to many positive effects on the speed and quality of knowledge transfer, and on the absorption of new knowledge”(Inzelt, 2011, p. 5). Correspondingly, Inzelt (2011) examines the flows of researchers from and to different countries and concludes that ”there are important differences among the EU27 Member States in their attractiveness for researchers”(Inzelt, 2011, p. 17). Furthermore, ”the intra-European flows dominate mobility in European countries”, whereas ”the process is still strongly characterised by westward mobility”(Inzelt, 2011, p. 17). Grigolo, Lietaert, and Marimon (2010) go one step

further and investigate the possible reasons for differentiated scientific mobility by examining salaries, career steps and working conditions. In contrast to these studies, we focus solely on whether a migration is associated with equal chances of successfully securing funding, which is a requirement for effective researchers. Grigolo, Lietaert, and Marimon (2010) find that there are 4 clusters of countries within Europe that are graded according to their attractiveness and openness to foreigners (Anglo-Saxon, Central and Eastern Europe, Continental, and Scandinavian).

In addition, there are several approaches that consider mobility within certain countries of the EU (see Ackers and Gill (2005), Baláž and Williams (2004), Mavroudi and Warren (2013), Okólski (2000), Okólski (2001), Pelizon (2002) Sretenova (2003)). However, because we are interested in comparing access to external funding among different regions, we do not go into detail regarding specific mobility within a country.

The second strand, which focuses on higher education systems and research funding, may be divided into 2 dimensions. First, there are political publications, mainly edited by the EU, that describe established systems and progress across Europe (see European Commission (2011), European Commission (2010), and van Dijk (2011)) and provide information on the general circumstances in various countries. In addition, there is other literature that examines certain European regions in greater detail, typically Central and Eastern European (CEE) countries (see Radosevic and Lepori (2009), and Lepori, Masso, Jablecka, Sima, and Ukrainski (2009)), with the objective of describing the transformation of research funding systems since the breakdown of socialism. Other scientific papers also consider and analyze research funding. Lepori (2011) compares project funding, vertically integrated funding and core funding in higher education systems and in public research laboratories in a general setting. By highlighting the strengths and weaknesses of different systems, he develops propositions based on "the conditions under which funding systems can be expected to perform well"(Lepori, 2011, p. 366) and proposes an identification and examination of weaknesses in existing funding portfolios and instruments instead of establishing completely new systems and concludes that "the existence of stable institutions and expectations on the future is critical for the development of actors' strategies and thus make a case for a progressive rather than for a radical approach to funding system's reforms"(Lepori, 2011, p. 365). Whereas Lepori (2011) focuses on public research funds, Muscio, Quaglione, and Vallanti (2013) examine the relationship between public and private research funding and find that they are strategically complementary such that "public funding can play an important role in stimulating those university-industry interactions"(Muscio, Quaglione, and Vallanti, 2013, p. 73). This conjecture is consistent with our previous paper (Friedrici and Hakenes (2014a)) and is another reason to urgently consider foreigners' chances of being funded.

Several studies in the previous literature employ methods that resemble our approach and arrive at similar general results. Auranen and Nieminen (2010) find significant country-specific differences among European and Asian-Pacific funding environments and do so by distinguishing between input- and output-oriented funding systems. In addition, they

establish a connection to publication output and demonstrate that a competitive funding system (such as that in the UK) appears to increase research activity. This type of performance-based funding system is also theoretically analyzed by Geuna and Martin (2003), who compare costs and benefits and are convinced that the former most likely exceed the latter over time and that a hybrid system that is based on performance and educational size[30] appears to be a promising alternative. However, Mariathasan and Marimon (2011) and Ivancheva and Gourova (2011), both based on surveys, likewise find substantial differences in the allocation of research funds in the ERA: "Unfortunately, the national actions did not create a homogenous environment and researchers face various problems when moving between countries"(Ivancheva and Gourova, 2011, p. 196), particularly with respect to research funding. Nonetheless, the previous research does not analyze concrete differences in the access to public and private research funding experienced by foreign scholars compared with national scholars.

13.2 Theoretical Background and Motivation

As Europe continues to coalesce and mobility within member states continues to increase, new challenges that have previously not existed at this level must be confronted. As a result of blurring boundaries, Europeans are freer to decide where to work and where to live. This condition affects researchers, in particular, who historically have been more flexible than other occupation groups. However, this blurring of boundaries also begs the question as to whether foreign researchers have the same access to work as their native colleagues who may be more familiar with local systems, are native speakers of the local language and who tend to have better professional connections in their native country. In this regard, we emphasize that we do not discuss Europe sensu stricto; instead, we are focused on the ERA. This region is defined as a "unified research area open to the world based on the Internal Market, in which researchers, scientific knowledge and technology circulate freely and through which the Union and its Member States strengthen their scientific and technological bases, their competitiveness and their capacity to collectively address grand challenges"[31]. In defiance of this characterization and due to the great diversity of countries, requirements and circumstances for researchers, we assume that the unification is not yet completed. Existing research systems vary widely from one another and require researchers from abroad to acquire a taste for the specific situation in the new country more or less intensively. Therefore, before mastering with the local and national political structures, bureaucracies and possible funding sources, the research professions generally must scale a learning curve. Above all, this condition might become conspicuous if external research funding is considered. Therefore, we formulate our hypothesis 1 as follows:

[30] This type of system has been implemented in the Scandinavian countries.

[31] European Research Area Progress Report (2013).

H1: Foreigners in the ERA have more problems than nationals in securing access to external funding.

As discussed above, we observe a wide range of political and economic differences among countries in the ERA. Consequently, the higher education sector is heterogeneous in this region, and conditions for researchers must be considered and evaluated not as a general matter but on a country-by-country basis. we address this need by describing the higher education systems, beginning with those systems in the United Kingdom[32].

The UK higher education system, which has been adapted by, for instance, Ireland and the Netherlands, is characterized by having the largest and fastest-growing R&D budgets (together with Continental Europe) and the largest amounts of foreign funds. In addition, the UK has the highest degree of competition and openness to external researchers because of the frequent and transparent ex ante and ex post evaluation procedures, in addition to unfettered and transparent recruitment procedures. Because foreign researchers at all levels are understood as representing the primary driver of the dynamic culture of the UK at its higher education institutions, the UK shows the highest rate of academic staff from abroad within the EU. These scholars and their colleagues from the UK enjoy advantages in their academic flexibility, high-quality administration and freedom from teaching responsibilities. These benefits offer researchers a sharper focus and more time to spend on research. Consequently, these benefits are reflected in the amount and quality of scientific performance at UK institutions of higher education, which is internationally outstanding and leads the ERA. Moreover, the liberalization process over the last 20 years has engendered a progressive salary tariff that incentivizes researchers to engage in even more research and to remain within the scientific system. Specifically, salaries are relatively low at entry positions and increase over the span of an academic career, and foreign researchers have greater access to high positions than in other countries because of few informal agreements and rules. Likewise, the structure of funding opportunities enables success. There is a great variety of independent funding agencies that allocate financial support for specific purposes at different career stages. In particular, programs for young researchers are open to everyone and foreign scholars are inducted into the academic system at early stages.

The Danish scheme, which is also implemented in Sweden and Norway, is typically open, competitive and meritocratic. Job advertisements are published internationally, local institutional structures augment an advantageous and efficient research environment and the funding system is formally open. Nonetheless, this scheme is characterized by informal rules. Vacant positions are regularly filled with either familiar researchers or scholars already employed by the university. Therefore, external and foreign researchers are seldom engaged, and the researcher mobility is moderate. Similarly, academic careers are frequently managed through informal agreements. Therefore, there is a low likelihood for external and foreign researchers to successfully pursue long-term careers. In addition,

[32]For further details, see Marimon (2008).

language barriers may aggravate access to the regime and to universities themselves because there are teaching obligations, and these classes are held in the native language. Researchers must perform teaching tasks that demand as much time as research itself; in addition, many positions (including tenure-track positions) are primarily temporary. However, as in the case of the UK, there are many independent funding agencies. These agencies implement their objectives independently and are transparent and competitive. Meanwhile, funding itself is mainly constructed in a centralized manner, and the government prescribes the major targets through a general research agenda. In summary, the Danish system shows both open and restricted elements, but the system plans on being more open in the future. To a greater degree, current research structures are expected to be enhanced through reforms in research strategies and more funding. In addition, the international qualification of young researchers will be supported through facilely obtainable funding to grant recognition for scientific outcomes.

Continental Europe consists of highly heterogeneous higher education systems, but all these systems share a relatively inner-oriented strategy and a high level of centralization as a result of much formalization. However, informal rules, as emphasized by Grigolo, Lietaert, and Marimon (2010), also dominated de facto the recruitment procedures such that vacancies are frequently filled with known colleagues, and external and non-national researchers face considerably lower chances of employment. Analogously, academic careers are dominated by seniority rules and determined by positive assessments of scientific output. In addition, job advertisements are either published in the native language or not at all. Therefore, countries such as France, Germany, Italy and Spain obstruct foreign scholars' access to their academic systems. Moreover, the incentive design is not well elaborated; in particular, young researchers suffer from low salaries and are thus only weakly encouraged to increase the quantity and quality of their output and their visibility in the academic world. The primary funding sources and researchers' decision making are somewhat less independent because of ex ante evaluation schemes that involve senior researchers from the same country, which indicates that the allocation of funds may not correspond to scientific performance or the value of research. In addition, foreign funds appear to be decreasing. With these conditions in mind, it is clear that the system is not particularly meritocratic and relatively closed to international competitors. However, as argued at the beginning of this paragraph, there is a great diversity among the Continental European countries with respect to how closed they are. In the recent past, France, Germany and Spain have reformed their systems at different levels to foster more competitiveness, flexibility and openness.

Poland belongs to a group of countries that is even more heterogeneous than the Continental European cluster, i.e., the CEE countries. Nonetheless, these countries have several common attributes such as small research budgets, low wages and funding amounts and thus limited competitiveness, in addition to historically authoritarian Soviet academic structures. This cluster is endeavoring to reform its systems into more flexible, liberal and competitive academic environments to attempt to reduce the brain drain into Western

European countries. Therefore, these countries have adapted their curricula to international standards, changed the configuration of their universities, increased international networking and downsized administrative and teaching staffs. The private higher education systems in these countries in fact have superior administrative structures compared with those of other countries within the ERA, and research relies heavily on private funding. However, these countries face a range of problems. The issues of informal rules, non-transparency, language barriers and issues with openness and external evaluation are even more prevalent than in their neighboring countries to the West. As a result, foreign researchers' access to the systems is substantially afflicted in spite of the fact that Poland and other countries are taking auspicious measures.

This short overview of the main characteristics of selected countries urges us to distinguish carefully between these groups of countries. National public funding is the major source of funding, particularly in the UK and in Continental European countries, whereas private funding is becoming increasingly prominent in the CEE countries. Salaries vary substantially, and some countries (such as Denmark, Germany, Norway and Spain) are able to attract more promising junior scientific staff than others. These countries feature a high share of young researchers, whereas only a few foreign full professors are employed. Conversely, Switzerland and the CEE countries feature a greater number of foreign full professors and smaller numbers of foreign junior researchers. Accordingly, we derive our next hypothesis by assuming that an open higher education system comes along with balanced funding probabilities:

H2: Countries with an open higher education system tend to have a more balanced allocation of research funds between national and foreign scholars than countries with closed higher education systems.

As discussed above, the systems and research environments within the ERA are heterogeneous. We suspect that successfully integrating scholars into a new research environment is sharply affected by differences between the well-known home system and the system in the country of residence. Thus, we use the example of an English researcher moving to Croatia, who comes from an open system with efficiently constructed funding schemes, no teaching obligations, high-quality administration and high salaries. He neither speaks the local language nor has any points of contact in his new system, which is substantially different from his own. It would most likely take a long time for him to learn about funding opportunities, to pursue local networking and to accustom himself to teaching and to his administrative tasks (even more so if they are conducted in the local language). In contradistinction to this example, we can examine the same researcher immigrating to Ireland. He then knows the language and will find many similarities with respect to the academic structures in his home country. The administrative standard is identical, as is his teaching flexibility and the language. Accordingly, the integration process should not be difficult. Ultimately he should cope with the system much better than would in the Croatian case. Thus, we obtain our third hypothesis:

H3: A greater distance between the configuration of the higher education systems in the home country and the country of residence implies that access to external funding will be more problematic.

In the course of this work, we will repeatedly make reference to and reassess these hypotheses.

14 Empirical Analysis

14.1 Data Source and Description

The three surveys conducted by the Academic Careers Observatory of the Max Weber Programme in the years 2010 and 2011 serve as the basis for our empirical analysis. At that time, economists, sociologists and political scientists residing in over 50 countries were separately requested to complete an online questionnaire concerning research funding in the social sciences in Europe. The objective was to learn about their funding experiences.

My main concern is with the probability of successfully being externally funded. Therefore, we created new variables using the data from the survey; we were not interested in the concrete amounts of the financial support. Instead, we focused on whether a researcher secures funding. Therefore, we created a dummy variable and assigned the value 1 to all researchers who indicated either a positive amount of the annual budget or a positive fraction of funds stemming from external funding sources. To all other researchers, we assigned 0. In addition, we distinguished between public and private funding. In the same manner, we managed the particular funding sources, including funds from national and regional institutions, the European Research Council and the Framework Programme with respect to public funding and national and regional firms and firms awarding prizes and conducting consultancy contracts regarding private funding. If a researcher stated, for example, that he/she secured a positive fraction of funds allocated by a national public institution, he obtains 1 and 0 otherwise. The overall and single characteristics, interpreted as success probabilities, have each finally been accumulated and separated into the funding probabilities for nationals and foreigners[33].

In addition to information about individual funding, the multiscientific dataset also gathers personal and institutional characteristics. More precisely, the researchers were exempli gratia asked to provide their age, gender, position, employer, department, the allocation of their working time and the years that have elapsed since they received their highest

[33]We did not use the variables "Application Success Rate" given in the survey because there were too few answers given.

degree. We interpreted the last as academic age and assume that this measure is more important than "true" age. Therefore, we substitute the first for the second. The variables "employer" and "position" have been modified. Because we are primarily interested in the academic sector, we only included universities and research institutes[34] into our estimations and omit private organizations, governments and central banks (which represent only 7% of the participants). For purposes of our research questions, we believe that the nature of employment is crucial. Therefore, we split "position" by using non-tenured (0) and tenured as characteristics (1). On a related note, the most important individual variable is foreign status. We used information on the 70 different nationalities and countries of residence to compare both. If they coincide, the researcher is classified as being a national; if not, he is a foreigner. Similarly, we classified "soft" and "distant" foreigners. If nationality and residence are identical, we denote the researcher as being national; if the researcher is non-national but from a country belonging to the same cluster, he is a "soft" foreigner and otherwise is a "distant" foreigner.

Furthermore, we included a set of national-level variables to control for country-specific conditions and to conduct an alternative classification of countries[35] in addition to the regional clustering[36]. Namely, these are the H-Index, the net yearly remuneration averages as measured by Purchasing Power Standard (PPS), the gross domestic expenditure on R&D (GERD) as a percentage of GDP, and the affinity of the national language as related to English, which is commonly considered the scientific language. The H-Index and the GERD are implicitly integrated in the estimations, whereas all of these measures are used to generate the alternative country groups.

We now want to describe the applied key figures in detail. Therefore, we begin with the H-Index, which is an index that measures the efficiency and relevance of a researcher's published work. This index is based on the most cited papers and the amount of citations that they have received in other publications (such as books, reports, etc.). Thus, a researcher with an index of x has published x papers, and all of these papers have been cited in other journals at least x times. Instead of using this individual index, we apply it in a country setting. This approach is driven by the lack of information (we do not have information on the personal H-Index of the participants of the survey, so we entrusted the country H-Indices to the countries of residence). The second national measure we employed is the set of net yearly remuneration averages based on PPS, which represents the rate of exchange that accounts for price differences across countries, that is transformed into a standardized form with the EU region as a base[37]. The third feature is the rather structurally political GERD as a percentage of GDP[38]. Finally, we included the affin-

[34] Such institutions are the second most important employer for research economists (see Research Funding for Economics in Europe).

[35] This classification may be found in the Appendix.

[36] See Section 14.2.1.

[37] Marimon (2008).

[38] This information is collected from the databases of Eurostat, the OECD and the World Bank.

ity of native languages related to English with the aid of the Maximum clade credibility tree. In the survey, we find 4 linguistic families: Caucasian, Afroasiatic, Uralic and Indo-European. The Uralic is itself split into 3 groups (Finnish, Estonian and Hungarian), and Indo-European is split into 4 groups (Germanic, Italic, Balto-Slavic and Hellenic).

We constrained our analysis to the researchers who applied for external funding (except for the means of consultancy contracts, which do not require an application) to ensure that we depict the real differences between nationals and foreigners. To further ascertain this finding, we only included scholars who received any funding and/or stated that they applied for funds during the last 10 years and/or did not answer that they never applied for funding in relation to the question how long they needed to apply for funding. Again, we accomplish this finding for every specific funding source just as with the general case of public and private funding. Moreover, all of the participants are either high-quality economists, sociologists or political scientists[39]. Through the determination of this quality, an exacting comparability is guaranteed.

Finally, we seek and correct any inconsistences (e.g., total working time not amounting to 100%).

A detailed description of the dataset is showcased in the Section 16.

14.2 Descriptive Statistics

To test our hypotheses, we use a wide range of variables requested in the survey as our variables of interest, such as the particular funding probabilities and the foreigner variable, as one group, and we involved a set of explanatory variables as another grouping, which may be categorized into 3 smaller groups: the indicators of individual characteristics of the researchers, work- or experience-related characteristics and countrywide information. All of these variables and their main features are presented in Table 15.

In short, the variables of interest and the dependent variables are public funding and private funding. In addition, we take a closer look at the sponsors who finance research externally, such as national and regional institutions, the European Research Council, and national and regional firms. We must note that we do not have any information on funding schemes and include all research funds unconditionally.

At first glance, we find great variations between the features of the secured funds. Whereas the probability of public funding in general is on average approximately 80 %, private funding accounts for only 40 %. Upon a closer examination of the different funding sources, certain significant differences are obvious. Within the public sponsor group, the probability of being funded by the European Research Council accounts for only 5%,

[39]This determination is based on RePEc (Repository of Papers in Economics) and ISI Web of Knowledge.

Table 15: Descriptive Statistics on the survey respondents

Variable	Obs	Mean	Std. Dev.	Min	Max	t-test
public funding (d)	1601	.80	.40	0	1	3.94***
public funding national (d)	1599	.68	.47	0	1	4.72***
public funding regional (d)	1594	.16	.37	0	1	4.45***
public funding ERC (d)	1592	.05	.21	0	1	0.36
public funding FP (d)	1593	.22	.41	0	1	0.34
private funding (d)	1597	.40	.49	0	1	3.29***
private funding national (d)	1596	.19	.39	0	1	2.24**
private funding regional (d)	1593	.04	.21	0	1	1.69*
private funding prizes (d)	1592	.06	.24	0	1	0.49
private funding consultancy (d)	1593	.20	.40	0	1	2.61***
foreigner/national (d)	3539	.26	.44	0	1	
gender (d)	3539	.33	.47	0	1	
years from graduation	3360	3.11	1.30	1	5	
tenured (d)	3539	.42	.49	0	1	
position	3539	5.50	2.34	1	8	
department	3539	1.55	.77	1	3	
employer university (d)	3539	.81	.39	0	1	
employer research institute (d)	3539	.12	.33	0	1	
work environment	3539	2.51	.71	0	3	
working time research	3539	49.24	22.17	0	100	
working time fund raising	3539	5.10	6.88	0	70	
EEA/ESA/ECPR membership (d)	3539	.68	.47	0	1	
H-Index (c)	34	289.29	202.36	53	802	
affinity of native language (c)	34	1.85	1.46	0	5	
net yearly remuneration (PPS) (c)	30	23775.13	8456.14	9801	46432	
GERD (c)	34	1.57	.98	.22	3.87	

(c) indicates country wide information

(d) indicates dummy variables

We test, whether the mean of the funding probabilities differs between foreigners and nationals.

t-statistics are displayed, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

whereas national funds are offered at a probability of 68 % on average. Similarly, the probability of being privately funded by regional institutions (4%) differs substantially from the probability of securing funding from a consultancy (20%). However, these disparities do not appear only between funding sponsors. Indeed, through a mean comparison test (t-test), we find significant differences in the allocation of funds between foreigners and nationals. In this univariate attempt, general public funding, general national and regional public funding and general private funding, national and regional private funding and funding from consultancies are moderate to highly unbalanced. This finding is consistent with our hypothesis 1 and thus requires further examination in a multivariate setting to exclude any bias, which is conducted in the following sections.

For our approach, we focus specifically on the individual feature if the researcher is a national or foreigner in his state of residence. As appears from Table 15, the European countries examined show an average proportion of 26% of foreign researchers, whereas there is wide variation among individual countries. This foreigner variable is essential to all our research questions.

The individual information is split into gender (33% of the researchers are female) and academic age (on average between 5 and 9 years[40]). The work-related characteristics considered are, e.g., the time spent on research, which accounts on average for 49% and the time applied to research funding, which is only 5% of the entire working time. Most of the participants (81%) are employed at universities, whereas almost all of the rest (12%) are salaried at research institutes. Approximately 61% are either assistant, associate or full professors, whereas only 42% are tenured. The majority conduct integrated research[41]. Approximately 62% of the researchers are located in economics departments, whereas the remaining researchers are split almost evenly between sociology and political science. Finally, 68% are members of either the European Economic Association (EEA), the European Sociological Association (ESA) or the European Consortium for Political Research (ECPR).

In addition, we included such country-level features as the H-Index, the net yearly remuneration averages as measured by PPS, the GERD as a percentage of GDP and the affinity of languages to English. Within the ERA, the medium share of financial support to R&D amounts to 1.57% of the particular GDP. On average, the H-Index is approximately 289, and the average researcher has yearly $23,775$ euros at his disposal. The number of countries with a distant affinity with English is relatively large, which is why the average language index is only 1.85 (distance is measured from 0 to 5).

14.2.1 Clustering of countries

With regard to our hypothesis 2, we wish to show that some countries treat foreign researchers less favorably when external funds are allocated than others. In this way, we assume that there is a relation between the openness of a higher education system and access to external funding. However, what is meant by "open"? Certainly there are many possible starting points. The authors of the survey, Marimon, Guardiancich, Mariathasan, and Rossi (2011), rely on the key figures presented by Lietaert and Marimon (2009) and are revisited in Section 13.2. The authors show that the mobility of researchers (and thus openness to foreign researchers) depends on academic salary, recruitment procedures, promotion along the career ladder and funding conditions.

[40] Academic age is characterized in intervals.

[41] the given value 2.51 reflects this behavior.

The authors find evidence that there are as many as four systems in the ERA: the Anglo-Saxon, the Continental, the Scandinavian and the CEE systems. Lietaert and Marimon (2009) argue that among these systems, the Anglo-Saxon system is the most open to foreign scholars and thus stands in stark contrast to the Continental system and (in part) to the Scandinavian system. This proposal is based on the fact that the Anglo-Saxon model attracts foreign researchers and creates enormous scientific output, whereas the Continental and Scandinavian models are characterized by relatively restricted openness. According to Lietaert and Marimon (2009), this phenomenon affects performance-oriented evaluations and thus international competition. Because of the region's recent past and its different academic tradition, CEE countries must cope with brain drain to the West. To prevent further scientific migration, these countries themselves are becoming more dynamic and competitive.

Although the argumentation of Lietaert and Marimon (2009) is clear, we use a regional grouping. The reason for this clustering is the assumption that neighboring countries tend to have similar systemic conditions and develop in the same direction (such as the CEE countries). By deduction, we also grouped countries into four clusters with slightly refined distinctions compared with Lietaert and Marimon (2009).

- The Western European group includes Ireland, the Netherlands and the United Kingdom.
- The Northern European group consists of Denmark, Finland, Iceland, Norway and Sweden, which is consistent with Lietaert and Marimon (2009).
- The Continental and Southern European region represents the major cluster and contains Austria, Belgium, France, Germany, Italy, Malta, Portugal, Spain and Switzerland.
- The last group is the Central, Eastern and Southeastern European countries (CESE), which consists of Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Georgia, Greece, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, and Ukraine.

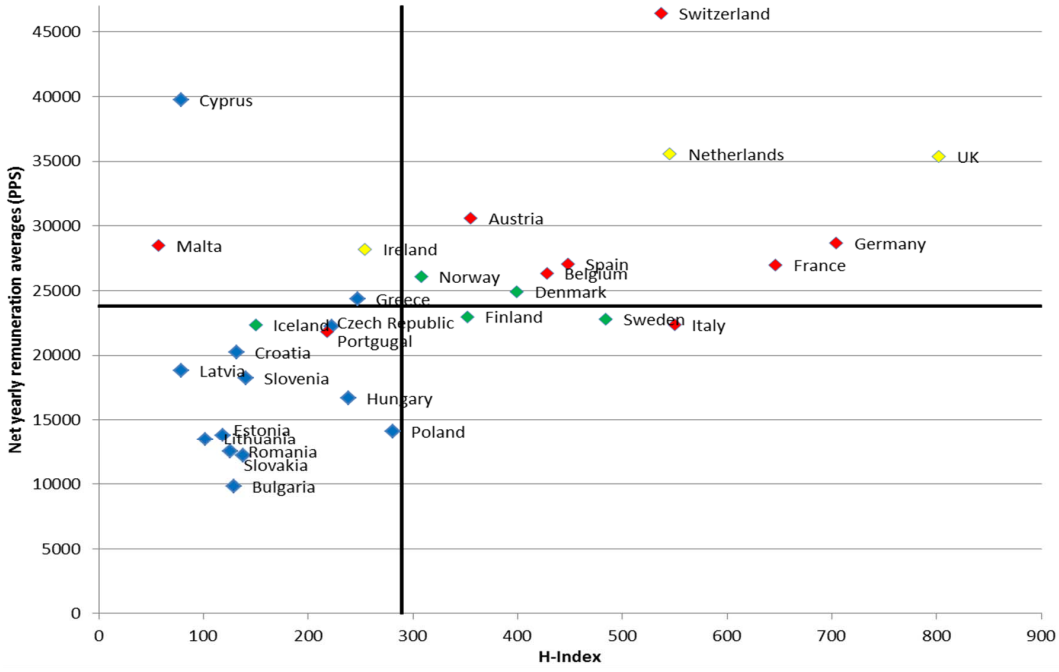
As discussed above, the regional clustering is based on the assumption that adjacent countries feature similar systematic requirements. Nevertheless, it is possible that there are differences regarding research environments and how financial support of research is addressed even when there is surface resemblance. Like Lietaert and Marimon (2009), we suppose that "international openness and integration of research are tightly connected to the attitudes toward funding opportunities of researchers in a particular country"[42]. Although we assume that individual openness and attractiveness act as indicators for balanced funding probabilities and vice versa, we construct another clustering-not based on

[42]The authors even find evidence for that relation exists.

regional figures but corresponding to the each country's accessibility to research funding. We take this alternative approach because we wish to validate our results and guess that there are certain features depicting the indicator. These key figures are the H-Index, the net yearly remuneration averages as measured by PPS, GERD as a percentage of GDP, and the affinity of languages to English. In addition, we involve the number of scientific workers in a country in proportion to published articles. All of the indices used are premised on country levels because of the lack of individual-level information.

We now wish to provide rationales for the used key figures and, after discussing them thoroughly, we examine whether an alternative clustering has some influence on the expected effects[43]. As argued in Section 14.1, the H-Index is an improvement on or at least alternative to, established journal impact factor measures to evaluate a researcher's work. It is the most important key figure for the grouping of our units. we use it in all graphics presented hereafter. We reason that countries with a higher H-Index are more competitive and thus attract more foreign researchers. The second measure we employ is the net yearly remuneration averages based on PPS. Following this logic, we assume that countries with a high net yearly remuneration average are considered attractive.

Figure 15: Net yearly remuneration averages (PPS)



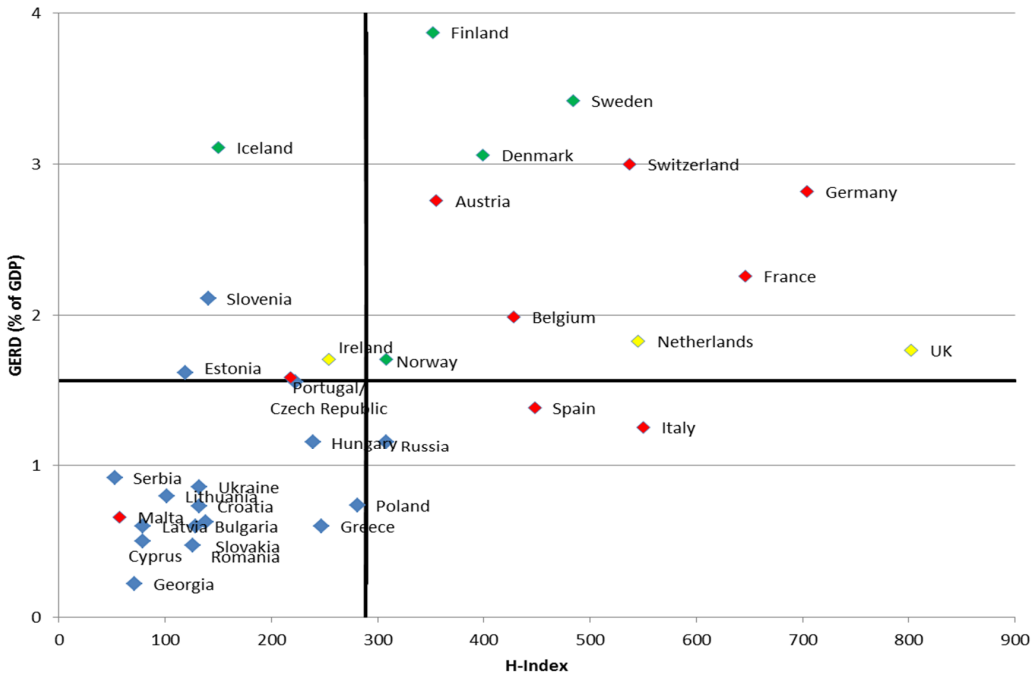
In Figure 15 great differences between countries are obvious. Because most of the Central and Southeastern European countries are below the average of both key figures, the

[43]This question is addressed in the Robustness Section (see the Appendix).

remainder of the other countries are mostly above them. This finding suggests that the remunerations and, equally, the H-Indices are small in this group. Therefore, we assume that they are less attractive and open than the rest. With the exception of Finland, Iceland, Ireland, Italy, Malta, Portugal and Sweden, all other residual countries exhibit a higher-than-average H-Index and above-average remuneration. Iceland and Portugal are similar to the CESE countries in that they are below average in both measures. Finland, Italy and Sweden show comparatively low remuneration averages, and Ireland and Malta have comparatively low H-Indexes.

In considering the attractiveness of a country, we also include political parameters. We decided to use the structural measure GERD as a percentage of GDP in the year the survey was conducted (2010)[44]. We suppose that this finding is indicative of attractiveness even for foreign researchers. Therefore, a higher fraction invested in R&D implies better underlying monetary circumstances. This treatment is presented in Figure 16.

Figure 16: GERD (as % of GDP)



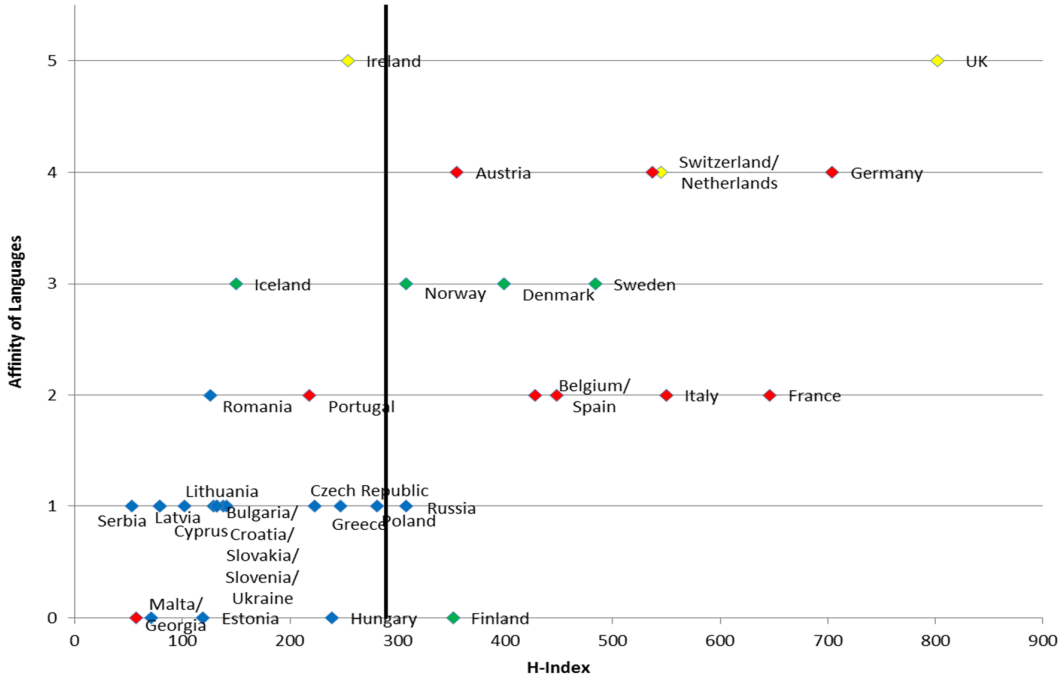
Indeed, the countries under consideration vary widely. The northern countries, except Norway, show the highest shares of investment (approximately 3.4%) and the CESE countries the lowest (on average 0.9%). Malta and Portugal are also in this group. The highest-ranking country in the CESE countries is Slovenia with a share of 2.11%. The Continental

[44]Unfortunately, Georgian, Greek, Icelandic, Serbian and Ukrainian data are only available for the years 2005, 2007 and 2009.

and Southern European countries remain more or less closely behind the Northern European countries, although Spain and Italy are in fact substandard in terms of GERD. The remainder of countries in the Continental and Southern European countries show approximately average levels of GERD.

Finally, we closely examine the affinity of native languages related to the generally accepted scientific language, English (see Figure 17). We suppose that a closer affinity to English might facilitate mobility, access to other academic systems and funding sources as a consequence. Therefore, we match the H-Index and the affinity of languages to identify which nationalities make it easier to change residence and which might make such a change more difficult.

Figure 17: Affinity of native languages



Using the Maximum Clade Credibility Tree, we classify the relation of languages to English from 0 to 5, as shown in Figure 15[45]. 0 corresponds to the languages that are furthest from English, which are the Uralic, Afroasiatic and Caucasian languages. All other languages are Indo-European languages but are related to English to different degrees. Within the Indo-European linguistic family, Greek and the Balto-Slavic languages are the least related to English and are thus classified as 1. The Italic linguistic family is classified as 2[46]. With the Northern European languages, we enter in the Germanic linguistic

[45] An overview of the accurate classification of languages is provided in Section 16.

[46] We here included Belgium because Dutch and French are almost pari passu. We could even put Belgium in the West Germanic group. In the end, it is indiscriminative either for grouping or for our results.

family and encoded them as 3. A minor group are the West Germanic languages, to which English belongs[47]. The last class, assessed as 4, covers the Old High German languages, which are vernacularly also spoken in Switzerland[48]. Recapitulating the relation between the H-Index and the affinity of the native language to English, an interesting observation may be made. We could draw a notional line at an angle of 45 degrees. Thus, a closer linguistic distance to English, which might be indicative of affinity, appears to be linked to a higher H-Index.

Conclusively, we may declare that the regional clustering should be an efficient method to prove our second hypothesis that there are some countries that display similar degrees of openness and attractiveness with regarding external funding and thus vary significantly from other countries, which in turn are relatively similar. In addition, we find some outliers that do not appear to fit in their group. For this reason, we provide an alternative clustering, which is considered in Section 16, where we compute the effects of foreign status on the accessibility of external funding in 4 slightly different groupings based on the key figures presented, which are the following:

- The new Western European Group, including the Netherlands, Switzerland and the United Kingdom, with high H-Indices, net yearly remuneration averages and affinity with the English language and above-average GERD.
- The new Northern European Group, including Austria, Belgium, Denmark, Finland, Iceland, Ireland, Norway and Sweden. All of these countries are characterized by medium remuneration averages, moderate H-Indices, a moderate to high affinity with the English language and a medium to very high GERD.
- The new Continental and Southern European Group, which contains France, Germany, Italy and Spain. These countries have average features in almost all disciplines. Only with regard to the H-Index are these countries relatively high. Admittedly, Germany features a comparatively high GERD and affinity with English, but in general, it harmonizes with the other countries in this grouping.
- In the new Central, Eastern and Southeastern European group are again all the CESE countries (Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Ukraine) in addition to Malta and Portugal. These countries are distinguished by low remuneration averages, a low H-Index, little affinity of the native language to English and small GERD fractions (except for Slovenia, as discussed above).

[47] Here, the UK and Ireland are rated at 5 because, in addition to Irish Gaelic, which is a Celtic language, the Irish speak English fluently and use it in their everyday lives.

[48] Approximately two out of three Swiss, thus the large majority, are native German speakers.

14.3 Methodology and empirical specifications

Utilizing this approach, we wish to estimate the parameters of the interscientific accessibility of different funding sources and funding in general to foreign researchers compared with national researchers. This approach is based on the idea that there might be barriers that prevent foreign researchers from immigrating or residing in specific countries with the result that these countries are believed to be closed. It is our aim to identify these countries and identify those that are improving in this regard. In the course of this study, we distinguish between public and private funding (the fact if a researcher obtains any funds at all), and we closely examine sponsors themselves to determine which of these tends to have an unbalanced allocation result.

First, we assess whether the fact of being a foreigner influences access to public and private research funding at all and to the various sources of external funding (hypothesis 1). Consistent with our hypothesis 2, we perform approximately the same assessment for each of our defined country groups. Ultimately, we examine whether all foreign researchers are treated as equals or whether foreigners coming from similar countries are at an advantage or disadvantage relative to researchers coming from distant countries (hypothesis 3).

Hereinafter, the tables featuring no significant effects are shown in Section 16, as is a validation of our results by dint of an alternative clustering based on the presented key figures.

14.4 Empirical results

14.4.1 Accessibility of external funds in Europe

As outlined above, we first closely examine funding in Europe in general. In detail, we investigate whether the fact of being a foreign researcher in the country of residence influences the possibility of funding. Given the binary nature of the dependent variables, we use a Logit regression to predict whether there is a link[49].

Table 16 reports the estimation results for the Logit model with public funding in general and the different sources of public funding as the dependent variables. Column (1) refers to the estimation of public funds in general, column (2) refers to funding from national institutions, column (3) to regional sponsors, column (4) to funds granted by the European Research Council (except for the Framework Programmes) and column (5) to Framework Programme funds. Note that the marginal effects and the z-statistic based on robust standard errors (in parentheses) to account for heteroskedasticity are presented. We run three regressions on each dependent variable. The first includes estimation without any control

[49]The results are also robust if we use a Probit model. These results are available upon request.

Table 16: Europe (public)

Foreigner/National	**funding public**	**funding public national**	**funding public regional**	**funding ERC**	**funding FP**
No controls					
Margins	-.0868***	-.1231***	-.1432***	-.0061	-.0098
z-value	(3.94)	(4.77)	(4.36)	(0.36)	(0.34)
N	1535	1509	1198	1144	1289
R-squared	0.010	0.011	0.018	0.0002	0.0001
Country dummies					
Margins	-.0770***	-.1301***	-.1303***	.0041	.0144
z-value	(3.14)	(4.69)	(4.02)	(0.20)	(0.47)
N	1505	1487	1175	1011	1287
R-squared	0.044	0.054	0.110	0.044	0.042
All controls					
Margins	-.0428*	-.0896***	-.1053***	.0071	.0464
z-value	(1.67)	(3.02)	(3.09)	(0.32)	(1.48)
N	1451	1434	1130	977	1242
R-squared	0.122	0.090	0.137	0.099	0.082

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

variables, the second includes country dummies, and the last merges all country dummies and control variables.

Evidently, there is indeed some general disadvantage for foreign researchers seeking to obtain public funds. The probability of funding is significantly lower for such researchers (approximately 4.3%) if we control for all countries and possible influencing factors. We suppose the reason why the significance level is strongly decreasing if control variables are included primarily results from heterogeneity between the funding framework conditions in the countries under examination. Therefore, we will more closely examine the groupings and analyze which countries drive this effect in Section 14.4.2.

The individual funding of institutions differs widely with respect to the allocation of their resources. At the national and regional levels, the probability of a foreign researcher obtaining funds is approximately 9.0%, which is 10.5% lower than for nationals. In reference to the extent of disadvantage, we regret to say that both values are economically and statistically significant (at the 1% level).

At the European level, we observe the opposite effect. The funds stemming from the European Research Council and from the Framework Programme are provided without discrimination and show tendentially positive marginal effects. In other words, a researcher from abroad does not fear that he will suffer from any discrimination because he has the same probability of being funded by the European institutions.

Table 17[50] presents the estimation results for the Logit model, where private funding and the funds allocated by the different organizations are the dependent variables. Overall, there is a negative relationship among the explanatory variable, foreigner, and national and private funding. A foreign researcher receives private funds with a 6.9% lower probability than nationals. This effect is significant (at the 5% level) if we control for all countries and possible features. As observed in the detailed regressions, the foreigners' disadvantage with respect to the access to private funds stems from national sources. All other donors treat foreign and national researchers equally, whereas the probability of finding access to national private funds is significantly lower (7.9%) for foreigners (at the 5% level).

In summary, we have offered strong evidence that there are indeed economically and statistically significant differences between foreign and national researchers, which corroborates our hypothesis 1. Although we argued in a rather general way and did not specify the certain sources, we find here that it is primarily the national sponsors that are the cause of discriminatory treatment.

[50]This and all following tables are constructed similarly to Table 2.

Table 17: Europe (private)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins	-.1037***	-.0663**	-.0343	-.0092	-.0664***
z-value	(3.32)	(2.23)	(1.64)	(0.49)	(2.60)
N	1391	1249	1066	1171	1538
R-squared	0.006	0.004	0.006	0.0004	0.005
Country dummies					
Margins	-.0870**	-.0750**	-.0134	.0185	-.0579**
z-value	(2.66)	(2.44)	(0.56)	(0.86)	(2.13)
N	1389	1214	941	1035	1533
R-squared	0.035	0.050	0.072	0.047	0.043
All controls					
Margins	-.0689**	-.0791**	-.0096	.0143	-.0333
z-value	(2.00)	(2.40)	(0.35)	(0.60)	(1.17)
N	1340	1170	907	987	1479
R-squared	0.067	0.064	0.117	0.107	0.092

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

14.4.2 Accessibility of external funds within the country groups

After resolving the question of whether there are problems for foreign researchers in finding access to external funding, we now wish to refer to our hypothesis 2 and assess whether certain countries are more open, and perhaps more attractive, to foreign researchers than others. Therefore, we clustered the European countries into 4 groups as previously discussed in Section 14.2.1. The Western European group is established as open. Because of the international reputation of their universities, particularly English and Dutch universities, their relatively high net remunerations and their affinity with English, these countries might attract many foreign researchers.

Lietaert and Marimon (2009) reason in their work that this group-they name it Anglo-Saxon-is the most open in Europe. Although we slightly deviate from their grouping, we make an educated guess and agree with the authors. Therefore, there should be no significant difference in the competitive tendering procedure. Table 34 summarizes the results for the Western European group.

Indeed, no public institution is found to engage in significant discriminatory treatment of foreign researchers in an economic or statistical manner. In other words, foreign and national researchers are treated as equals. If there are identical results for private funds, we feel vindicated with regard to our clustering and to the assumption of an extremely open group. Therefore, we will present the private sponsors in the following table.

Table 18 clearly shows that the significant negative relationship between the foreign status and the allocation of private funds is caused primarily by the significant lower probability of obtaining national funds. This probability is approximately 14.8% (at the 5% level) lower for foreign researchers if we control for all factors. In addition, firms appear likely to conclude consultancy contracts with an 8.8% lower probability with foreigners, which is weakly significant at the 10% level. These effects give rise to a 15.6% reduced probability (significant at the 5% level) of receiving private research funds at all. The remaining funding sources make no distinction between nationals and foreigners.

In fact, we take as demonstrated that this first group is relatively open to foreign researchers, especially if we assume public funds to be the primary financial support of researchers grounded in the social sciences. Although there is a major disadvantage in awarding national private funds and a minor disadvantage regarding concluding consultancy contracts, every researcher has the same opportunity to receive almost all external funds. On a related note, the Western European group appears to be quite attractive to international academic immigrants.

The next group, which contains the Scandinavian countries, is supposed to be moderately open. According to Lietaert and Marimon (2009), it is a type of hybrid between the Western European and the Continental and Southern European groupings. As in the first group,

Table 18: West European Group (private)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins	-.1290**	-.1118**	.0050	.0277	-.0953**
z-value	(2.36)	(2.18)	(0.28)	(0.94)	(2.15)
N	307	275	226	253	346
R-squared	0.013	0.017	0.002	0.009	0.014
Country dummies					
Margins	-.1301**	-.1131**	.0054	.0290	-.0945**
z-value	(2.38)	(2.23)	(0.29)	(1.00)	(2.13)
N	307	275	209	253	346
R-squared	0.016	0.035	0.002	0.020	0.017
All controls					
Margins	-.1563**	-.1476**	.0413	.0021	-.0878*
z-value	(2.50)	(2.52)	(1.04)	(0.05)	(1.87)
N	297	265	90	243	336
R-squared	0.073	0.088	0.224	0.162	0.104

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

the Northern European countries tend to have competitive systems and international tendering for academic jobs, but, similarly to the third group, they are characterized by many informal rules. With respect to openness and attractiveness, we classify them in this group because of their affinity with English, their medium net remuneration and scientific output as slightly behind the first group. If our reasoning is correct, there should be a few differences between nationals and foreigners. Therefore, we analyze the public funding possibilities for foreign researchers and show the results in Table 19.

At first glance, we find some interesting phenomena. Most notably, it is the economic and partially statistical significance that is most pronounced if we include only the country dummies. More precisely, the marginal effect (12.8) is relatively high regarding the general allocation of public funds. Likewise, we find a 16.1% lower probability that foreign researchers are nationally supported (significant at the 5% level). Nevertheless, both effects disappear if we control for all variables. One reason-at least for the general case-might be related in part to the particularly advantageous allocation of funds from the Framework Programme. The probability of obtaining funds from the Framework Programme is approximately 20% higher for foreign than for national researchers (at the 5% level) if we subtract out all other possible impact factors. This having been said, the Framework Programme might be regarded as a compensatory funding source. Another reason is the significant positive influence of the academic position and the time spent on research, which are included as control variables in the third regression. Because of a small number of researchers being funded by regional sponsors and the ERC, we regret to say that it is not possible to estimate any results for these funding sources.

We ultimately find that estimating the allocation of private funds is somewhat problematic (see Table 35). Regrettably, we are unable to estimate the relation between foreign status and the probability of obtaining funding from regional institutions and from institutions awarding prizes. All other private funding sources are divided almost equally or, to be precise, are granted with nearly identical probabilities to foreigners and to nationals.

As a whole, the Northern European group presents differentiated effects. At first glance, we find a substantial difference mainly in the provision of national public funds. Closer examination reveals that this initial result is driven by other impact factors and that the allocation is rather indistinct. in addition, the balanced overall probability for foreign researchers is mainly driven by an advantageous European distribution of public funds, whereas the private funds are completely indiscriminative. These facts support our hypothesis 2 that there are indeed differences among the European countries and that it made sense to cluster them. However, because of the unsuspicious granting of private funds, we cannot affirm the assessment of Lietaert and Marimon (2009) at this point. Therefore, we classify the Northern European group, right ahead-and not behind-the Western European group with respect to openness and attractiveness for foreign scholars.

The third group, i.e., the Continental and Southern European Group, contains the majority

Table 19: North European Group (public)

Foreigner/National	**funding public**	**funding public national**	**funding public regional**	**funding ERC**	**funding FP**
No controls					
Margins	-.1180*	-.1581**	/	/	.0903
z-value	(1.68)	(2.12)	/	/	(1.43)
N	170	170	/	/	129
R-squared	0.015	0.020	/	/	0.019
Country dummies					
Margins	-.1282*	-.1606**	/	/	.0804
z-value	(1.86)	(2.22)	/	/	(1.20)
N	170	170	/	/	129
R-squared	0.039	0.045	/	/	0.063
All controls					
Margins	-.0273	-.0480	/	/	.1996**
z-value	(0.36)	(0.60)	/	/	(2.54)
N	164	164	/	/	124
R-squared	0.195	0.191	/	/	0.301

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

of researchers[51]. In compliance with Lietaert and Marimon (2009), we classify this cluster as being moderately closed. The first evidence for this reasoning lies in the moderate ratio of foreign researchers compared with the Western European group[52]. The next tables will indicate whether this categorization could be confirmed. First, we will examine the public allocation of funds in Table 20.

In this group, the funding decision appears to be a double-edged sword. On the one hand, the funds allocated at the European level exhibit no differences between foreign and national researchers in an economically relevant or a statistically significant manner. Conversely, we observe a dramatically disadvantageous situation for foreign researchers at the national and regional levels. The probability of obtaining national funds is approximately 13.2% lower for foreign scholars (significant at the 1% level), even when we control for all variables. Furthermore, the chance of securing regional funds is in fact 18.1% lower than for nationals (also significant at the 1% level). Both effects are by far the most powerful we have found until now. Not surprisingly, the overall probability for foreigners to receive funding is likewise substantially lower. Specifically, the probability is approximately 8.5% smaller for foreign scholars (at the 1% level). As in the Western European group, the indifferent allocation of European funds is advected.

After finding a badly lopsided situation on the public side, we are deeply interested in the distribution of private funds. If these are similarly unfavorable, the combined effects of these two phenomena may critically influence the attractiveness of these countries.

Table 21 indicates that the Continental and Southern European group does not suffer from unequal conditions with regard to private funds. Without controlling for any variables, we find a significant disparity in the overall probability between foreigners and nationals. However, this disparity disappears if we include all possible impact factors. All other donor firms distribute their financial support equally. In the aggregate, this finding identifies a balanced allocation of private funds.

However, the Continental and Southern European group shows large deficits regarding openness on the public side, which is the most important funding source for researchers in the social sciences, but it is not only primarily the level of unequal treatment but also the significance that is worth considering. Likewise, it is worrisome that only the national and regional sponsors, who typically provide the majority of external funds, engage in discrimination.

The last group embraces all CEE countries, which is consistent with Lietaert and Marimon (2009). We vary slightly from the grouping in that previous study because we add Cyprus and Greece into this group. Of course, at first glance, the countries have little in common

[51] see Section 14.2.1.

[52] These figures are calculated from the data out of the survey; we find an average proportion of foreign researchers of 46.32% in the Western European group and 22.50% in the Continental and Southern European group.

Table 20: Continental and South European Group (public)

Foreigner/National	**funding public**	**funding public national**	**funding public regional**	**funding ERC**	**funding FP**
No controls					
Margins	-.1132***	-.1362***	-.2024***	.0044	-.0249
z-value	(4.04)	(3.78)	(4.11)	(0.20)	(0.59)
N	831	811	688	618	708
R-squared	0.020	0.013	0.023	0.0001	0.0004
Country dummies					
Margins	-.1236***	-.1713***	-.2042***	-.0022	-.0016
z-value	(4.27)	(4.59)	(4.26)	(0.08)	(0.04)
N	831	811	688	577	708
R-squared	0.057	0.065	0.098	0.018	0.026
All controls					
Margins	-.0854***	-.1320***	-.1806***	-.0054	.0244
z-value	(2.82)	(3.34)	(3.68)	(0.18)	(0.55)
N	803	784	666	558	685
R-squared	0.149	0.106	0.123	0.086	0.079

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 21: Continental and South European Group (private)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins	-.0940**	-.0678	-.0286	-.0069	-.0571
z-value	(2.11)	(1.59)	(0.94)	(0.24)	(1.54)
N	671	677	591	650	833
R-squared	0.004	0.004	0.003	0.0002	0.003
Country dummies					
Margins	-.0748	-.0741*	-.0217	.0159	-.0425
z-value	(1.64)	(1.80)	(0.71)	(0.56)	(1.10)
N	671	677	591	650	833
R-squared	0.023	0.063	0.016	0.033	0.020
All controls					
Margins	-.0270	-.0545	-.0164	.0297	-.0093
z-value	(0.56)	(1.23)	(0.45)	(1.01)	(0.22)
N	737	653	573	630	804
R-squared	0.055	0.085	0.087	0.112	0.070

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

with the CEE countries[53] and are typically not clustered together with CEE countries. Nonetheless, we count them in this fourth group because they appear to fit more closely (not only regionally but also structurally, e.g., in terms of expenditures for R&D) than with the Continental and Southern European group. We expect this group to attempt to be open. Obviously, thus far, this group is not as attractive as the other clusters to foreign researchers. To prevent the brain drain to western countries of junior scientific staff and to attract foreign researchers, we suppose a rather balanced distribution of external funds. Whether we are correct in making this assumption is assessable in Table 22.

The case of public funding in the CESE group is exceptional. First, we observe much lower access to public funding in general for foreigners in the fourth group, which is mainly characterized by a far smaller chance for them to obtain national public funding. If we control for all variables, we find 37.5% and 23.2% lower probabilities for foreign researchers, respectively. Similarly, funding from the Framework Programme appears to show a slight preference for scholars who are nationals, which indicates that nationals receive these funds with a 10.9% higher probability than their foreign colleagues, in effect. Altogether, this outcome actually surpasses the disadvantage with regard to the allocation of public national funds in the Continental group. However, this difference is not statistically significant. The lack of significance might be explained by the great variance within this group that could not be averted by the small subsample. For this reason, we assume an economically relevant difference between foreign and national researchers, but we cannot confirm it by distant facts. Conversely, a favorable distribution of regional funds is noticeable and thus slightly compensates for the negative relationship regarding national funding. Although we find that being a foreigner is accompanied by a 33.5% higher probability of receiving regional support (indeed, at the 5% significance level), funding from ERC is unfortunately not specifiable. Next, we will examine private funding.

In Table 36, we find no statistically significant effects. Nonetheless, we are again astounded by the level of marginal effects. Whereas foreign researchers tend to have a 13.5% higher probability of receiving private funds, they are affected adversely in terms of funds from consultancy at a 15.2% lower probability. All other funding sources are less prominent and not specifiable. Consequently, it is clear that it is difficult to make a statement regarding the CESE group. On the one hand, we observe high bidirectional marginal effects; on the other hand, only the advantageous provision of regional funds is significant. Therefore, our assumption is supported-although not completely-that the fourth group is attempting to overcome brain drain and to attract non-national researchers by attempting to grant equal accesses to external funding.

In summary, it may be stated that the constructed groups effectively contrast strongly with one another. Whereas the Northern European group is relatively open and hence attractive (presenting almost no differences between foreigners and nationals), the Continental and

[53]This lack of commonality is in reference to the fact that neither has a communist history.

Table 22: CESE Group (public)

Foreigner/National	**funding public**	**funding public national**	**funding public regional**	**funding ERC**	**funding FP**
No controls					
Margins	-.0890	-.0542	.0124	/	.0147
z-value	(0.69)	(0.31)	(0.08)	/	(0.08)
N	189	187	149	/	163
R-squared	0.002	0.004	0.0001	/	0.000
Country dummies					
Margins	-.2000	-.1164	.1329	/	.0162
z-value	(0.93)	(0.49)	(0.68)	/	(0.09)
N	161	167	129	/	161
R-squared	0.066	0.120	0.055	/	0.084
All controls					
Margins	-.3749	-.2322	.3352**	/	-.1094
z-value	(1.47)	(1.51)	(2.13)	/	(0.64)
N	151	157	121	/	154
R-squared	0.241	0.250	0.218	/	0.186

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

Southern European group may be classified as contrary (enormous differences in public funding to the disadvantage of foreigners). The Western European group trails the Northern European group slightly (featuring enormous differences with respect to private funding, to the disadvantage of foreigners) and the CESE group comes thereafter (with differentiated results). The reason for these results (Northern, Western, CESE, Continental) is that we assume that public funds are the primary external funding source for researchers in the social sciences because of the rather "basic" nature of this field of study[54]. In Table 23 and Table 24, the qualitative results based on the estimation with all control variables are summarized to provide a short overview of the main findings.

Table 23: Recapitulatory results (public)

Group	general	national	regional	ERC	FP
West	+	-	+	+	+
North	-	-	/	/	+**
Continental/South	-***	-***	-***	-	+
CESE	-	-	+**	/	-

Table 24: Recapitulatory results (private)

Group	general	national	regional	prizes	consultancy
West	-**	-**	+	+	-*
North	-	-	/	/	+
Continental/South	-	-	-	+	-
CESE	+	/	/	/	-

Returning to the European level, we may basically conclude that the negative relationship with respect to public funds mainly stems from the Continental group and as to private funds primarily from the Western European group. Therefore, hypothesis 2 is partially confirmed. Indeed, there are differences in access to external funds and in the attractiveness among the country groups. Nevertheless, we expected the Western European countries to be ranked highest due to their having the highest degree of openness in their higher education system. These findings mainly coincide with the results of Lietaert and Marimon (2009), although we clustered in a marginally different manner. In contrast to

[54]This finding is shown through the survey data, with which we ascertain beyond doubt that the proportions of researchers' budgets stemming from public institutions represent the largest share of external funds.

that study, we classify the Northern European countries as being the most open and thus changed the sequence of the Western and Northern European groups.

14.4.3 Accessibility of external funds for related and distant foreigners within the country groups

We now turn to testing our hypothesis 3 and examine whether the "distance" (not only the regional but also the linguistic and systemic distances) is crucial to access to external funding. We proposed that a greater distance leads to more difficulties in integrating into the foreign scientific community and thus in achieving an equal opportunity to obtain external funding. Therefore, we designed 2 specific groups of foreigners for each cluster, denominated them as "distant" and "related" and compared them to scholars who are nationals. "Distant" foreigners in this sense hail from countries that are in another country group, and "related" foreigners originate in the same cluster but not in the country of residence. For purposes of clarity, we refer to the first group as an example. Nationals are researchers who have the same residence and nationality (e.g., a Dutch researcher working in the Netherlands, etc.). "Related" foreigners reside in a country belonging to the same group but are not nationals there (e.g., a Dutch researcher working in Ireland). "Distant" foreigners come from outside the group (e.g., a German researcher working in Ireland). Again, we begin with the allocation of public funds in the Western European group.

Table 37 presents the estimation results for the Logit model where public funding and the precise funds are the dependent variables. Not surprisingly, we yield results broadly similar to the case where we did not distinguish among different foreigners, shown in Table 34. Nonetheless, it is extremely interesting that "related" and "distant" foreigners tend to have a higher probability of receiving public funds than nationals. Even if we control for all possible influences, they have a slightly higher probability in general and at the European level (although this effect is not statistically significant). The only exception is the allocation of national public funds. In this case, we observe a relatively high-but statistically insignificant-negative marginal effect regarding "related" foreigners, which at its most pronounced is 13.7 %. However, analyzing the magnitude and significance of most of the marginal effects, we conclude that the discriminatory treatment is not relevant. In summary, we do not observe any disadvantage for foreign researchers but the contrary. The following table provides the outcome for private funding in the Western European group.

In Table 18, we find a significant negative relation between being a foreigner and the probability of receiving private funding. This general result is confirmed by Table 25. We wish to know whether both groups of foreigners are similarly disadvantaged. We find that only the "distant" foreigners suffer from a significant lower funding probability. If we include all the control variables, the general probability is approximately 17%, the chance to

Table 25: West European Group (private)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins distant	-.1368**	-.1074**	.0070	.0314	-.1158**
z-value	(2.45)	(2.05)	(0.38)	(1.04)	(2.50)
Margins related	-.0224	-.1721	/	/	.0905
z-value	(0.14)	(0.97)	/	/	(0.89)
N	307	275	217	247	346
R-squared	0.014	0.017	0.004	0.011	0.023
Country dummies					
Margins distant	-.1421**	-.1132**	.0066	.0374	-.1159**
z-value	(2.57)	(2.19)	(0.34)	(1.24)	(2.51)
Margins related	.0391	-.1109	/	/	.1077
z-value	(0.22)	(0.61)	/	/	(1.01)
N	307	275	204	247	346
R-squared	0.018	0.035	0.003	0.031	0.027
All controls					
Margins distant	-.1696***	-.1506**	.0432	.0265	-.1097**
z-value	(2.64)	(2.49)	(1.06)	(0.64)	(2.29)
Margins related	-.0473	-.1188	/	/	.0470
z-value	(0.26)	(0.66)	/	/	(0.46)
N	297	265	86	237	336
R-squared	0.074	0.088	0.217	0.185	0.109

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
z-statistics based on robust standard errors are in parentheses
All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.
/ indicates no estimation result because of an insufficient number of observations

obtain national private funds is 15.1% and the probability of gaining consultancy funds is approximately 11% less than for nationals (significant at 1% and 5% levels, respectively). Therefore "distant" foreigners are highly likely to be funded considerably less and are disadvantaged to a relatively great extent. The remaining funds are allocated equally, although we cannot, unfortunately, specify the differences between "related" foreigners and nationals with regard to private regional funding and the granting of prizes.

Overall, the Western European group presents itself again as a comparatively open and attractive research cluster. Only the allocation of private funds partially discriminates against "distant" foreigners compared with nationals, and "related" foreigners do not suffer from any discrimination.

Next, we will have a detailed look at the Northern European group. In Section 14.4.2, we learned that the funds from the Framework Programme offset the slightly unfavorable distribution of national funds to the extent that the overall probability is at least fairly balanced.

Clearly, this compensation does not work for all foreigners. Whereas the overall probability for "distant" foreigners is insignificantly higher than for nationals, which is influenced by a statistically significant 21.8% higher probability of receiving funds from the Framework Programme, general access to public funds among "related" foreigners is substantially diminished. These individuals suffer from more than 34.6% lower probability of public support (significant at the 5% level). This finding stems mainly from a dramatically lower probability (42%, which is significant at the 5% level) of obtaining national public funds. We observe that the related foreigners are similarly disadvantaged. Bearing in mind that public funding is the most important external support for researchers working in the social sciences, this result is alarming. Moreover, this finding stands in contrast to our first result (in which we noticed a rather balanced allocation) and thus to our expectations. Now we must realize that this result is accomplished only by an advantageous situation for "distant" and a strongly disadvantageous situation for "related" foreigners. Regrettably, the estimation results for the regional public, ERC and (for the "related" foreigners) Framework Programme funds are not specifiable. Whether our first classification concerning the openness of the Northern European group remains correct or is refuted by the outcome is presented in Table 38.

To briefly summarize, we observe no unequal treatment among nationals, "related" and "distant" foreigners in an economically relevant or statistically significant way. Up to the grave situation regarding the discrimination against "related" foreigners of national public funds and (consequently) public funds in general, the Northern European group appears to be rather open, although we now characterize them as substantially lagging behind the Western European group. Why there is such a discrepancy in the success rate between a Swede and a Dane, both of whom live in Denmark and are applying for national public funds, is unclear to us.

Table 26: North European Group (public)

Foreigner/National	funding public	funding public national	funding public regional	funding ERC	funding FP
No controls					
Margins distant	-.0906	-.1374*	/	/	.1019
z-value	(1.22)	(1.75)	/	/	(1.59)
Margins related	-.3528*	-.3578	/	/	/
z-value	(1.76)	(1.54)	/	/	/
N	170	170	/	/	127
R-squared	0.024	0.025	/	/	0.024
Country dummies					
Margins distant	-.1052	-.1433*	/	/	.0901
z-value	(1.43)	(1.88)	/	/	(1.36)
Margins related	-.3270*	-.3282	/	/	/
z-value	(1.70)	(1.47)	/	/	/
N	170	170	/	/	127
R-squared	0.045	0.048	/	/	0.067
All controls					
Margins distant	.0403	.0216	/	/	.2181**
z-value	(0.48)	(0.25)	/	/	(2.58)
Margins related	-.3463**	-.4201**	/	/	/
z-value	(2.42)	(2.47)	/	/	/
N	164	164	/	/	122
R-squared	0.219	0.212	/	/	0.302

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

The Continental and Southern European group is not only the major cluster but also the cluster with the largest gap in success probability between national and foreign scholars. Now we are interested in whether all foreign scholars-regardless of their home countries-are disadvantaged in their access to public and private funding.

As previously suggested in Table 20, there are substantial differences in funding probabilities. Above all, this finding is unique to "distant" foreigners in the general case. These foreigners possess a 13.4% lower probability for public support (significant at the 1% level). Even so, the "related" foreigners are also treated less favorably. With respect to the allocation of national public funds, both foreign groups suffer from lower probabilities compared to nationals. "Related" foreigners have a 10.2% (significant at the 5% level) lower probability, and "distant" foreigners have a 17% (significant at 1% level) lower probability. There is even a sharper distinction in regional public funds. We find that a foreigner in the same cluster has a 15% lower success probability and that "distant" foreigners are even more punished by a 23.5% lower success probability (both significant at the 1% level). At the European level, we observe no distinctions. This difference is dramatic and leads us to the conclusion that the third group is in fact relatively closed-particularly toward foreigners from other groups. In no other group is there such a consistent and severe discriminatory treatment against both types of foreigners.

Consistent with Table 21 in which we found no significant negative probability for foreigners compared with nationals in terms of private funding, we now-as we split up the group of non-nationals-see little distinction between nationals and related foreigners and nationals and "distant" foreigners. Admittedly, the probabilities are clearly lower in most cases but not in a statistically significant way.

In summary, it may be said, that because of the great extent of the marginal effects of most notably national public and regional public funds, this group may be classed as being less attractive to foreign researchers. In addition, the overall probability of public funding is simply blanched over by the equitable allocation of European funds.

Finally, we wish to provide an answer to the question of whether our hypothesis 3 is correct by analyzing the last group, CESE countries. In Table 29 and Table 39, the results of the estimations are presented.

Table 29 reveals similarities to the Logit regression without any distinction among the groups of foreigners (see Table 22). Again, we only accomplish statistical significance by controlling for all variables. Notably, the "related" foreigners feature the sharpest effects. Although we cannot specify any results for the "distant" foreigners, related foreigners are afflicted by a 35.5% lower probability (significant at the 5% level) of obtaining national public funding. This dramatic situation is partially offset by a 41.7% higher probability (significant at the 1% level) with respect to the access to regional public funding. This finding is aggravated by a 23% lower chance of receiving funding from the Framework Programme. Although the effect is not statistically significant, the economic relevance is

Table 27: Continental and South European Group (public)

Foreigner/National	funding public	funding public national	funding public regional	funding ERC	funding FP
No controls					
Margins distant	-.1892***	-.2133***	-.2819***	-.0051	-.0461
z-value	(5.43)	(4.25)	(3.33)	(0.15)	(0.73)
Margins related	-.0385	-.0761	-.1546***	.0110	-.0104
z-value	(0.99)	(1.62)	(2.59)	(0.41)	(0.20)
N	831	811	688	618	708
R-squared	0.033	0.018	0.025	0.001	0.001
Country dummies					
Margins distant	-.1861***	-.2215***	-.2833***	-.0066	-.0265
z-value	(5.18)	(4.36)	(3.47)	(0.18)	(0.42)
Margins related	-.0549	-.1277**	-.1536***	.0010	.0168
z-value	(1.38)	(2.57)	(2.60)	(0.03)	(0.31)
N	831	811	688	577	708
R-squared	0.067	0.067	0.100	0.018	0.026
All controls					
Margins distant	-.1344***	-.1704***	-.2353***	.0049	.0244
z-value	(3.34)	(3.09)	(2.84)	(0.12)	(0.37)
Margins related	-.0353	-.1018**	-.1495**	-.0112	.0243
z-value	(0.91)	(1.97)	(2.53)	(0.32)	(0.46)
N	803	784	666	558	685
R-squared	0.155	0.107	0.124	0.087	0.079

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 28: Continental and South European Group (private)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins distant	-.0650	-.0586	-.0075	.0075	-.0977*
z-value	(1.02)	(0.96)	(0.19)	(0.20)	(1.67)
Margins related	-.1161**	-.0749	-.0495	-.0193	-.0308
z-value	(2.04)	(1.37)	(1.12)	(0.51)	(0.68)
N	761	677	591	650	833
R-squared	0.005	0.004	0.005	0.001	0.004
Country dummies					
Margins distant	-.0575	-.0823	-.0018	.0291	-.0828
z-value	(0.90)	(1.40)	(0.04)	(0.76)	(1.42)
Margins related	-.0889	-.0671	-.0425	.0043	-.0145
z-value	(1.52)	(1.28)	(0.93)	(0.12)	(0.30)
N	761	677	591	650	833
R-squared	0.023	0.063	0.018	0.033	0.021
All controls					
Margins distant	.0229	-.0454	.0252	.0592	-.0474
z-value	(0.33)	(0.70)	(0.60)	(1.57)	(0.73)
Margins related	-.0633	-.0613	-.0649	.0065	.0152
z-value	(1.09)	(1.11)	(1.10)	(0.18)	(0.31)
N	737	653	573	630	804
R-squared	0.056	0.085	0.094	0.115	0.071

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 29: CESE Group (public)

Foreigner/National	**funding public**	**funding public national**	**funding public regional**	**funding ERC**	**funding FP**
No controls					
Margins distant	/	.0783	/	/	/
z-value	/	(0.35)	/	/	/
Margins related	-.1228	-.1121	.0418	/	-.1347
z-value	(0.92)	(0.60)	(0.28)	/	(0.55)
N	188	186	148	/	162
R-squared	0.004	0.002	0.001	/	0.002
Country dummies					
Margins distant	/	/	/	/	/
z-value	/	/	/	/	/
Margins related	-.2358	-.2464	.2321	/	-.1100
z-value	(0.96)	(0.96)	(1.04)	/	(0.46)
N	160	166	128	/	160
R-squared	0.081	0.122	0.062	/	0.084
All controls					
Margins distant	/	/	/	/	/
z-value	/	/	/	/	/
Margins related	-.3936	-.3545**	.4166***	/	-.2304
z-value	(1.42)	(2.16)	(2.99)	/	(1.21)
N	150	156	120	/	153
R-squared	0.240	0.252	0.220	/	0.188

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
z-statistics based on robust standard errors are in parentheses
All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.
/ indicates no estimation result because of an insufficient number of observations

considerable and surely has some influence on the overall probability, which is likewise not statistically significant. However, this finding does not belie the economic relevance of the remarkable negative marginal effect (39.4%) compared with nationals.

The allocation of private funds in the CESE group appears to be quite advantageous for "related" foreigners[55]. Although we do not observe any statistical significance, the marginal effects are relatively large compared with their national colleagues. The overall chances of funding for "related" foreigners are 33.7% higher than for national researchers. This effect might be interpreted as an offset to the poor allocation of public funds, but the result must be treated with caution because of the small subsample and a relative great variance within this group, as previously discussed in Section 14.4.2.

Aside from the statistically irrelevant outcome, there is an enormous negative discriminatory treatment for "related" foreigners with respect to the allocation of public funds. Meanwhile, we observe a positive tendency for them regarding the distribution of private funds. For these reasons, we can neither negate nor affirm our hypothesis 3 for this group.

To reassess our hypothesis 3 universally, we summarize the computed results and focus on the general probabilities (see Table 30 and Table 31 for the qualitative results). In the Western European group, the public funding conditions for "distant" foreigners are as good as for "related" foreigners and for nationals, whereas these distant foreigners are at a substantial disadvantage in terms of private funding. In the Northern European group, the opposite is true: "related" foreigners are treated less favorably by public funds, whereas we find no disadvantage regarding private funds. My supposition is most directly confirmed by the Continental and Southern European group in that we learn that "distant" foreigners have more difficulty obtaining any national or regional funding and have a significantly lower probability of gaining public funding than their "related" foreigner counterparts. "Related" foreigners are discriminated at the national and regional levels, whereas no differences are observable for private funding. The last group appears to be torn. On the public side, there is significantly lower access for "related" foreigners to national public funding and higher access to regional funding compared with the nationals and on the private side, we ascertain a much higher (if not significant) probability of receiving private funds. Accordingly, it is difficult to make an absolute declaration, and we must leave open the confirmation of hypothesis 3 in which we stated that the regional, linguistic and systematic distance is the responsible factor for access to external funding. In Table 10 and Table 11, the qualitative results based on the estimation with all control variables are summarized to provide a short overview of the main findings.

Referring back to hypothesis 2, we turn to another classification of the country groups. The Western and the Northern European groups swap places because public funding serves as the more important financial support to social scientists, and we did not find any differences between nationals and both types of foreigners with respect to public

[55]The estimation for "distant" foreigners is not possible here.

Table 30: Recapitulatory results (public)

Group	general	national	regional	ERC	FP
West					
distant	+	+	-	+	+
related	+	-	+	/	+
North					
distant	+	+	/	/	+**
related	-**	-**	/	/	/
Continental/South					
distant	-***	-***	-***	+	+
related	-	-**	-**	-	+
CESE					
distant	/	/	/	/	/
related	-	-**	+***	/	-

Table 31: Recapitulatory results (private)

Group	general	national	regional	prizes	consultancy
West					
distant	-***	-**	+	+	-**
related	-	-	/	/	+
North					
distant	-	-	/	/	+
related	-	+	/	/	/
Continental/South					
distant	+	-	+	+	-
related	-	-	-	+	+
CESE					
distant	/	/	/	/	/
related	+	/	/	/	-

funding in the first group. Immediately lagging behind this group is the CESE group, which shows some changing effects. In last place is the Continental and Southern European group, which is the only group that is substantially disadvantaging ”distant” and ”related” foreigners in their access to public funding. Ultimately, the sequence proposed by Lietaert and Marimon (2009) is consistent with mine, although the reasoning and the considered key figures in that study deviate from mine.

15 Discussion and Conclusions

This approach examines the relationship between the foreign status of researchers within the ERA and their access to different sources of public and private funding. We provide empirical evidence that there are indeed significant differences between nationals and foreigners regarding the allocation of public and private funds at the European level. Therefore, hypothesis 1 may be affirmed. A closer look reveals that these effects mainly stem from national funding sources, which is crucial because these are the donors who are issuing most of the funds.

These first results give rise to a further investigation to find whether all regions in the EU suffer from the problem of unbalanced allocations of external research funds. We find this situation not to be the case. Regrettably, it is the largest group of countries, the Continental and Southern European countries, that treats foreign scholars particularly less favorably in terms of the public funding offered. Alternatively, we find significant evidence of lower access to private funding in the Western European countries. In the Northern European countries, funding from the Framework Programme appears to compensate for the slightly inadequate allocation of national public funds such that both types of scholars have more or less equal access. Within the last group, the CESE countries, great differences between nationals and foreigners regarding public funding are found. However, except for an advantageous allocation of regional funds, these differences are not significant, which may be attributed to large variations within the group.

We extended our empirical analysis to a precise distinction among different types of foreign scholars, which had interested us. In this way, we wish to reassess our hypothesis 3 and consider which region is the most promising for researchers with certain nationalities. Therefore, we classify foreigners into the category "related" if they stem from a neighboring country that exhibits similar characteristics (in such areas as higher education systems) and is consequently clustered into the same country group and "distant" foreigners as those scholars coming from other country clusters. As we compare both types of foreigners to nationals and obtain various results, we find that we cannot conclusively confirm hypothesis 3. Within the Western European countries, the effects coincide with our expectations: only the "distant" foreigners are disadvantaged regarding private funding. By contrast, in Northern European countries, "related" foreigners have significantly lower access to public funds. Although the CESE countries feature significant positive and negative effects for "related" foreigners with respect to public funding, the Continental and Southern European countries are even more discriminatory. In that group, both types of foreigners face significantly lower public funding probabilities.

Finally, we are able to formulate some concluding remarks and related policy and individual implications. First, our empirical analysis supports the ongoing processes performed by some governments in Continental and Southern Europe to increase the openness and competitiveness of their higher education systems and to attract more scholars away from

the Northern and Western European countries. Obviously, the established systems there grant a more balanced allocation of external resources. However, there remains much work to do. For instance, an installation of independent funding agencies and ex post and ex ante evaluations of research projects should be pursued. Both types of projects appear to be promising strategies to improve the intended targets.

For the individual researcher, our results signify that a move abroad entails a significant need to raise external funds successfully. In making this statement, we do not wish to dissuade scholars from moving to other countries, but we do want to point to a factor that is an issue apart from more apparent conditions (such as salaries and endowment, reputations of various universities). It seems to be good advice for each scholar to review his/her financial needs. If there is a high interest in private funds, the Western European countries are not the best choice-so long as they are not in one's home cluster. Meanwhile, Scandinavians should leave their own cluster or alternatively remain within their home country to find the most ideal public funding conditions. Unfortunately, moving from anywhere abroad to a Continental or Southern European country entails a disadvantage in gaining public funding compared to nationals.

However, once coming to the conclusion to go abroad, it must be considered carefully where to apply. The European funds (from the ERC and the Framework Programme) are always non-discriminating or even advantageous for foreigners. A scholar residing in a Western European country may comfortably tap all public funding sources, whereas those in all other country groups will find similar advantages in seeking private funding sources.

16 Appendix

Table 32: Description of the variables used in the regressions

Variable	Description	Data Source
public funding (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
public funding national (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
public funding regional (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
public funding ERC (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
public funding FP (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
private funding (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
private funding national (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
private funding regional (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
private funding prizes (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
private funding consultancy (d)	0 if there is no funding, 1 if there is any	Survey (adapted)
foreigner/national (d)	0 if national, 1 if foreigner	Survey (adapted)
gender (d)	0 if male, 1 if female	Survey
years from graduation	1 if PhD not completed, 2 if <5, 3 if 5-9, 4 if 10-20, 5 if >20	Survey
tenured (d)	0 if non-tenured, 1 if tenured	Survey (adapted)
position	1 if Lecturer & Economist, 2 if PhD, 3 if Researcher, 4 if PostDoc, 5 if Senior Economist/Lecturer, 6 if Assistant Professor, 7 if Associative Professor, 8 if Full Professor	Survey
department	1 if Economics, 2 if Sociology, 3 if Political Sciences	Survey
employer university (d)	0 if not employed at a university, 1 if employed at a university	Survey (adapted)
employer research institute (d)	0 if not employed at a research institute, 1 if employed at a research institute	Survey (adapted)
work environment	0 if sporadic, 1 if some individual research, 2 if mostly single effort, 3 if integrated research	Survey
working time research	fraction of the working time spend on research (0-100)	Survey
working time fund raising	fraction of the working time spend on fund raising (0-70)	Survey
EEA/ESA/ECPR membership	0 if no, 1 if yes	Survey
H-Index	expresses the country's number of articles (h) that have received at least h citations and quantifies both journal scientific productivity and scientific impact	SCIMAGO LAB
affinity of native language	the "distance" of languages to the scientific language English (maximum clade credibility tree)	Max Planck Institute
net yearly remuneration (PPS)	yearly net salaries minus the cost of living for researchers based on standardized Purchasing Power Parities (PPS)	European Commission
GERD	Gross domestic expenditure on research and development performed on the national territory	Eurostat, World Bank & OECD

Table 33: Classification of languages

linguistic family	**subgroup**	**subgroup**	**subgroup**	**countries**	**code**
Afroasiatic	Semitic	Central Semitic	Arabic	Malta	0
Caucasian	Kartvelian			Georgia	0
Uralic	Finno-Ugric	Finno-Permian		Estonia	0
				Finland	0
				Hungary	0
Indo-European	Balto-Slavic	Baltic		Latvia	1
				Lithuania	1
		Slavic		Bulgaria	1
				Croatia	1
				Czech Republic	1
				Poland	1
				Russia	1
				Serbia	1
				Slovakia	1
				Slovenia	1
				Ukraine	1
	Hellenic			Cyprus	1
				Greece	1
	Italic	Romance	Eastern Romance	Romania	2
			Gallo-Iberian	Belgium	2
				France	2
				Italy	2
				Portugal	2
				Spain	2
	Germanic	North Germanic		Denmark	3
				Iceland	3
				Norway	3
				Sweden	3
		West Germanic	Central German	Austria	4
				Germany	4
				Switzerland	4
			Low Franconian	Netherlands	4
			Anglo-Frisian	UK	5
				Ireland	5

Table 34: West European Group (public)

Foreigner/National	**funding public**	**funding public national**	**funding public regional**	**funding ERC**	**funding FP**
No controls					
Margins	.0233	-.0645	-.0173	.0277	.0148
z-value	(0.48)	(1.24)	(0.41)	(0.95)	(0.29)
N	345	341	238	256	289
R-squared	0.001	0.003	0.001	0.009	0.0003
Country dummies					
Margins	.0234	-.0651	-.0176	.0316	.0143
z-value	(0.49)	(1.26)	(0.41)	(1.02)	(0.28)
N	345	341	238	237	289
R-squared	0.001	0.009	0.002	0.055	0.004
All controls					
Margins	.0703	-.0078	.0146	.0548	.0615
z-value	(1.28)	(0.13)	(0.28)	(1.52)	(1.17)
N	335	331	228	179	279
R-squared	0.127	0.111	0.146	0.140	0.071

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 35: North European Group (private)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins	-.0607	-.0175	/	/	-.0084
z-value	(0.62)	(0.19)	/	/	(0.17)
N	153	148	/	/	173
R-squared	0.002	0.0002	/	/	0.0004
Country dummies					
Margins	-.0567	-.0042	/	/	-.00004
z-value	(0.57)	(0.05)	/	/	(0.00)
N	153	148	/	/	173
R-squared	0.030	0.044	/	/	0.041
All controls					
Margins	-.0981	-.0614	/	/	.0036
z-value	(0.88)	(0.58)	/	/	(0.07)
N	147	142	/	/	167
R-squared	0.118	0.174	/	/	0.209

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

Table 36: CESE Group (private)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins	-.0614	.0676	.0757	/	-.1301
z-value	(0.27)	(0.40)	(0.71)	/	(0.64)
N	170	149	137	/	186
R-squared	0.0003	0.001	0.005	/	0.002
Country dummies					
Margins	.1674	/	/	/	-.0418
z-value	(0.81)	/	/	/	(0.21)
N	168	/	/	/	183
R-squared	0.114	/	/	/	0.059
All controls					
Margins	.1348	/	/	/	-.1522
z-value	(0.62)	/	/	/	(0.77)
N	159	/	/	/	174
R-squared	0.277	/	/	/	0.257

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

Table 37: West European Group (public)

Foreigner/National	funding public	funding public national	funding public regional	funding ERC	funding FP
No controls					
Margins distant	.0246	-.0532	-.0414	.0333	.0047
z-value	(0.50)	(1.00)	(0.89)	(1.09)	(0.09)
Margins related	.0070	-.1992	.1121	/	.1106
z-value	(0.05)	(1.40)	(1.49)	/	(0.92)
N	345	341	238	247	289
R-squared	0.001	0.006	0.019	0.012	0.003
Country dummies					
Margins distant	.0231	-.0535	-.0420	.0336	.0065
z-value	(0.47)	(1.01)	(0.91)	(1.06)	(0.12)
Margins related	.0269	-.2060	.1187	/	.0893
z-value	(0.19)	(1.41)	(1.39)	/	(0.66)
N	345	341	238	233	289
R-squared	0.001	0.011	0.020	0.054	0.005
All controls					
Margins distant	.0704	.0100	-.0101	.0576	.0630
z-value	(1.23)	(0.16)	(0.16)	(1.53)	(1.09)
Margins related	.0693	-.1369	.0846	/	.0536
z-value	(0.52)	(0.96)	(0.91)	/	(0.39)
N	335	331	228	176	279
R-squared	0.127	0.113	0.152	0.138	0.071

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
z-statistics based on robust standard errors are in parentheses
All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.
/ indicates no estimation result because of an insufficient number of observations

Table 38: North European Group (private)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins distant	-.0630	-.0223	/	/	-.0455
z-value	(0.62)	(0.23)	/	/	(0.06)
Margins related	-.0388	.0249	/	/	/
z-value	(0.14)	(0.09)	/	/	/
N	153	148	/	/	170
R-squared	0.002	0.0004	/	/	0.000
Country dummies					
Margins distant	-.0533	-.0018	/	/	.0050
z-value	(0.52)	(0.02)	/	/	(0.10)
Margins related	-.0876	-.0241	/	/	/
z-value	(0.29)	(0.09)	/	/	/
N	153	148	/	/	170
R-squared	0.030	0.044	/	/	0.040
All controls					
Margins distant	-.0901	-.0844	/	/	.0231
z-value	(0.78)	(0.79)	/	/	(0.44)
Margins related	-.1368	.0433	/	/	/
z-value	(0.41)	(0.16)	/	/	/
N	147	142	/	/	164
R-squared	0.118	0.175	/	/	0.217

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
z-statistics based on robust standard errors are in parentheses
All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.
/ indicates no estimation result because of an insufficient number of observations

Table 39: CESE Group (private)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins distant	/	/	/	/	/
z-value	/	/	/	/	/
Margins related	.0392	.1263	.1023	/	-.0967
z-value	(0.16)	(0.70)	(0.93)	/	(0.47)
N	169	148	136	/	185
R-squared	0.0001	0.003	0.008	/	0.001
Country dummies					
Margins distant	/	/	/	/	/
z-value	/	/	/	/	/
Margins related	.3163	/	/	/	.0169
z-value	(1.36)	/	/	/	(0.08)
N	167	/	/	/	182
R-squared	0.116	/	/	/	0.059
All controls					
Margins distant	/	/	/	/	/
z-value	/	/	/	/	/
Margins related	.3370	/	/	/	-.1080
z-value	(1.58)	/	/	/	(0.48)
N	158	/	/	/	173
R-squared	0.286	/	/	/	0.258

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
z-statistics based on robust standard errors are in parentheses
All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.
/ indicates no estimation result because of an insufficient number of observations

16.1 Robustness

To test the robustness of our estimations, we use the partitioning around medoids (PAM) algorithm to generate alternative clusters that are based not on regional classification but on the standardized key figures we presented in Section 14.2.1. In addition to the above-mentioned indicators (H-Index, net yearly remuneration averages (PPS), GERD ratios and language index), we included the number of scientific workers in the considered countries in proportion to the articles published. With the help of the PAM algorithm, which is more robust than K-means because it minimizes the sum of dissimilarities instead of the sum of squared Euclidean distances and accepts a dissimilarity matrix, we again obtained 4 clusters.

Overall, we find results that are tendentially similar to those presented in Section 14.4, although the marginal effects and the significance levels differ slightly, as expected. Indeed, the algebraic signs of the effects that were found to be significant in both approaches are consistent with those found with the other method.

Table 40: new West European Group (public)

Foreigner/National	funding public	funding public national	funding public regional	funding ERC	funding FP
No controls					
Margins	.0232	-.0471	-.0262	.0166	.0026
z-value	(0.51)	(0.95)	(0.64)	(0.55)	(0.05)
N	365	361	249	267	303
R-squared	0.001	0.002	0.002	0.002	0.000
Country dummies					
Margins	.0153	-.0609	-.0251	.0162	.0048
z-value	(0.34)	(1.25)	(0.60)	(0.53)	(0.10)
N	365	361	249	267	303
R-squared	0.008	0.027	0.003	0.045	0.002
All controls					
Margins	.0343	-.0283	.0259	.0372	.0263
z-value	(0.70)	(0.53)	(0.50)	(0.94)	(0.49)
N	356	352	232	200	249
R-squared	0.136	0.123	0.167	0.128	0.062

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 41: new West European Group (private)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins	-.1391***	-.0984**	.0124	.0450	-.1194***
z-value	(2.64)	(1.99)	(0.63)	(1.50)	(2.81)
N	322	287	238	266	366
R-squared	0.015	0.013	0.009	0.027	0.023
Country dummies					
Margins	-.1346**	-.0934*	.0114	.0462	-.1159***
z-value	(2.54)	(1.90)	(0.61)	(1.55)	(2.69)
N	322	287	238	266	366
R-squared	0.017	0.020	0.013	0.035	0.027
All controls					
Margins	-.1315**	-.1027*	.0141	.0621	-.1019**
z-value	(2.25)	(1.92)	(0.59)	(1.41)	(2.38)
N	313	278	162	185	357
R-squared	0.078	0.064	0.281	0.124	0.127

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 42: new North European Group (public)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins	-.0963*	-.1398**	-.0779	/	.0845
z-value	(1.88)	(2.38)	(1.23)	/	(1.46)
N	280	272	217	/	220
R-squared	0.012	0.016	0.008	/	0.009
Country dummies					
Margins	-.1007*	-.1238**	-.0968*	/	.0435
z-value	(1.96)	(2.10)	(1.70)	/	(0.72)
N	280	272	217	/	220
R-squared	0.037	0.038	0.133	/	0.081
All controls					
Margins	-.0337	-.0400	-.1115*	/	.1376**
z-value	(0.63)	(0.60)	(1.96)	/	(2.45)
N	268	260	207	/	209
R-squared	0.148	0.092	0.244	/	0.213

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

Table 43: new North European Group (private)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins	-.0757	-.0586	-.0407	/	.0308
z-value	(1.07)	(0.88)	(0.90)	/	(0.70)
N	251	231	189	/	283
R-squared	0.004	0.003	0.017	/	0.002
Country dummies					
Margins	-.0732	-.0140	-.1027	/	.0095
z-value	(1.03)	(0.22)	(1.19)	/	(0.22)
N	251	231	102	/	283
R-squared	0.028	0.101	0.115	/	0.095
All controls					
Margins	-.0467	-.0417	-.1385	/	.0468
z-value	(0.60)	(0.61)	(1.21)	/	(1.02)
N	240	220	96	/	271
R-squared	0.094	0.171	0.233	/	0.192

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

Table 44: new Continental and South European Group (public)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins	-.1399***	-.1793***	-.2460***	.0251	-.0221
z-value	(4.34)	(4.30)	(3.90)	(1.06)	(0.44)
N	649	637	545	484	561
R-squared	0.028	0.021	0.027	0.005	0.0003
Country dummies					
Margins	-.1388***	-.2026***	-.2587***	.0330	.0123
z-value	(4.27)	(4.78)	(4.30)	(1.40)	(0.24)
N	649	637	545	484	561
R-squared	0.071	0.075	0.104	0.018	0.018
All controls					
Margins	-.0920**	-.1675***	-.2193***	.0346	.0236
z-value	(2.52)	(3.62)	(3.64)	(1.14)	(0.43)
N	628	617	528	469	544
R-squared	0.182	0.129	0.135	0.076	0.073

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 45: new Continental and South European Group (private)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins	-.0740	-.0722	.0757	.0102	-.0496
z-value	(1.40)	(1.38)	(0.71)	(0.31)	(1.11)
N	605	544	466	511	651
R-squared	0.002	0.003	0.002	0.0003	0.002
Country dummies					
Margins	-.0650	-.1016**	-.0213	.0220	-.0306
z-value	(1.22)	(1.99)	(0.57)	(0.68)	(0.68)
N	605	544	466	511	651
R-squared	0.010	0.037	0.011	0.024	0.016
All controls					
Margins	-.0094	-0953*	-.0021	.0328	.0266
z-value	(0.16)	(1.73)	(0.05)	(0.90)	(0.54)
N	586	525	453	496	629
R-squared	0.044	0.064	0.100	0.121	0.083

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

Table 46: new CESE Group (public)

Foreigner/National	funding private	funding private national	funding private regional	funding prizes	funding consultancy
No controls					
Margins	-.0632	-.0884	.0474	/	-.0906
z-value	(0.62)	(0.70)	(0.45)	/	(0.56)
N	241	239	187	/	205
R-squared	0.002	0.002	0.001	/	0.001
Country dummies					
Margins	-.0963	-.1326	.1230	/	-.0505
z-value	(0.70)	(0.94)	(0.98)	/	(0.35)
N	213	219	167	/	203
R-squared	0.062	0.098	0.049	/	0.104
All controls					
Margins	-.2724*	-.2533*	.2493*	/	-.1658
z-value	(1.96)	(1.67)	(1.81)	/	(1.24)
N	201	207	158	/	195
R-squared	0.194	0.164	0.157	/	0.190

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

/ indicates no estimation result because of an insufficient number of observations

Table 47: new CESE Group (private)

Foreigner/National	**funding private**	**funding private national**	**funding private regional**	**funding prizes**	**funding consultancy**
No controls					
Margins	-.0967	-.0277	.0299	-.0043	-.1978
z-value	(0.55)	(0.20)	(0.32)	(0.04)	(1.10)
N	213	187	173	191	238
R-squared	0.001	0.0003	0.001	0.000	0.007
Country dummies					
Margins	.0724	.1755	.1614	-.0035	-.1154
z-value	(0.47)	(1.15)	(1.35)	(0.02)	(0.69)
N	211	155	136	147	235
R-squared	0.108	0.068	0.123	0.041	0.070
All controls					
Margins	.0059	.2306	.1017	-.0991	-.1954
z-value	(0.04)	(1.57)	(0.77)	(0.71)	(1.24)
N	201	150	130	122	224
R-squared	0.214	0.164	0.182	0.265	0.212

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

z-statistics based on robust standard errors are in parentheses

All control variables as mentioned in Section 14.2 are included. Detailed results are available upon request.

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