Pros and Cons of Distribution Streams of Governmental Funding for Research

Analysis by Dr. Michael Stampfer

FORMAS | ETT FORSKNINGSRÅD FÖR HÅLLBAR UTVECKLING
A SWEDISH RESEARCH COUNCIL FOR SUSTAINABLE DEVELOPMENT

Well we know where we're going
But we don't know where we've been
And we know what we're knowing
But we can't say what we've seen

(Talking Heads, Road to Nowhere)

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Foreword

The aim with this report is to summarize our current knowledge on the effects of different funding streams to the universities and to single out pros and cons.

In most countries, governments channel their funding of research through a dual support system, with direct funding allocations to the universities as well as funding through external research funding agencies. In Sweden, the current system for higher education and research is under scrutiny. The government has asked for a comprehensive review of the steering of resource allocation to Swedish state Higher Education Institutions HEIs, including suggestion on a new framework of governance and funding to develop strong and responsible HEIs. As part of this investigation, the roles of the governmental research agencies have also been discussed. The investigation, known by its acronym STRUT, was delivered to the Swedish government in February 2019.

To have a better basis for the discussion on different governmental funding streams, Formas commissioned a conceptual (theoretical) analysis to investigate the pros and cons of direct research funding to universities versus distribution through research agencies. As an independent analyst, Dr. Michael Stampfer agreed to undertake the commission, between December 2018 and March 2019.

An advisory group consisting of leading international experts from academia as well as senior advisors in research policy from research councils was appointed and the group gathered together with Dr. Stampfer in a workshop at Formas in February 2019 to give input to the analysis. I would like to thank the advisory group including Jean-Luc Barras, Swiss National Science Foundation, Aldo Geuna, University of Torino, Steven Hill, UK Research and Innovation, Elisabeth Koier, Erasmus University Rotterdam, Stephan Kuster, Science Europe, Terttu Luukkonen, retired from the Research Institute of the Finnish Economy and Stig Slipersæter, The Research Council of Norway.

I also would like to thank Katarina Nordqvist, Senior Analyst at Formas, who has been instrumental in the commission of the report. Foremost, I would like to thank Dr. Michael Stampfer for an impressive work, it has been a real pleasure working with him. He has made a thorough and comprehensive analysis of wide-ranging material in a very complex field to summarize the current state of knowledge in this field and to single out pros and cons. Despite a tight deadline Michael has worked to the most professional and exacting of standards throughout the process.

The issues raised here are complex but with this report I hope we at Formas can inspire an evidence-based discussion and a deeper understanding of what roles and influences the different funding streams have, to achieve high-quality research for a better and sustainable world.

Ingrid Petersson
Director general, Formas.

Formas is a government research council for sustainable development. Formas areas of activity primarily include the environment, agriculture sciences and spatial planning. In 2019 Formas will award close to 1.6 billion kronor to fund both research and innovation activities. Formas also develop strategies, perform analyses and conduct evaluations.

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1 Executive Summary

What is the main task of this report?

This literature review provides an overview on what we currently know about *university research funding mechanisms* and their impacts. With the main focus on European countries, it analyses various forms of public basic allocations ("Direct Appropriations") and public funding through programmes and projects ("Third Party Funding" / TPF) e.g. via Research Funding Councils.

Formas, the Swedish Research Council for Sustainable Development, has commissioned the review *"… to investigate the pros and cons of distributing research funding directly to universities vs. distribution through research councils / agencies, comparing how these different streams of funding are influencing institutional, environmental, organisational and individual factors*". The analysis shall serve the current Swedish discussion how to best finance university research with public funds in the future. This discussion is of high relevance, as universities stand for nearly the whole public research output in Sweden. The GDP share of public Higher Education funding for research is among the highest in Europe. The STRUT commission, a government investigation on university governance and funding, has published a voluminous report in February 2019 and has proposed a number of changes in the system. The next four-year Research Bill is due in 2020.

The exercise therefore serves to find out what we know about the *pros and cons* of individual funding instruments and about the interplay between such instruments, both derived from the scholarly literature and from evaluations. It contains no search for best practices, no *what-if* speculation and no kind of ranking which model or mechanism works better than others. All the mechanisms under scrutiny are thickly coated with specific cultural properties. Each country has its own profile. Historical trajectories often do matter more strongly than the technical design of funding instruments as such. Universities within countries and across Europe are still very different, although our analysis excludes other actors in Higher Education like university colleges. Universities date back up to 800 years, TPF up to 100 years, New Public Management 50 years and "excellence" funding programmes 30 years.

What can be said is what seems to work in a certain context, and which price tag ("*the cons*") comes with each funding mechanism and its (mostly) intended positive impacts ("*the pros*"). Often the literature shows correlations, although some causal effects have been also identified. Further it can be safely said that no "silver bullet", i.e. no optimal model does exist, but there is a lot of evidence what works in which context. For this exercise, it has been necessary to reduce the context factors as they are abounding. In addition, there is no *"no lens"*: Although we deal with science, research and the quest for objective results, the discussion how to finance university research is not at all a neutral and technocratic issue, but laden with assumptions how the world works and how it should work.

The analysis is built in a very simple structure to identify the *pros* and *cons* as well as some interdependencies in a step-wise approach: *Chapter 2* informs about the tasks and the structure of the review in more detail. In *chapter 3* we see what we can learn from studies and analyses about the universities as organisations, followed by a short overview on context factors and future Higher Education challenges in *chapter 4*. The next *chapter 5* sheds some light on size and flows of input as a strong determining factor. *Chapter 6* deals with Direct Appropriations and *chapter 7* with TPF, both describing various sub-forms, mechanisms, context and impacts. *Chapter 8* presents studies, programmes and phenomena dealing with direct crossroads of the two funding streams. *Chapter 9*

provides some pros and cons lists, while *chapter 10* comes forward with conclusions on different macro- and meso-levels.

Universities and university research

Universities are under scrutiny. They receive considerable public funds, but the hopes and expectations they should live up to are much higher. Universities today shall play a key role for wealth creation through research and new knowledge, and they shall provide for orientation, in now unsteady times where truth and facts have become a kind of variable or a commodity. These expectations have grown along a trajectory over the last 50 years and have triggered a lot of policy action. Steering, management and funding instruments have evolved in a fast way, impacting on a kind of organisation that is not just like any other.

Universities are organisations where both production and transfer of knowledge is based on old and very specific foundations. Their inner organisation is deeply rooted in traditions and formed through the way academic research is being pursued. This can be described by a few attributes: curiosity and following ones' own ideas, deep specialisation, academic militia service and strong bottom up dynamics for good or bad. Intrinsic motivation is a key driver. People next door and up in the hierarchy cannot judge the quality of a certain research activity, at least not in advance. *Global* epistemic communities wield a lot of power through various kinds of grooming and bonding as well as through peer review and other forms of judgment. *Local* intra-academic turf wars for resources, careers and recognition influence the shape of the universities. Further, it is the individual researchers that regularly apply for external funding: In case of success TPF may also thematically and financially determines considerable parts of Direct Appropriations. Thematic priorities are often defined on government level or in funding agencies. Finally there is the authority of the university professor who enjoys higher degrees of independence than an employee of any other kind of organisation.

No wonder that the entry barriers have always been high and very specific. No wonder the general public still sees universities as a kind of black box where only the "*useful-results-out*"-door is really interesting when it comes to research. The attention of the research and Higher Education policy has traditionally focussed more on the "*money-in*"-door that became bigger with mass higher education and the innovation-based economy. In the last decades policy has been watching both doors *and* all kinds of corridors in between. Policy instruments and university leaders shall provide for accountability, value for money, impacts and critical mass.

Since the 1970s big waves of reforms, as a response to New Public Management (NPM), have indeed changed the universities to a certain degree, but not completely. The universities were given higher autonomy, a stronger (but nevertheless sandwiched) central management and they were confronted with more competition on all levels, including various effects of globalisation.

NPM was instrumental in introducing mostly indicator-based, ex-post Performance Based Research Funding Systems (PRFS), and / or Performance Contracts (PAs) which negotiate plans for the future. Further, NPM made it easier to shift parts of the state budgets for university research from block grants to competitive instruments including a growing TPF share, all with efficiency and accountability arguments. Finally, the managerial reforms constituted leadership and actorship on the side of the universities from the mid-1980s onwards. These assumptions did not fully materialise and had a number of unintended but not completely surprising side effects like short-termism, excessive Matthew effects or conflicting incentive structures.

Policy makers have constituted a kind of social contract, where tax money is given in exchange for graduates, research results and transferrable deliverables. Due to their nature universities still are no organisations comparable to companies and they still have their individual profiles. Policy research has termed them as *loose* or *incomplete* organisations.

The individual and country profiles are therefore both shaped by the forms of funding *and* by their structural properties: For each university it matters whether they are already top performers, or venerable traditional universities, or upward-oriented "wannabes" or smaller niche players with a main focus on education. Namely the top performers appear to be able to digest various forms of funding better than others and to transform it into a constant high quality output. The quality and strictness of recruiting and career models on organisational and national level might play a specifically important role in this context.

The link between the two "in" and "out" doors is often difficult to constitute: The universities, as a hybrid of traditional and new organisational elements *and* as expert organisations, defy simple steering and measurement approaches. The impacts are often not immediately visible due to the fundamental character of the research being done: When a company launches a new product, nobody sees the science within it, and only in some cases can we judge to what extent the market success is attributable to the original research.

Whomever we address with these questions, we should not forget that they all relate not only to academics, university leadership and policy makers, but also to the taxpayer who does finance the public universities.

How much does the input side and input growth matter?

University-based research amounts to a quarter of all research spending in Europe. While the variety across countries is wide, state funding has remained the dominating source. Small European nations like Sweden, Denmark, Switzerland or the Netherlands are among the countries with the highest GDP input shares, and their universities yield high outputs and impacts as well, measured mainly in publication counts and citation impacts in a global comparison. Apart from this "small successful country" pattern not many obvious relationships between research funding shares and research performance can be observed, see the example of the UK with decreasing input and constantly high outputs and impacts.

Internationally there have been shifts in the composition of funding; much less in the mix between private and public sources than within the public sector allocations: TPF shares have grown, as well as the performance-based elements within the Direct Appropriations. However, within the public funding portfolio, Direct Appropriations are nearly everywhere still larger than the national TPF sources taken together. Within these boundaries all countries are different and to a certain degree determined by historical trajectories.

The latter make some kinds of comparisons difficult or even impossible, as e.g. the U.S. university system has no public Direct Appropriations for research at all, and TPF comes with full overhead cost. In Europe strong countries can defend their positions, while countries with a weak HE system struggle to catch up. This again can serve as an example for context and culture as the complete revamping of governance, recruiting or funding structures proves even more challenging than the massive growth of university budgets. In Asia this ability to catch up through ambitious change processes appears to be stronger.

University budgets in Europe have been increasing but not in all countries. Needs and challenges are growing everywhere, including global and digital shifts: It will take some investment to keep (public) universities at the knowledge production frontier. Further, student number growth exhibits different patterns across the continent.

For research the form of allocations does matter to a certain extent. However, recent comparative studies imply that a large fraction of output and impact growth is linear to input growth. Starting from this basis our analysis tries to find markers for difference in published sources, namely how individual instruments and mechanisms can and do make a difference. Publication outputs and namely impacts are the indicators most widely used and best suited for international comparisons of university research. They allow for comparability across the board although formidable difficulties do exist. As this is a literature review, university rankings come in only marginally.

Funding of universities takes place in two different forms. Either the state hands out money directly to universities as *Direct Appropriations* or it comes as *Third Party Funding* (TPF) through public research funding councils (RFCs) and agencies.

Direct Appropriations for university research

Such recurrent funding can come in various forms and sub-forms in different countries. In principle, the general mechanism allows for *continuity* through the basic provision of funding within a predictable financial framework; and for deeper, fundamental *change* over a longer time period regarding research quality, career models or other structural factors. When compared to the multitude of TPF sources and programmes taken together, Direct Appropriations focus on a few key targets. As a rule they treat all universities similarly with one set of instruments in one country. Note that Performance Agreements can be an exception to this rule.

Each system has to find its balance between continuity and change. The rating scales of the U.K. REF definitely send out different signals than the Swedish indicator-based funding mechanism. The differences are striking across Europe, and out of the top-3 countries, only the UK has a strict performance-based research funding system (PRFS) in place. From the 1980s and onwards, more countries have switched to assessments of past research to increase output through competition. Starting with the *peer-based* UK exercise (RAE / REF), there was a profound change of governance and properties in a number of university systems. In a broad definition, performance-based funding is present in the majority of European states, with a number of borderline cases. We can observe a shift from more input- to more outcome-oriented policy instruments coupled with a second shift from more centralised and regulated to more decentralised, market-style approaches, the latter including TPF as a competitive funding stream. The main options for Direct Appropriations are the following:

- Self-steering through historically based Block Grants (main model 1)
- Ex post research assessments through peer review (main model 2a)
- Ex post research assessments through metrics / indicators (main model 2b)
- Ex ante oriented Performance Agreements, often coupled with indicators (main model 3)

The trends over the last 50 years first show an increasing variety in instruments and approaches, coupled with feedback, learning and adaptation mechanisms, also to prevent strategic behaviour on the side of the academics to “play” the system.

An overall view on pros and cons of Direct Appropriations as such is not being presented as the options and instruments are too different.

Main Model 1: Block Grants

Recurrent payments can and traditionally did come as Block Funding. This is an unconditional funding form based on past allocations plus some negotiations and some ministry influence, often combined for research and teaching. The state is directly delegating funding and does not condition how the money is spent. The researchers are supposed to be self-motivated and competing anyway. Some very successful small European countries like Denmark, Sweden or Switzerland are among those who still use it as a prime mechanism according to an EUA classification, with funding formulae or in some cases PAs being used as secondary mechanism only.

*The main advant*age is the provision of a safe space for researchers to realise their own ideas, before proposals have to be written and peers are called in. New and seemingly crazy ideas often need time and a certain proof of concept. Evidence shows that public needs are often better met in settings with less pressure to produce certain outputs. *The main disadvantage* of the "old" Block Grants is that it is difficult to set priorities, the money streams remain sometimes unclear and deadweight can be high: The non-performers get a lot of resources and "just like yesterday" is a mixed blessing in a future-oriented activity like research.

Main Model 2a: PRFS with ex post research assessments through peer review

Peer review based-PRFS shall increase productivity and make universities and their research efforts more efficient as well as more customer-oriented. The main properties include: (i) Research is being evaluated, not other university functions. (ii) The evaluation comes ex post, contrary to PAs and project evaluations. (iii) Research output must be evaluated, normally through publication data and citation impacts. (iv) Future government allocations must depend on the outcomes of the evaluation. (v) It has to be a national system.

A typical setting includes peer groups to judge the quality of research and other outputs within each field nation-wide on the basis of narratives and best results provided by university departments, often supported by quantitative analyses. The results of the assessments lead to a categorisation of departments or other units along a scale. Each rung on the ladder is linked to sometimes drastic financial consequences. The main goal is a combination of quality-orientation and efficiency: More and better output shall be produced through strong competition and re-allocation. Some countries have through these mechanisms seen strong changes in their university landscape, with a lot of money and prestige at stake for universities, fields and researchers.

*The main advant*ages include the "value for money" approach, resources are being directed towards high (past) performers. Organised feedback and learning takes place. In some countries the share of excellently rated researchers has increased over time but causality cannot easily be constituted. There is also a link between instrument and behaviour that can be interpreted as a welcome impact or as considerable pressure on researchers. *Main disadvantages*: There might be tendencies to favour mono-disciplinarity, non-cooperation and less risky research. The system is expensive and can incentivise all kinds of „gaming" strategies. If not executed strictly, with a rating system that doesn't hurt, moderate changes could be more than offset by high financial and social cost. If executed strictly and punishing the weaker organisations and less central fields, then strong geographic and other concentration tendencies can follow.

Main Model 2b: Ex post research assessments through metrics / indicators

This model also assesses past performance. It determines part of future funding through a mathematical formula. It is an easier and cheaper way to perform ex-post assessment instrument than

peer-based models. The exercise can be done annually and inform next years' budgets for each university. It can also be part of a multiannual budgeting design and often adds a competitive twist to an otherwise historical / negotiation-based funding model. In some countries like Sweden there is also a cap or a minimum baseline. In use in many countries, the indicators can trigger reallocation within a "close envelope" (i.e. within a fixed HE budget), while others allow for growing overall budgets. To avoid a rush for high quantities of output, citation impact scores or a "top paper" category can be used.

*The main advant*age is that indicators come relatively easy and cheap and also smaller-scale signals seem to work. Some goals can be realistically achieved and indicators can be coupled to other allocation instruments. *Main disadvantages* include that indicators cannot capture the full realm of university research and might also crowd out less mainstream work. Causality is often difficult to constitute. Finally, indicators can make believe that a real competition is going on while in fact this might not be the case.

Main Model 3: Ex ante oriented Performance Agreements

Other countries prefer ex ante steering through negotiations. These Performance Agreements (PAs) are contracts between the state and universities, stipulating (in most cases additional) efforts by the university. These PAs can also be coupled to (in some cases additional) financial allocations and to indicators. They are forward-oriented instruments in form of multiannual contracts between individual universities and the state. Future performance is being negotiated *individually* with universities. This is often a soft instrument but can influence the behaviour and budgets of universities. The main functions include profiling and strategic dialogue in recurrent rounds.

In use in many countries, the „surplus model" appears to work better than the „comprehensive" model: While the former only contains additional activities for the next period, the latter includes the full spectrum of each universities activities and therefore takes a lot of effort and resources to deliver.

*The main advant*age is the individual character of the contracts providing for individual next developmental steps, including profiling and negotiated co-development. It can work well when a surplus is being negotiated in a focussed way. It can further help to improve dialogue, transparency and accountability. *Main disadvantage*: A *steering instrument* between two uneven partners called *contract* carries some ambiguities that could hollow out university autonomy. In the "comprehensive" version it can be a process binding a lot of resources. Goals are difficult to set in a spectrum between comfort and survival.

Third Party Funding through programmes and projects

Project and programme funding is the second big stream of state allocations for university research. The state entrusts Research Funding Councils (RFCs) or innovation agencies with the allocation of projects. This kind of funding comes with the expectation to get clear-cut and manageable ideas, better quality control through peer review and more value through competition and monitoring. The main function of TPF is twofold: On the one hand it sends quality signals and funding directly to the researchers who apply for grants. On the other hand, TPF can in a flexible way induce or incentivise relatively quick change in one or more dimensions like science-industry collaboration, societal challenges or careers for young researchers. With its flexibility and adaptability TPF funding treats different things differently.

Councils and agencies act as agents for the state – the principal without domain knowledge – in expert fields. Therefore, power and money are being delegated to representatives of the scientific community

or other knowledgeable agents. Note that many such funding bodies are being controlled or co-shaped by the scientific community itself.

Some TPF instruments have become large and influential while others work in defined niches. Taken together they cover a huge spectrum of specific targets within a given country. Each funding source or programme has specific intervention logics and uses or should use output and impact measurement as well as evaluations. As with Direct Appropriations, outputs and impact levels vary, but to a strong degree also depend on the input side.

In general, TPF / competitive funding schemes have the following *advantages or "pros"*: (i) They increase quality and relevance of research proposals through invitation to apply, funding criteria and reviewing. (ii) They ensure minimum quality standards through planning a project along a structured template, and through reviewing; this is also a path to efficiency as many proposals are indeed of weak quality. (iii) They allow for testing ideas with peers: Peer review has clear advantages here, as many scientists review to see what their colleagues are planning to do. In this context it is important to avoid over-competition and small or local peer pools. (iv) They build trust along fair procedures. This is a core task of RFCs and funding agencies. (v) They send thematic, structural or quality signals to the relevant communities with the funding programmes. (vi) They send the funds precisely where they should go to: The researchers who won the grant actually receive the money for "their" project; and if overheads come with the grants the university even gets a visible inflow causal to the efforts of certain researchers.

The *disadvantages or "cons"* of competitive funding schemes include: (i) They might induce short-termism due to increased competition and to the nature of fixed term grants, which inter alia makes it difficult for hiring of PhDs and PostDocs. (ii) They are vulnerable to mainstreaming and to funding less-risky proposals (with mixed evidence). Truly novel ideas can struggle with TPF. (iii) They produce considerable (hidden) costs of writing, processing and appraising proposals. These costs explode when many formal rules meet low acceptance rates. (iv) They might contribute to the universities becoming a research hotel without proper integration of projects and people into the realm of the university: This can happen in combination of generous TPF and underfunded and/or weakly organised universities. (v) Gaming as a strategy can be substantial (as with Direct Appropriations).

Peer Review and alternative proposals

A lot of such criticism centres around the common practice of peer review in TPF and PRFS, e.g. that it cannot identify the best from the very good, that it is laden with various and serious biases and conservative by nature. The gender bias does exist both in Direct Appropriations and with TPF but (as many other biases) becomes more visible and better measurable in the context of TPF due to its higher degree of transparency. Many problems arise from non-curated / unsmart peer review; or from oversubscription. Alternative proposals for selection strategies include egalitarianism, lotteries, crowdsourcing, challenges and – most interesting – programmes to fund transformative, risky and interdisciplinary research. The issues and flaws are increasingly taken seriously by many actors. Two valid properties of peer review are: (i) Mechanisms can be curated and adapted; and (ii) it still works quite well and enjoys quite a lot of trust, as a comparatively fair and rational way to allocate resources to extremely specialised people and proposals.

Variety of TPF sources and programmes

TPF comes in different forms:

- *Individual smaller projects* are the basic products of RFCs and allow for ideas to evolve within a certain timeframe. *The main advantages* are the bottom-up character and the freedom of project design. *The main disadvantages* include short-termism as a direct downside and oversubscription and conservatism in decision making often as an indirect downside. The latter is due to the large number of active researchers and often the reduced room for manoeuvre within their own university, as Direct Appropriations often are to meagre to support experimental research (and TPF selection procedures then has problems with such unproven research designs).
- *(Young) Investigator projects / large person-centred grants* allow for increased (early) autonomy for top researchers. They provide considerable funding for new avenues and bigger ideas. Universities and systems can be challenged through such funding mechanisms like the ERC grants. *The main advantages* are the size, scope and duration (and increased autonomy), allowing researchers to do different things *and* things differently, on a considerable scale. Further, such grants impact organisations, with different consequences in different countries. *The main disadvantage* might be the popularity of this instrument with funders and policy makers, creating Matthew effects and a sometimes too close relation between star funding and academic career paths. A further challenge is the question whether future best performers are selected.
- *Strategic and mission-oriented programmes* allow for organised collaborations that would not always take place without such funding, e.g. industrial or societal innovation through university funding over the longer term. *The main advantages* are the ambitious outcomes made possible. If focussed, they are a form relatively easy to implement, e.g. of science-industry collaborations, leading to fruitful outcomes for both sides. The *main disadvantage* of focussed strategic programmes is that "real" results in business and society take a long time to be generated and yield profit, and the appropriation of impacts is difficult. Too much happens afterwards within the company and with third parties.
- *Complex multi-actor programmes* are based on more challenging multi-actor concepts and combinations, from the helix-style to European Added Values through consortia funding, often close to a tipping point to over-complexity. *The main advantages* of complex multi-actor programmes are that pre-competitive platforms can be created and maintained over longer periods, they exert influence on expectations, norms, on standards and joint outputs, lowering barriers in multi-actor arenas. Further the spectrum of university activities can be widened, contributing to industrial and societal challenges. *The main disadvantages* of such complex multi-actor programmes include deadweight and high cost of collaboration. They probably nurture the illusion that such collaborative consortia can achieve what normally only strong competition can achieve. Over-complexity is an imminent danger, as well as bureaucracy and fuzzy impacts.
- *Centers of Excellence* (CoEs) are another form of top research funding through networks or centres with quite some popularity among nations and universities. *Main advantages* of CoEs include size and scope and the pooling of resources through long-term funding for important topics. They often are platforms for cross-disciplinary interaction and in some programmes yield very high scientific outputs and impacts. *The main disadvantages* are that some programmes cannot show that "their" CoE-funded research produces higher impact than research funded through normal grants. The afterlife is often difficult and such large centres do in general not remodel the research landscape.

One more step: Interactions between different forms of funding

While there is a lot of literature and evidence on individual funding instruments and mechanisms, much less is known how they interact. The main challenges here are the mostly unclear interrelationships, dynamics, impacts and causal pathways; and then there are loads of context and history everywhere. It proves very complicated to analyse a funding system within one country, let alone to compare systems across countries.

Fortunately some efforts have been made by scholars to understand and by policy makers to influence such systemic mechanisms. This review discusses three kinds of sources and phenomena: comparative studies of quantitative and qualitative nature; hybrid instruments; and characteristic crossroads between the two main funding instruments.

Comparative studies in a nutshell

- The *policy view* contains mostly qualitative exercises: For such studies, leadership, competition and strong actors are the success factors. They often argue for stratification, quality signals through TPF and Direct Appropriations, priority setting at national level, increased direction and funding of research, and governance of universities and notably university leadership.
- The *comparative model based view*: In these mostly quantitative, model-based studies the winners are sometimes the less competitive systems with no PRFS, offering evidence that such systems can also be very efficient, measured on a funding per publication scale. These studies argue for research evaluation systems (but no PRFS) and for generous block grants.
- The *how-do-indicators-work view* contains quantitative plus qualitative studies: They sometimes reveal more gains in outputs than in impacts and they struggle often with causality in a hard-to-control outer world. However such studies come forward also with arguments in favour of indicator-based funding.
- The *qualitative, shop floor view* often asks how researchers and epistemic communities do react and adapt. Many observations do support a policy mix creating options, (not only) with a well-endowed TPF system, including bottom-up but also top-down funding elements. At the same time a world with too meagre Block Grants is no good place to be. The researchers view with (social) capital accumulation metaphors is a useful one, as many mechanisms become clearer on a comparative micro- and meso-level. Intra-scientific factors and societal goals might matter more than funding opportunities, but the latter again are more important than signals from university governance.
- The *vice chancellors' / deans' office view* includes a mix of quantitative and qualitative approaches: TPF has steering effects on Direct Appropriations, but much depends whether universities have a clear strategy regarding recruiting and thematic portfolios. The execution of such strategies allows the build-up of a vibrant portfolio. If a strategy is not in place (for whatever reason), TPF can suck off Direct Appropriations and the general feeling of poverty can emerge even in well-endowed places.

Hybrid funding models

Examples from different countries like the German *Exzellenzinitiative* or the Swedish *Strategic Research Areas* show that elements of Direct Appropriations and TPF can be combined to strengthen stronger places and groups. The learning is very country-specific. There are many positive effects,

however the main intended advantage of electrifying whole universities and systems is more difficult than perceived.

Crossroads between funding instruments

A few such crossroads are being discussed in the review. *Overhead payments* allow for some coverage of real cost of research as we find no full cost TPF model in Europe. Overheads can serve as a useful quality signal to university leadership. The opportunity to use them as a strategic token seems not to be utilised by universities very often. The *strategic use of TPF* depends on the existence of university strategies and full cost models show that considerable amounts of Direct Appropriations are needed to fully cover cost of TPF projects. If, however, TPF is binding most of the Direct Appropriations for research *and* TPF funded staff can achieve permanent positions in greater numbers, the main advantage of Block Funding of all kinds does vanish. *Academic careers* are being explicitly and implicitly influenced by a number of TPF instruments, like large person-centred grants asking for tenure track or similar career paths to facilitating early independence. In some countries excellence grants stand for safe career options, with meagre career opportunities for those researchers who do not succeed with these quite rare large grants.

What can be found in the Conclusions chapter?

The final chapter presents three approaches. First, along a number of phenomena and four country examples it tries to summarize what works under which conditions. Second, it argues for a level-playing field. All the weak points of TPF are highly visible due to the transparency paradigm of project and programme funding in design, criteria and evaluation practices. When actors call for more basic allocations and trust based management, they should be able to produce a more or less comparable level of transparency and self-criticism, although the need for TPF to legitimise will always be a little higher. Third, the pros and cons for Direct Appropriations and TPF are again presented along three dimensions: Research quality and impacts on science; Developing people and gender equality; and Going for relevance and “real world” connections.

2 Overall Frame

2.1 Background and commission

The following analysis is a review of existing literature on governmental funding streams for research and serves as a contribution to the discussion of the relative advantages and challenges they pose. It takes a view on contributions from the different strands of scholarly research, evaluations and policy documents and shall feed into the current discussion on university research funding in Sweden. Formas, the Swedish Research Council for Sustainable Development, together with other funding organisations is preparing for the next phase of Swedish research policy which will be designed in the 2020 Research and Innovation Bill next year. In this context the future university funding is currently under review; the so-called STRUT report (SOU, 2019) has been issued in February 2019.

Therefore, the roles of research funding organisations, both Research Funding Councils (RFCs) and funding agencies, will be part of the negotiations. This current step builds on long-term discussions in the Swedish research system, starting with the Malm Commission in the 1940s. This led to varying configurations, always with universities at the core of research policy and a comparatively large number of RFCs, agencies and foundations as providers of competitive (third party) funding streams. Impacts have always played a strong role in this discussion, as well as the balance between Direct Appropriations and Third Party Funding (TPF).

The question of who is at the steering wheel appears to be of even higher importance for the actors involved. Here strong parts of the scientific community often managed to secure large budget shares for what they think was best for research, for their fields and for Sweden in general, while innovation policy approaches and mission-orientation often had a more difficult time to get proper resources. As Sweden is not a country known for rigid top-down control and priority setting, these discussions tend to cluster around the Research and Innovation Bills every four years where basically the surplus (i.e. budget growth) is being distributed. Finally, the Swedish public university system puts some, but definitely no excessive emphasis on strategy formulation, strong internal competition and a full-blown tenure track system with active recruiting. The steering through the Direct Appropriations in this respect isn't excessive either. Therefore, it is important to see which kinds of signals from both forms of state funding have which effects and impacts, and as more challenging task, how they influence each other.

Formas has asked for a conceptual (*theoretical*) analysis *"… to investigate the pros and cons of distributing research funding directly to universities vs. distribution through research councils / agencies comparing how these different streams of funding are influencing institutional, environmental, organisational and individual factors*" (taken from the Formas request to commission the analysis). This analysis is of qualitative nature and includes both a literature review of literature / and analytical elements. It is based on existing research and will not produce new evidence. The main level of analysis is the EU 28 plus associated countries. In addition, evidence from other countries and global surveys are being used where needed for comparisons.

The author conducted an extensive literature search and wrote this analysis independently. An expert group workshop took place 18 February 2019 in Stockholm that provided valuable advice and guidance and further served for quality control of the first draft or this analysis. This expert group consisted of seven senior experts as members: Jean-Luc Barras (Swiss National Science Foundation, Switzerland), Aldo Geuna (University of Torino, Italy), Steven Hill (UKRI / Research England, UK),

Elizabeth Koier (Erasmus University Rotterdam, Netherlands), Stephan Kuster (European Science Foundation), Terttu Luukkonen (ETLA, Finland) and Stig Slipersaeter (Research Council of Norway, Norway). A Swedish stakeholder workshop with 25 participants from universities and funding organisations was held on 8 March 2019 to discuss the second draft of this analysis.

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2.2 No silver bullet but no complete shotgun approach either

The task of this analysis is to identify the pros and cons of various instruments in the international discussion regarding the main funding streams for research in the university sector. In Sweden and nearly everywhere else the two main allocation mechanisms are (i) direct appropriations to universities (*Direct Appropriations*) and (ii) Project Funding (*Third Party Funding*, TPF). Due to the specificities of each national system, they come in various forms and together with a broad array of incentives and under different conditions. Each country therefore has its own distinct profile, stemming from history, from underlying policy narratives, further from the properties of its university sector and of the research support system. Additional shaping factors include socio-economic needs, the degree of organisational university autonomy as well as the degree of international openness. Mutual learning about instruments and some mainstreaming does take place increasingly, both within and across countries. However, the different trajectories appear to outweigh the common features.

This multi-faceted picture becomes even more complex due to a "moving target" effect. Funding instruments and steering mechanisms are created at a certain point in time, always with limited information and with – *more or less* – focussed intervention logics. Even if they work perfectly, which is not always the case, the actors take further steps, change their approaches and incorporate new developments. Academics and their organisations are very good and quick in finding mitigation strategies as well as creating bypasses, sometimes changing the meaning and intended effects of the steering mechanisms. Therefore, the overall policy settings and individual rules and incentives have to move and change also. This creates two challenges for our analysis: First, what we see from the literature and from evaluations is relevant for the moment or time period studied and is therefore also reported here as a message from a certain moment in time. What we describe as a "pro" or a "con" often has a movement towards the other pole already embodied; and there is a large number of eroding or self-regulating mechanisms over time. Geuna and Piolatto (2015) title their review of Research Assessments: „*Costly and difficult, but probably worth it (at least for a while)*". … At least for a while, and then the world has changed again. So, what to do? First we refer to poetry: „*Wo aber Gefahr ist, wächst / Das Rettende auch*."[1] Second, we have to ask our readers to accept that this review is about pros and cons and not about a whole web or jungle of contexts.

Further, serious data and information problems do not allow to come forward with a kind of universal success formula. Qualitative studies can always draw only a part of the whole picture, while

[1] Friedrich Hölderlin, from *Patmos* (1803); *Where there is danger, also grows the saving power.*

quantitative studies often cut out much of the context and framework conditions. Researchers and policy makers often do not know enough about the real impacts of certain instruments within a given country or a set of countries; they know even less about the interplay of such instruments like competitive project funding and direct appropriations e.g. through a performance-based funding system (PRFS). Cross-country comparisons therefore are difficult to draw, and only with caution.

On the other hand, there *is* a substantial stock of publications on these issues, including evaluations, literature reviews, in-depth analyses, international comparisons of instruments, country reviews and policy reports. A lot of research has been conducted on various forms of direct appropriations to universities as well as on project funding, including their impact on specific factors like mobility, careers, research content or links to industry and society. Researchers as well as policy makers have been trying to find out which kinds of steering efforts are working better under which conditions, unveiling a number of correlations and also causalities. Yet, the conclusions often are: "*we don't know*", "*if only the data were better*", "*it depends*" or "*more research is needed*". As there is a lot of serious work being done, this shows how complex and sometimes opaque the interplay of funding streams are and how difficult it is to describe, let alone prove impact pathways.

As no "silver bullet" could be found in the existing literature, a step-wise approach for the analysis has been chosen, taking into account the underlying main assumptions and qualitative as well as quantitative research lines. Answers are required about pros and cons: Therefore, it is of minor importance to describe which research fields like economics or sociology of science have made which contributions to the body of knowledge. We are interested in results and evidence and of course also in the limitations to what we can find out with different approaches. On the other hand, it is important to examine important shaping factors like the input side, the issue of impacts or the use of peer review as a dominant method in TPF (and sometimes also in Direct Appropriations).

Another important point is how the pros and cons are treated: Due to the wealth of publications and the heterogeneity of approaches in the surveyed literature, the synoptic overview at hand necessarily remains coarse and not exhaustive. We have also chosen a very simple structure to identify the pros and cons *as well as* some interdependencies, also with other factors, in a step-wise approach: In *chapter 3* we see what we can learn from how universities have been studied and analysed, followed by a short overview on context factors and future Higher Education challenges in *chapter 4.* The following *chapter 5* sheds some light on size and flows of input as a strong determining factor. Then three main parts follow, *chapter 6* on Direct Appropriations and *chapter 7* on Third Party Funding (TPF), both describing various sub-forms, mechanisms, context and impacts. *Chapter 8* presents studies, programmes and phenomena dealing with some direct crossroads of the two funding streams. *Chapter 9* provides some *pros and cons lists*, while *chapter 10* comes forward with conclusions on different macro- and meso-levels.

2.3 Terminology

In this analysis the following terms are being used:

- *Universities* are the main subject of this analysis on the performing side, therefore this term will be normally used in the analysis. The term *Higher Education Institutions (HEIs)* is used when the whole tertiary education sector including Polytechnics / Technical Colleges is being addressed. However, the latter do not play an important role for this analysis. The term *Binary System* means that universities and polytechnics follow different legal and regulatory systems.

The term Research Organisation or *Research Performing Organisation* (RPO) is not used because the subject are always HEIs, in most cases universities.

- *University leadership* includes the top level of the university (like rectors, vice rectors, presidents or vice chancellors). *University management* is used synonymously.
- *The state* is the public entity providing public funding, setting the regulatory frameworks and intervening in other various ways. It can be one or more ministries and/or specific agencies and bodies for regulation and funding, or actors on another level like regional governments.
- *Direct Appropriations* means all kinds of block grants, formula-based funding, namely Performance Based Research Funding Systems, PRFS) and other basic HE funding including public appropriations steered through *Performance Agreements* (PAs). "Direct Appropriations" is the term used in the Formas request for this analysis. Note that there are alternative terms being used in the literature also. The term *Block grants* stands for a completely unconditional funding stream, delivered by the state to the universities, either for research or research and education.
- *Third Party Funding* (TPF) stands for all kinds of projects, programmes, centres and initiatives provided by *Research Funding Councils* (RFCs), public funding *agencies* and other public actors. These TPF activities range from purely bottom up funding to various kinds of top down elements of a thematic, mission-oriented or structural nature. The term TPF is being used as in this analysis there is no need here to further classify this funding into second- and third-stream *public* money (but see e.g. Koier et al., 2016). For the analysis these include all main external sources for research except industry and philanthropic funding.
- *Epistemic communities* are the researchers sharing the same scientific sub-discipline. They form a global college bound by common methods, rules and related research topics.

For *Impact* the definition of the EURECIA project (Nedeva et al., 2012, p. 12) has proven useful: "*A difference of B that can be fully or partially attributed to A*": Attributable change is key, as well as causality and a clear outline of drivers and objects of change. Note that there are different forms of impacts along the two axes Intended/Unintended and Expected/Unexpected. Of course, such a definition makes the lives of funders, university managers, scholars and evaluators difficult as there are so many unknowns, so many actors and intervening factors and so many differences on all levels.

For s*teering*, a useful definition is the following: *"… the externally derived instruments and institutional arrangements which seek to govern organizational and academic behaviours within HEIs … usually but not always emanating from the state*." (Ferlie, Musselin and Andresani, 2009, p. 2).

The analysis will not cover the following topics due to the goals and requirements by Formas:

- *Science-industry* relations and university income from industry or other for-profit activities are not part of this analysis; with the exception of public appropriations for university transfer activities and TPF funding science-industry consortia like cooperative research centres.
- *Teaching* and other non-research activities and funding streams are also out of the scope of this analysis. Where block funds or similar Direct appropriations come as in form of a single stream funding, we speak about its research share (however difficult it might be to know the exact amount).
- Although the state is not only the national state and transnational structures as well as regions play a strong role in many countries, we do not enter into the *multi-level governance* discussion for reasons of complexity reduction. This decision has been taken also in the light of Sweden being a centralist state without considerable responsibilities for HE regional level.

- *Foundations and philanthropic organisations* are important but no public actors. There is a grey zone as their allocations are very similar to public TPF and some research supporting foundations in a few countries can be termed as semi-public.

Terminology is important, and as there is a wide range of literature and quite some disciplines involved, various concepts, terms and definitions are being used. For this analysis we cannot go into detail and have therefore decided to use a very simplified terminology, even if it sometimes may not fully conform to the literature this review is drawing its information and ideas from. Where we stick to a specific source we sometimes have to follow its terminology.

2.4 Sources used

What are the most important sources for this analysis? A useful breakdown of the material is proposed by Sandström and Heyman (2015) for a similar discussion: (i) Single issue policy studies to influence policy in the own country, bringing forward international evidence; (ii) OECD style innovation country reviews with a strong comparative element; (iii) EU Commission or European University Association (EUA) type of reports listing where each country stands, also including data comparisons; (iv) a broad range of scholarly studies comparing countries on own methodological foundations, often producing the data they analyse. The latter are using quantitative and qualitative methods in different forms and combinations. To this breakdown we add (v) mainly interim and ex post programme evaluations by professional evaluators, academics (panels as well as studies) and other actors.

For the analysis at hand we mainly draw upon the following body of literature:

- When it comes to institutional settings and the nature of universities as organisations, there is a rich literature from various strands of social sciences, mainly from different sociological, economics and political science approaches. So (iv) forms the main pool, but there are relevant sources from other pools as well.
- Direct Appropriations are being analysed mainly by scholarly contributions and by comparative reports, with innovation country reviews as another useful kind of source. So (ii), (iii) and (iv) provide useful information.
- We can learn about project funding from a rich evaluation literature as well as from scholarly contributions, with country reviews and comparative reports supporting this evidence. So (iv) and (v) are key, and (ii) and (iii) are also important.

3 Governance and funding of universities and university research

3.1 Universities as a special kind of organisations

Dealing with universities and funding them is no trivial affair for the state and its agents. Neither is HEI management an easy task for their respective leaders. Universities are expert organisations because academics are specialists belonging to their home institutions in a special way, with a substantial degree of independence. At the same time academics are part of their discipline and therefore a global epistemic community where different forms of loyalty and authority prevail. Their academic careers, both within organisations and communities, stem largely from a long series of small territorial gains. Therefore, many of them are trained in tactics and aware of their position. They also have considerable negotiation power (Luukkonen and Thomas, 2016). Further, the nature of their work in research and teaching cannot be understood by many others, it is highly individual, and in most cases driven more by factors like intrinsic motivation or reputational status than by pecuniary motives or given orders of any kind. The university professor in a democratic state is an entity of her own: She can and shall speak up in public and to a certain degree act as an individual person, choose – again to a certain degree – her own research topics (Whitley and Gläser, 2014) and teaching courses. "*Science can be described as a complex, self-organizing, and evolving network of scholars, projects, papers and ideas*" (Fortunato et al., 2018, as analysts of complex systems now board the train of science policy analysis). The freedom of scientific research and academic teaching is a constitutional right in many countries and university staff is the main direct beneficiary of this freedom (… as the author of this analysis recollects from his own legal studies background). However, the increasing focus and the introduction of the third mission of universities to engage in society also put pressure on professors to engage and make research results publicly available to society.

Although there are common pressures through new management paradigms for the public sector (see New Public Management / NPM section below), through mass education and mission-oriented innovation policies and programmes, it does not seem that diversity has decreased. Universities have gained more autonomy (Estermann and Nokkala, 2009; Estermann, Nokkala and Steinel, 2011 and following EUA Scorecard exercises) and have reacted on the NPM challenges. However, this does not mean that they gave their answers in uniform ways. Universities can within boundaries act strategically and position themselves in a quite spacious arena (Fumasoli and Huisman, 2013). At the same time their organisational nature draws limits on their ability to change. They are also termed as *loose* or *incomplete organisations*, strongly different from most other organisations regarding identity, hierarchy and rationality (Reale and Primeri, 2015). While they exhibit similarities to other expert organisations like those in the health system, there seem to be more specific properties. Signals from the outer world and dynamics within the university cannot be answered by shrewd inner changes or quick moves into new fields of activity. Their managers have to share authority in practically all core processes with many actors and "*a great number of divergent and highly diffuse social contexts*." (Whitley and Gläser, 2014, p. 32). The inner world of universities might be described as full of bounded rationality, long-burning but controlled conflicts and multitudes of hierarchical and non-hierarchical power relations, even leading earlier sociologists utilising the *garbage can model* to describe them.

This complex situation is also due to the multi-purpose nature of universities[2], providing different linked outputs: Research is just one of the main *products* of universities. These are mainly created with public funds, most often in state-owned or state-governed universities. The large amount of public funds constitutes a social contract through which academics cannot stay ignorant of real-world questions. Academics and universities shall contribute to an identifiable greater good (Martin, 2011).

The question is how to steer such organisations to achieve public, i.e. state and societal goals (see Box 1 for an illustration). Here a whole spectrum applies, from efficiency, effectiveness and accountability goals to delivering outputs and contributing to impacts on various levels. In the last fifty years the expectations have been growing: Universities should produce graduates that are specialists *and* generalists *and* future leaders; they should provide research results that are ground-breaking and useful and part of a greater innovation arena, helix or system; they should also pursue "Third Mission" activities towards industry and society at large; they should be stalwarts of open science, open societies and responsible action; and with all this contribute to the international reputation of the country they belong to.

Box 1: High-flying outliers – examples for successful university organisation

The way universities and other research institutions are organised seems to have a considerable influence on their research performance, i.e. how they translate financial inputs into research results and outcomes. A number of quite specific organisations with many "breakthrough" research results have been subject to organisational research. This includes studies on the early times of the Institut Pasteur (Hage and Mote, 2010) or the Rockefeller University (Hollingsworth, 2002) with their specific properties in endowment, recruitment, introduction of new topics, cross-disciplinary work etc. Both describe a culture of institutionalising excellence, in the former early case combined with very practical activities like vaccination serum production or public health outreach. In a similar vein, the founding document of the Austrian Institute for Science and Technology (Harari, Kuebler and Markl, 2006) draws similar lessons from the outstanding Israeli Weizmann Institute, with a strong emphasis on strict recruitment and tenure track regulations. These examples are of course outliers as these institutes neither have to deal with undergraduate students nor with lack of funding nor with typical state university regulation.

Case studies of more "normal" universities also show that there are links between organisational set up, strategies and success. A juxtaposition of the MIT with ETH Zurich (Herbst et al., 2002) has been done to show that at that time the very successful Swiss university still might improve through learning from the U.S. example. Paradeise and Thoenig (2013) describe four distinct typologies of Swiss, French, Italian and U.S. universities. The *Top of the pile*, the *Wannabes*, the *Venerables* and the *Missionaries* show different organizational patterns, collaboration networks and values and norms in order to position themselves. Although increasing international competition and rankings are imposing

[2] Just as a note: The state itself as the main vis-à-vis of universities is also a complex multi-dimensional entity. It comes with various agendas and instruments: As owner, as funder for various policies, as buyer of knowledge, as watchdog for quality and behaviour and as a main demand source for all kinds of graduates. Therefore, the state (as well as professional associations) is very close to the universities when it comes to the provision of the rule of law, the fear of god, the hands of surgeons, the calculation powers of engineers or to what teachers shall tell the kids about the world. Many of these issues have a link to research and research funding, but that would lead us too far.

a strong mainstreaming pressure, the local trajectories and strategies appear to be stronger. History matters, and many universities change their norms and practices only slowly, with the exception of the "Wannabes" trying to climb in the rankings. They do it by streamlining all their processes to create high impact research output. The *Top of the pile* do it right because they have always done so: Strict recruitment policies, high reputation and proven internal mechanisms allow for constant high cruise altitude.

It is a dialectic exercise to study the nature of universities and their relation to the state, in our case regarding research funding modes and impacts:

- The nature of their activities defies top-down command structures; universities have among many things survived a century of Tayloristic work organisation without being too much affected by it. Note that only two years ago, a new international association of research universities has been created, proudly calling themselves "The Guild"[3]. Universities are an old and venerable form of organisations with specific inner workings, co-shaped by the faculty and relations to the outer world. Compared to e.g. industrial companies or state bureaucracies they have always been much *looser* or *looser-coupled* (Musselin 2006) entities with strong bottom-up elements, both in their inner structure and in their links to the outer world. History matters and all these factors favour institutional (inner and outer) diversity and a path-dependence of each university.
- On the other hand, most universities across Europe are specific public-sector organisations, they receive most of their R&D resources from public budgets of different kinds (Jongbloed and Lepori, 2015) and they are regulated in different ways through public laws and ordnances. Therefore, many public-sector rules apply. As they cannot escape the trajectory of legal and institutional development of their home countries, the diversity among countries is very strong.

Finding common traits of universities is therefore a multidimensional game with moving targets[4]. When it comes to the relationship between the individual development paths of universities on the one hand and government regulations and other mainstreaming pressures from the outer world, policy research (Musselin, 2006; Whitley, 2012; Paradeise and Thoenig, 2013; Whitley and Gläser, 2014; Paradeise et al., 2009; Jongbloed and Lepori, 2015; Elken, Frolich and Reymert, 2016) therefore uses different categorisations and approaches to find these traits. It also has to be noted that different strands of literature come to different conclusions with different methods and terms. For this review we cannot go into detail which research lines view the universities through which epistemic and conceptual lens, and there are many. It makes a difference whether we take management literature or organisational sociology, and also within sub-disciplines there are considerable differences to be found, both regarding research approaches and results.

[3] https://www.the-guild.eu/

[4] We do not envy social scientists studying universities: They have to combine the abilities of an ornithologist (thousand species, all with their own birdcall), an animal cognition scientist (eye-tracking in the wild is a serious challenge; and before, the beast does not show up for a long time) and a quantum physicist (the experiment changes the state; and, more important, two states exist in parallel).

Even staying on a single continent and leaving out the relations to the state for a moment, universities take the most different shapes and forms according to historical trajectories, missions, internal structures, legal requirements and other factors, including the way they are financed. The Aquameth project (Daraio et al., 2010) mapped nearly 500 universities from 11 European countries. Variation is huge in all dimensions: horizontal diversity (mix of subjects taught, types of activities and products), vertical diversity (placing in a quality hierarchy), and properties like HEI age, outputs number of staff and students; plus other, including different main funding sources. In all these dimensions there are trends towards convergence and at the same time strong path dependencies / differentiations. Some cross-country indicators like publication output per academic staff show surprisingly low degrees of differentiation. Jongbloed and Lepori (2015) title their overview on funding of research in HE in Europe: "*Mixed Models and Mixed Results".* They also reveal wide variations between many hundreds of European HEIs in key indicators (some even on a logarithmic scale; based on data of the European Tertiary Education Databank ETER).

In their qualitative empirical project, Paradeise and Thoenig (2013) observe high levels of diversification that in fact coexist with global standardization patterns. The latter have "… *sent a massive shock wave throughout the academic community*" (p. 192), in all sorts of organisations.

The differences exist on many layers: (i) between larger cultural areas like the Anglo-Saxon world, Central Europe, the Nordics or Southern Europe; (ii) between individual countries with their laws, culture, support structures, financial frameworks and individual trajectories; (iii) between different kinds of universities along a more formal differentiation, like comprehensive or technical or small specific or regional organizations; (iv) between binary systems and those without a legal barrier between universities and other HE performers like university colleges; and finally (v) between different individual universities according to their history, strategies and prestige (e.g. Paradeise and Thoenig, 2013, see Box 1). Examining the relationship between universities' revenues and their expenditures, Leslie et al. (2012) find for the U.S. that public research universities' expenditures balance teaching, research and service, while private research universities directed their expenditures more aggressively towards the pursuit of research.

The dialectic synthesis – although not fully satisfying – is that all the state interventions and implementations of management modes do not seem to reduce the differences between the universities *within one country* in a more substantial way than they add in additional differences *between countries* through national developmental paths and trajectories.

3.2 New Public Management and other mainstreaming efforts

New Public Management (NPM) has been – reinforced through globalisation imperatives – the main trend to change university steering and governance (for many sources: Geuna and Rossi, 2015, pp. 74 ff.; Paradeise, Reale and Goastellec, 2009, pp. 197 ff.; De Boer, Enders and Schimank, 2007). It started from the 1970s onwards and was meant to make public sector organisations more efficient, in part more business-like, more outcome-oriented and accountable by giving them more autonomy, strategic actorship, by increasing contractual relations and by assessments of the performance. Stronger central management structures were introduced or empowered by the state (Estermann and Nokkala, 2009; Deem and Brehony, 2005; Deem, 1998). Schubert (2009) succinctly points out two further arguments for NPM: It can help raise the average quality and it can help reduce a specific behaviour within universities, where the principal allocates the resources and the agent remains unobserved, works too little and "… *would argue that possible failure has to be accrued to bad luck and not to laziness. This is known as moral hazard."* (p. 1226).

The transformation of universities across Europe in the two decades before 2000 came with the following assumptions (Geuna, 2001): (i) Accurate evaluation of research output is possible, (ii) the most promising research avenues can be identified, (iii) cost reduction does not mean a decrease in output quality, (iv) critical mass will increase output further, and (v) the benefits of assessments will outweigh the costs. Ferlie, Musselin and Andresani (2008) see quasi-markets, strong assessments and management empowerment as the three strong denominators. Broucker and De Wit (2015, pp. 70 f.) list marketization, budgetary reforms, autonomy complemented by accountability and a new management style as main characteristics. These properties do not come as a "package deal" but as a tool case for policy makers to pick and choose, increasing differences between countries. *More autonomy* is in some countries outweighed by *more steering and micro-managing.*

As shown in → *chapters 6, 7 and 8*, this policy shift affected the way research is funded along three dimensions: (i) NPM was instrumental in introducing mostly indicator-based, ex-post Performance Based Research Funding Systems (PRFS), and / or Performance Contracts (PAs) which negotiate plans for the future. (ii) NPM made it easier to shift parts of the state budgets for university research from block grants to competitive instruments including a growing TPF share with efficiency and accountability arguments, one example being Sweden in the 1990s and early 2000s. (iii) The managerial reforms constituted leadership and actorship on the side of the universities from the mid-1980s onwards (unsurprisingly starting with the UK; Paradeise, Reale and Goastellec, 2009, p. 205), albeit with a number of limitations. A shift towards an entrepreneurial (Clark, 1983) university management can be observed across countries, with tools for strategic management, planning and efficiency controls, plus new participatory forms, plus values and techniques borrowed from the business sphere (Reale and Primeri, 2015). These assumptions did not fully materialise and had a number of unintended but not completely surprising side effects like short-termism, excessive Matthew effects or conflicting incentive structures. Intended changes have not always taken place and their impact was questioned by many empirical studies (Musselin, 2006). Within and among universities, the level of competition was expected to increase. This happened, also due to other factors like globalization, but quite differently across countries. For further NPM characteristics, see Broucker and De Wit (2015, pp. 61 ff.).

As the goals, expectations and often the budgets have grown (and at the same time also shrunk, when compared to student numbers) much in the last 50+ years, steering and management also underwent massive transformations. The state gave up much of its direct control, while at the same time restricting the room for manoeuvre for university management (i) through changes in funding patterns, (ii) through still strong regulatory frameworks in many countries, (iii) some cherry-picking and (iv) through evaluation and monitoring instruments. Broucker and de Wit (2015, p. 60), state: "*Through isomorphic processes, NPM also evolved into becoming a transnational myth about what constitutes a rational management structure for HEIs.*"

While in the old times before the advent of HE reform, mass universities and NPM, the university leadership often had a rather ceremonial function with the true power having been with collegiate assemblies and individual professors, university leaders now have considerable powers and tools at hand. They are supposed to run or facilitate strategies, to build critical mass and to raise overall quality. In all these activities they appear to be sandwiched between strong pressures. From bottom up, i.e. within the university, epistemic communities and increasing Third Party Funding empower the faculty, while from top down, i.e. the state and its agents, university leaderships face strong accountability pressure, even in areas where the state is still commanding the rules of the game (and should at least share accountability). The existence of performance-based funding elements can be still

coupled with a high degree of protection for staff by the law or strong government preferences for a certain overall research portfolio (see also Schubert, 2009).

NPM has made universities *a little more* like companies[5], in a much more contractual framework, but the old traits remain. Therefore, the differences *across* countries remain strong, see also the country case studies in Paradeise et al., 2009, and so do the original properties and power relations within and beyond universities (Paradeise and Thoenig, 2013) in a given country. NPM has introduced many elements to make universities more complete organisations along the categories of hierarchy (management, leadership, procedures), common identity (specialisation, autonomy) and rationality (formal agreements, assessments *within*), but again the differences remain strong. However, different trajectories can be found, including some universities (in specific) countries trying stronger to be complete organisations and *managerial* instead of *traditional* universities. Heterogeneity indeed rules according to Seeber et al., 2014: The authors also conclude that "… *According to the modernization rhetoric, more complete universities are supposed to be more efficient and* research productive*, while so far the scholarly debate has not recognized such links.*" (ibid, p. 1455, → see also chapter 8).

Schubert (2009) finds for Germany correlations between NPM introduction and research efficiency. There appear to be – in this case positive –impacts of having stronger presidents, increasing operational flexibility or increasing strategic capabilities on the cost of producing a wide variety of research outputs. However, investigating the impact of new public management reforms on university leadership's capability to steer research activity, Seeber (2013) finds that in contrast to the dominant managerial rhetoric, there is considerable variation in the steering capability across disciplines. For more country cases, see Broucker and De Wit, 2015.

The nature of scientific research and the ways in which research funding is being allocated appear to uphold these specific properties. Whitley and Gläser (2014, pp. 31 ff.) present a number of reasons for this: Research is risky and outcomes are unpredictable. People next door and up in the hierarchy cannot judge the quality of a certain research activity, at least not in advance. Global epistemic communities wield a lot of power through various kinds of grooming and bonding as well as through peer review and other forms of judgment. Further, individual researchers apply for TPF that might in case of success also thematically and financially determine considerable Direct Appropriations. The thematic priorities are often defined on government level (Laudel and Weyer, 2014), in funding agencies, most notably in the European Framework Programmes (FPs), less in RFCs. Finally, university leadership in most countries is being (re-)elected by their colleagues. There is room for manoeuvre for university management, but it is limited.

Even more difficult to trace and identify are the changes in the mind-sets of academics and stakeholders. However, there is an emergent body of literature addressing the impacts of the shift towards more project-oriented funding and the dominance of indicator-based performance assessment associated with NPM (Müller and de Rijcke, 2017; Franssen et al., 2018). For instance, drawing on eight case studies in high performing Dutch research groups, Franssen et al. (2018) compare the different effects of funding acquired from prizes and those from project grants. The authors observe that "*funding arrangements structure how individual researchers, research groups and institutes organize research, whether they can deviate form their own research trajectory and how they organize*

[5] Note that there are many sides claiming that NPM has made universities a company or a slave to liberal capitalism or put it under another external logic of (knowledge) production. When working closely with universities such claims however remain quite abstract.

epistemic innovation" (p. 32). They find that, first, research groups funded by prizes were able to spend their money in a more flexible and adaptive way, focussing more on networks and staff members, while the project-based funds were rather spend on PhD-students and postdocs. Second, prizes were spent "*to intervene, first and foremost, in an organizational entity … bring[ing] about epistemic innovation at the level of their own research but also on a larger scale*" (p. 31). Finally, the establishment of networks that require a more flexible use of funding enabled epistemic innovation on a much deeper level than would have been possible through a project-based grant.

However, Franssen et al. explicitly state that prizes are not a suitable alternative, since they are typically rarely awarded and privilege research at the top of the proverbial food chain. Their point rather is to emphasize that the type of funding researchers receive has far reaching consequences in terms of how research itself is structured. In a similar vein, Müller and de Rijcke (2017) explore the role of performance metrics in the life sciences and show how performance metrics have come to dominate research practice, "*affect[ing] decision-making practices regarding research topics and the social forms in which research is being conducted*" (p. 165). The quest for high-impact publications shapes researchers' epistemic orientation and is potentially leading to (i) a limitation of epistemic diversity and (ii) a displacement of other, less quantifiable forms of research valuation. As the dominance of metric indicators becomes stabilized, it also becomes internalized by researchers and thus turned invisible.

Reputational capital and step-wise terrain profit act as strong drivers: It has proven useful to adapt the analysis of capital accumulation to the academic world (Fochler, 2016). NPM and related management concepts have for sure influenced the way how academics think, how they perceive their options and which kinds of pressures they encounter. There is another web of direct and indirect influencing factors, including Direct Appropriations, TPF, career opportunities, time constraints, peer pressure, administrative rules and paperwork, among others. This all materialise in a black box – or dark grey box – called universities. Here it is definitely true what academics like to end their papers with: More research is needed. The inner workings of universities are a topic definitely understudied. One of the nicest properties of academia is a strategy they share with internet giants like Facebook or Google, although for different reasons: They want to know all about us and the world, down to the last frog in the Amazonas Delta, while we should not know too much about them.

3.3 What can we expect from public funding of universities?

In a critical literature review surveying empirical literature on the benefits from public investment in academic research, Salter and Martin (2001) identify six main ways in which publicly funded basic research contributes to economic growth.

- First, public research increases the *"stock of useful knowledge"* (p. 520), since government-funded publications make the costly and difficult processes of accessing and using codified knowledge easier for firms.
- Second, "*skilled graduates"* (p. 522) not only are up-to-date on recent scientific research, but are also trained in complex problem-solving, using advanced techniques that can be translated into an industry context. Companies on the knowledge frontier employ more and more PhDs for their problem-solving capacities.
- Third, publicly funded basic research creates *"new scientific instrumentation and methodologies"* (ibid.), since researchers in basic research are often forced to create new equipment, techniques or procedures, which subsequently might get picked up by industry,

with the scanning electron microscope or superconducting magnets being prominent examples.
- Fourth, government-funded basic research provides firms with access to *"networks and social interaction"* (p. 523) within the *"national and international networks of experts and information"* (p. 527).
- Fifth, basic research contributes to the economy by increasing *"the capacity for scientific and technological problem-solving"* (p. 524)
- Finally — though with only limited empirical evidence — publicly funded basic research may also led to the eventual "*creation of new firms"* (p. 526) which in turn contribute to the economy.

This is a still valid list and no further details are needed here. A number of studies and evaluations presented in this review confirm these findings. We further learn from large surveys (e.g. Hughes et al., 2016) that the actual contribution of university-based research to industry and society at large is being rather underestimated. There are many pathways of these forms of transfer and specific funding mechanisms are just one of various transmission belts. This richness and variety in fact carries two messages: First this is an argument in favour of trust-based management. Much is happening through intrinsic motivation and initiatives by the researchers themselves and therefore to many forms of self-organisation. Other impacts are coming through incentives provided by funding mechanisms, both performance-based elements of Direct Appropriations and specific TPF programmes; this is being portrayed in → chapters 6 and 7. We also see that a lot of the impact (pathways and delivery) depends also on various forms of context, see → chapter 4.

3.4 Conclusions for the Pros and Cons

- Not only do many universities enjoy a considerable degree of autonomy; the senior staff does so as well. At the same time there are also considerable normative and everyday pressures, coming from managerial, financial, rhetoric and professional signals of all kinds. Being a university professor today is definitely different from being it in the good old days, whatever the good old days might have been. Further we might quite safely assume that intra-academic competition for resources, positions and reputation does shape the academic profession at least as strongly as all kinds of steering and managing tools do.
- Variety is huge, even within countries. Variety also means that in many countries we find a long tail of less fortunate places, and within most universities a long tail of less able-bodied departments. Many of their traits make universities specific and difficult objects for steering attempts, and some of these attempts are no good idea at all. On the other hand, the academic cry for freedom might translate for the outer world into "*leave us alone*" and "*we know best*". The borderline between trust-based management and moral hazard is therefore thin and both sides, the academics and the outer world, act wisely in acknowledging that.
- It appears to be very important to have strict recruitment procedures in place, as well as a tenure track or similar career paths guaranteeing early independence and merit-based promotion: Most senior staff stay for 20-30 years and has a strong say in the *university as an organisation*. Universities are still the sum of their senior staff. There might be a strong causal relation between the quality of a university and the quality of its staff.
- NPM has had strong consequences but the university management cannot play a fully executive role (and perhaps shouldn't). It is sandwiched between the ministry and the

academic staff. Therefore (Gläser and Laudel, 2016, p. 135), governance through funding will most likely remain a stronger influence than NPM inspired management mechanisms.

- NPM did not only change the Direct Appropriations but also went along with more TPF, as this source stands for efficiency and accountability.
- The universities are not fast movers. They carry the weight of their individual histories and traditions, which renders fundamental systemic change an eminently difficult endeavour.

4 A myriad of influencing factors and changing frameworks

4.1 A note about context

Universities, research and its funding are topics embedded in thick layers of context. Therefore, this analysis rather tries to decrease levels of complexity and concentrate in the topical chapters on the main results of evaluations and scholarly contributions, focussing on the main co-determining factors. The reasons are obvious: The analysis must be readable, the findings somehow comparable and the pros and cons should be described without endless explanatory or discounting text parts.

Whatever the effort, the context of course does not go away. Therefore, this section in a very brief form will list some contextual spheres relevant for university research funding (while section 4.2 deals with ongoing shifts that are about to change properties of the HE world). Most of these spheres are being taken into account in different chapters, but not everywhere and not all of them. Readers should be aware that these few pages here are not a "review" section and therefore work without the analysis of individual sources. For practical reasons we come forward with two different angles. First, we look at context factors through the lens of the main outputs of universities, as listed by Salter and Martin (2001, see also → chapter 3). Second, we look at different institutions in a broad sense, including norms and legal frameworks as well as important influencing factors.

Context factors influencing the outputs of universities include:

- The *stock of useful knowledge* is first influenced by the question *what* knowledge is and what is useful. For the universities there is a pressure to produce such knowledge, to be faithful to the social contract of university financing (i.e. money for results) and the patience of elites and the general public when these results become useful. The situation has become more complex through increased mission-orientation and helix-style / more open knowledge production arrangements. Second, it is of great importance *where* the stock of useful knowledge is being increased, as high hopes for wealth and power are a driver for regional / national / supranational innovation systems and property rights play an important role.
- The education of *skilled graduates* depends on the quality of those who instruct them and how much time they are able and willing to spend on teaching. The issue of combining or separating research and teaching is a core question in this respect (but not covered by this review). It depends further whether universities and individual curricula are being perceived as attractive by future students and by the outer world, a factor that will gain prominence in a number of countries due to the demographic developments. Another factor are contemporary forms of education and how they can be provided, see next section.
- *New scientific instrumentation and methodologies* are key for scientific progress and many research fields in the last decades could emerge only because of new tools to "see" new phenomena. Infrastructure is mainly a question of (research) funding: It is not covered in the review (i) due to complexity reduction and (ii) because its form of funding is much less contested than the way people or research projects are being funded. However, the larger the infrastructure, the more complicated the context will become. One example is about inter-governmental or supra-national negotiations to agree upon large scientific infrastructure projects, another one the worldwide networked analysis of immense data flows from all kinds

of large facilities. Some scientific instruments like satellites or space stations are at the same time political turfs.

- *Networks and social interaction within the national and international networks of experts and information* connect links to a whole encyclopaedia of contexts, from birdwatching citizen science to nuclear non-proliferation. Perhaps the most interesting point here is the researcher and her results as part of the political or policy process: The academic experts shall come forward with evidence, speak truth to power and serve society … in a process where evidence, truth and service is not always the key to success. Ethics is important, good policy procedures maybe even more. A lot of research at universities is being shaped, funded and commissioned because the state and society are in need of understanding pressing problems and obtaining results to answer them: The scientific problems then are born in the user sphere.
- The *capacity for scientific and technological problem-solving* does not depend on money alone, but on stable framework conditions. These include seemingly simple issues like access and permission to do research: The discussions about data protection levels, FDA approval or genetically modified organisms can shape whole research fields in a given country, as well as the access to public registers. The most important point here however is on another level: It is the personal *capacity*, i.e. the quality levels of the university researchers. Here we touch a central argument of this analysis: The ability of universities to attract and retain top people is one of the main influencing factors in the whole research funding debate. It works two ways: First (with less policy implications), top people can attract more TPF, publish better, have higher impacts and contribute to their home universities' financial success also in performance-based forms of Direct Appropriations. Second, it might matter less for a university or a country how HE research is being financed (i.e. the specific combination of Direct Appropriations and TPF) than the way how researchers are being recruited and promoted. We assume that the best funding system in the world cannot make up for less-meritocratic recruitment regulations and practices.
- Finally, the *creation of new firms* has to do with the degree of entrepreneurial spirit in a university, with the quality of research being done and the effectiveness of legal, organisational and commercial tools at hand.

Context factors from the institutional side depend on institutions. Therefore, everything is connected with everything *but* in different ways and with different properties across countries. So, for each country (in some countries for each region) the following applies: Laws, budgets and general rules are often interdependent and determine organizational behaviour, leadership action and the interaction between universities, funding organizations and other actors. These all influence the behaviour and opportunities of individuals, groups, departments and communities, again with all kinds of context. There is a bottom up influence of action and structures on higher levels through collective and group behaviour. There is history and historical trajectories are usually very strong and characterised by longevity in the university world. There is multi-level governance. Out of countless factors we present only two here:

- *University acts* regulate how the HE sector works. As shown in → chapter 3, we find a huge variety of legal frameworks across countries. This applies for all major categories, including leadership, budget, recruiting, staff status, student admission, curricula and much more. This has two dimensions in publicly-owned and publicly-financed HE systems: One is the degree

of university autonomy along various elements, ranging from high to low[6]. The other, often less discussed dimension is the density of the public legal framework: Some countries including Scandinavian nations restrict themselves to the regulation of principles and key mechanisms, leaving many detailed questions for future solutions or in a kind of subsidiarity to lower levels to deal with. Other countries like some German-speaking nations have huge university acts, full of detailed rules to fix all potential issues in an ex-ante process, with two consequences: One is the constant growth of these acts, as unsurprisingly new problems come around the corner. The other consequence is the cascade effect: What is regulated on the top layer must be duly negotiated and regulated on the lower levels, leading to the creation of magnificent layered systems, a bit like the famous Odessa Steps we know from the Sergej Eisenstein movie.

- *Foundations and philanthropic sources* are in some countries major financial contributors to university research and are therefore co-shaping research agendas, the instrument tool-case and all kinds of expectations. This can happen in rather "poor" systems like Italy, where regional foundations make up for a lack in public TPF. This takes place more often in richer and more dynamic systems like Denmark or the UK, where research foundations play a major role. The Wellcome Trust[7] currently spends more than a billion GBP, mostly on biomedical research within the UK. Such sources even lead to state regulations in university financing, providing for the missing full-cost equivalent of foundations through state appropriations. 14% of UK HERD is being provided by foundations. Some U.S. foundations have a larger annual research budget than a small, less fortunate European country. 9% of U.S. HERD is being provided by foundations. The picture is similar in Sweden: Private foundations in Sweden contributed 12% to overall research funding in Sweden including Direct Appropriations (UKÄ, 2019). This is a large contribution: Compare the SEK 4.9 billion from private foundations to SEK 6.4 billion from RFCs and funding agencies. Note that both TPF sources have each grown by around 75% in the last ten years, with a further growth potential.

4.2 Paradise lost? Will universities be the same in 15 years from now?

This short chapter shall raise the awareness that universities and HE research do not just face complex challenges within current set ups regarding steering, funding and impacts, which are the core topics of this analysis. While we have grown accustomed to a number of well-established beliefs and conflicts, there are further challenges ahead, some of which might profoundly change the mission and functioning of universities. The aim of these few lines also is to find a few less conventional or expected viewpoints for university funding, which shall feed into the discussion about challenges for (Swedish) university research funding in the future, with potential influence on governance and funding streams. Such challenges include:

- *Illiberalism and particularism:* While talking about ways to fine-tune state interventions for university research funding in European Welfare States, about 20 ERC grantees and their

[6] For the European University Autonomy indices and EUA work see chapter 3.

[7] https://wellcome.ac.uk/sites/default/files/wellcome-trust-annual-report-and-financial-statements-2017.pdf; see also https://wellcome.ac.uk/funding/guidance/funding-overheads. For the private non-profit / HERD data see Janger et al., 2019, p. 154.

colleagues from the Central European University start to pack their suitcases to move to Vienna as they have been ousted unfairly by an illiberal government representing an EU Member State. While we try to find out which funding mechanism works best on what level, the European country with the best ranked universities is about to leave the Union. While we look for general "pros" and "cons", at some U.S. universities students try to curtail curricula along dimensions of identity politics and topics that do not upset them too much.

- *Context load and different kinds of speed, …*we can continue …: While we immerse ourselves into loads of context, aspiring research nations like China apply different standards regarding ethics and frontiers of science as many examples have shown, including the CRISPR babies or the marriage of transplantation research and death penalty. To be clear: We need both, a pragmatic funding machine that does not drown in too many contextual and ethical considerations *and* ideas where to position ourselves and our universities regarding ethics, values and regulations.
- *The rise of dark knowledge*: Some authors (Jeschke, Lokatis, Bartram and Tockner, 2018, with a large number of sources) claim that the share of published research has been decreasing across the world. Currently the most prominent example for dark knowledge are the scores, perhaps millions, of gifted computer scientists, mathematicians and other highly educated experts around the world, doing unpublished research either in the huge digital corporations or, if they work for the state, as intelligence agency staff. A growing share of new products and processes and part of a changing social order therefore comes from sources that are often act de-contextualised and not open to public discussion[8]. The overall share of government-funded research is decreasing, and therefore also levels of control regarding research directions, intellectual property and safeguarding public interests. Even the OECD appears worried here[9]. Jeschke et al. also list other forms of dark knowledge, this time in academia, produced through biases, jargon or lack of reproducibility (Sarewitz, 2016). Therefore, the first task of university funding and TPF should be to guarantee that standards of academic production and discussion improve where this is necessary. The second task is to raise awareness that public research budgets for public sector research must grow, not to be completely dwarfed by actors who do not share and openly discuss what they search for and what they know. The challenges with university budgets will be further discussed in → chapter 5.
- At the same time, a *serious "open" movement* that started with open innovation concepts around 15 years ago and has gained prominence since then (Chesborough, 2003). Universities are challenged to take part in such open innovation constellations, to provide their knowledge but also to develop proper methods (Franzoni and Sauermann, 2014, on crowd science as an example). This is a challenge different from what started a few decades earlier with the Bayh-Dole Act and the pressure on universities to protect and sell their most attractive knowledge. For both modes of university financing this means first of all allowing room for experiments and a stable regulatory framework in which these experiments can take place. Both modes also have to support university researchers to become more connected to real-world problems and

[8] Although considerable amounts of secret industrial and state-led research have been around all the time.

[9] https://sciencebusiness.net/news/governments-risk-losing-control-over-direction-technology-research-oecd-warns, this is mainly about the rise of tax breaks as instrument but also with broader concerns for loss of control.

produce scientific research more for a demanding outer world and less for intra-science competition, the latter often with opaque methods and results (again Sarewitz, 2016, with a very outspoken position).

- *Research becomes digital and more data-driven* at high speed. For universities this means re-vamping most of their traditional disciplines, either through new combinations or a further massive inflow of data scientists and other experts into medicine, humanities and all other fields. This can be done both through TPF programmes and Direct Appropriations but it has to be done at high speed and large scale everywhere. Massive investments will also go into data storage, quality control and conversion, in an effort to make research more transparent and reproducible. Smaller but also considerable investments will go into the step change towards Open Access publication systems. Both challenges – digital research data and Open Access – will put considerable strain on universities' and funders' budgets. Digitalisation means also that HEIs must reinvent themselves in the light of distance learning and new actors on the one hand, and artificial intelligence and machine learning on the other: New forms of teaching and new curricula are needed (Aoun, 2017).
- Finally, we watch *continental shifts*. The academic production in many Asian countries is growing massively and there is no reason to believe that Europe will be safe on the quality side. While the enlargement of the pool of freely-produced scientific knowledge is positive, Europe has to think about the competitiveness of its knowledge producers as well as the absorptive capacity of its economies. The challenge posed the rise of China means that research and innovation budgets have to grow and that a large chunk of it should probably go into top quality research and universities that are visible and competitive on a global level.

4.3 Conclusions for the Pros and Cons

- The main challenge might be to keep knowledge a public good (see also Stephan, 2012).
- In many cases it might be more advisable to change framework conditions or legal and organisational settings than to ever fine-tune the funding system.
- When there is a choice, a lean legal act (or ordnance) serves the system better than detailed regulations.
- Significant public-sector investment will be needed for public research and for digitalisation of the HE sector. Universities have started their journey already.
- Serious policy challenges like research ethics or open science need an actively steered policy with incentives for universities through Faculty Appropriations, a mainstreamed approach with TPF sources, but also education and law-making.
- In times of change flexibility and rooms for experiments are needed. TPF is therefore often better suited as agent of change.

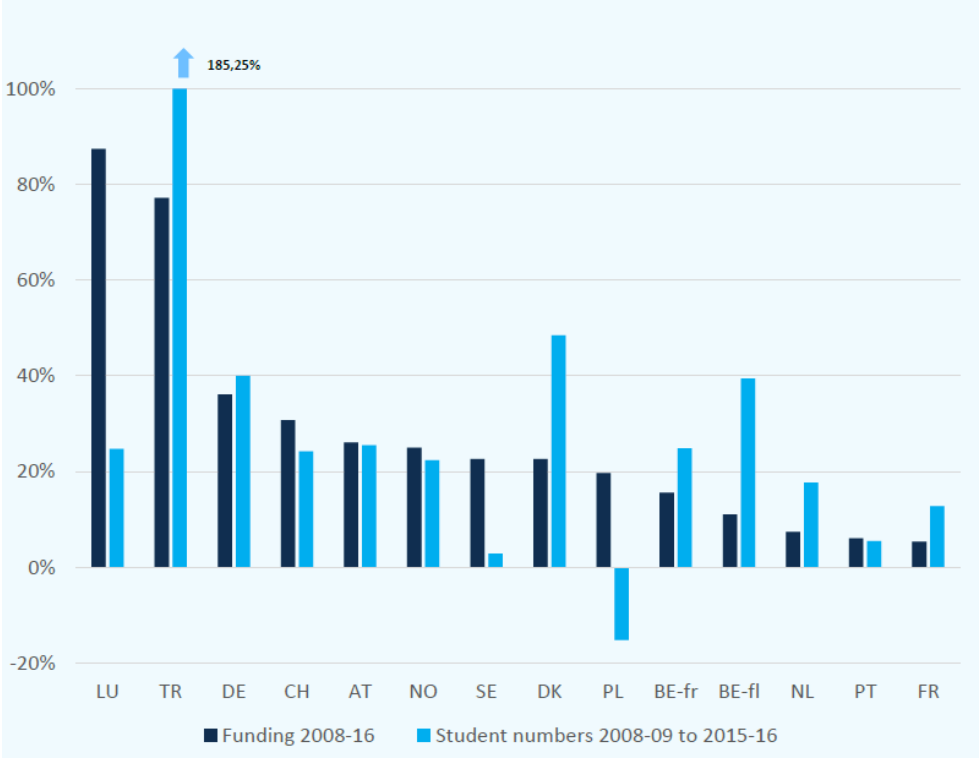
5 The input side and some key figures

5.1 Public university funding

As we have seen, universities are in many respects different from other public or semi-public organisations, with at least one exception: As a rule, budgets are tight, as student numbers and costs have often increased faster than the budgets. Further, new challenges like digitalisation, Open Access or local engagement are being constantly added to the university portfolio. In Europe, the development until the financial crisis had been more even than it was afterwards. The EUA Public Funding Observatory (Bennetot Pruvot, Estermann and Kupriyanova, 2017) shows a wide variety of state HE budget reactions to the post-2008 financial crisis: Many of the innovation follower countries like Spain, Italy or some Central and Eastern countries stopped their budget growth paths and massively reduced Direct Appropriations. For the universities in most Spanish regions, Cruz-Castro and Sanz-Menendez (2015) show the dire consequences.

In the following a few data will be presented. Note that due to various sources and data issues different tables and figures contain different sets of countries.

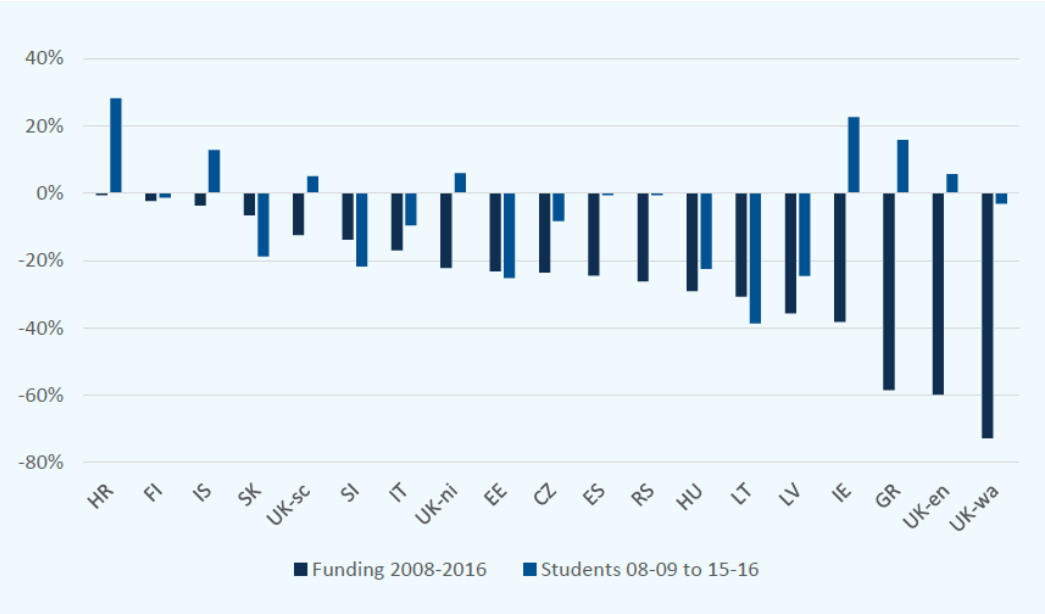
Figure 1: EUA observatory, university systems with increasing public funding 2008 → 2016



Source: Bennetot Pruvot, Estermann and Kupriyanova, 2017, p. 10, showing the development of student numbers and public university finance. Time periods are different for LUX (2009-2016), CH (2008-2014) and BE-fr (2008-2015).

Figures 1 and 2 show that better-off countries generally increased their budgets further, including Germany, France, most Nordic and the Benelux countries as well as Switzerland and Austria. As outliers, the UK went down and Poland and Portugal increased their budgets counter-cyclically[10]. All this can be seen also as a marker that the strongest research universities on the continent (not necessarily in UK where competitive pressure is being increased within and between universities) are gaining strength as they are situated in the countries with budget growth. Many governments put an emphasis on fostering excellence and critical mass.

Figure 2: EUA observatory, university systems with declining public funding 2008 → 2016



Source: Bennetot Pruvot, Estermann and Kupriyanova, 2017, p. 11, showing the development of student numbers and public university finance. Time periods are different for EE (2008-2015), FI (2010-2015), GR (2008-2015), UK-sc (2010-2016), UK-ni (2010-2014) and UK-wa (2009-2016). UK data do not include publicly subsided student loans.

Table 1 informs about HERD, the input for Higher Education Research and Development, as a percentage of the GDP for a number of selected smaller countries with a high innovation performance. They all lie above the OECD average. As input explains part of the output, this is a part of the explanation why small European countries are among the relatively strong science nations globally. Note also the relatively stable development which is also influenced by GDP growth levels.

[10] The countries with budget growth saw also an increase in students, while those with shrinking allocations fall into two categories, with rising and with decreasing student numbers.

Table 1: HERD as percentage of GDP

	2010	2012	2014	2016
Austria	0.70	0.72	0.73	0.73
Denmark	0.88	0.94	0.99	0.91
Finland	0.76	0.74	0.72	0.69
Netherlands	0.70	0.61	0.64	0.64
Norway	0.53	0.51	0.53	0.66
Sweden	0.85	0.89	0.91	0.87
Switzerland	0.73	0.83	0.87	0.90
OECD total	0.43	0.42	0.42	0.41

Source: OECD, MSTI, https://stats.oecd.org/Index.aspx?DataSetCode=MSTI_PUB

Table 2 shows that universities across Europe have completely different budgets per student at hand, although about the sample includes only good and outstanding research universities (a comprehensive and a technical university in each country) in comparable, stronger countries. We see: Input varies significantly.

Table 2: Selected university budgets across Europe (2015)

	University	Overall budget incl. TPF (EUR)	Students	EUR/student
Norway	University of Oslo	834 810 750	27 886	29 937
	NTNU	845 941 560	39 000	21 691
Switzerland	University of Zurich	1 273 505 000	25 358	50 221
	ETH Zurich	1 572 249 000	19 233	81 747
Austria	University of Vienna	544 386 000	94 000	5 791
	TU Vienna	347 360 217	29 919	11 610
Denmark	Univ. of Copenhagen	1 142 567 365	40 486	28 221
	TU Denmark	664 593 933	10 631	62 515
Finnland	University of Helsinki	750 000 000	34 833	21 531
	Aalto University	384 000 000	12 326	31 154
Sweden	Uppsala University	688 000 000	43 907	15 669
	KTH Stockholm	477 247 922	12 424	38 413
Netherlands	Leiden University	588 000 000	25 800	22 791
	TU Delft	931 800 000	22 188	41 996

Sources: Websites of the individual universities; overall budget is the overall income, students include PhD students (author's calculations). Used also in OECD, 2017

Table 3 shows the share between all core budgets (incl. teaching) and all TPF sources in various smaller European countries where appropriate data is at hand. Note the considerable variety in the

composition. With the exception of Ireland, where student fees provide the biggest share to the total annual revenue (45,5%), the core budget of universities represent the largest part, ranging from just over 55% (Netherlands) to more than 80% in the case of Norway. In general student fees provided only a small contribution to universities' annual revenue, with the Netherlands reporting the second largest share at 8,8%. With the exception of Norway at 16,1%, third party funding ranges consistently between roughly 20% and just above 30% for overall university budgets.

Table 3: Relative funding sources of public universities in six selected European countries

	Coverage (%)	Total core budget (%)	Total TPF (%)	Student fees funding (%)	Revenue unclassified (%)	Total Current revenues (EURO)
Finland	85%	77,5%	22,5%	0,0%	0,0%	2.975.962.664
Ireland	96%	24,4%	30,1%	45,5%	0,0%	2.392.311.750
Netherlands	100%	55,5%	28,3%	8,8%	7,4%	5.427.462.400
Norway	97%	80,7%	16,1%	0,3%	1,4%	4.434.601.536
Sweden	100%	67,4%	32,0%	0,7%	0,0%	6.581.848.827
Switzerland	97%	74,2%	20,4%	5,4%	0,0%	10.052.258.461

Source: ETER Databank, own selection supported by Joanneum Research. For the analysis, we only considered data from publicly funded universities and universities of applied sciences (for this tables subsumed as 'universities').

Finally, two things have to be noted: First, university staff has grown in many countries, often due to a growth of research budgets. There is a continuous "production" of highly mobile PhDs and Postdocs, which is also an impact of research funded in the past (Stephan, 2012). Second, demographic change threatens to reduce the student numbers significantly in some countries and some universities will be more affected than others. If student numbers count for university budgets, vicious cycles can be the result, both in the "growth of students – falling budgets" combination and in the "falling student numbers" scenario.

5.2 Appropriations and budgets for Public Sector / university research

Research is a key task and output of universities. In most of the industrialised countries the higher education sector is dominated by public universities. In addition, in countries with a strong private (non-profit) university sector the public provides considerable allocations also to these private actors, either through Direct Appropriations *and* TPF as in the UK or through TPF in the U.S. Therefore university-based research stands for a large part of the public-sector research performance and of public sector research outlays.

The level and growth of university budgets is important (and more so the share allocated for research): A number of studies show (Sandström and van den Besselaar; 2018; Reale, 2016; Martin, 2000) that a great part of output and impact growth is simply due to input growth. In reaction to the 2012 KVA report (Öquist and Benner, 2012) and its reform proposals to increase the level of highly cited Swedish research, Sandström and Heyman (2016, pp. 52 f.; see also Sandström and van den Besselaer, 2018, p.

372) present data showing the importance of input growth for impact growth: In most countries two thirds of the growth of citation rates (top 10% journals) can be explained with a corresponding growth of funding; input largely determines output. If this can be corroborated by other evidence, this is a message with massive weight, putting the topic of pros and cons of different funding streams into another, more modest, although still highly relevant perspective. The underlying study and other evidence will be discussed in → chapter 8. Sandström and van den Besselaar with their sample of mostly Western European countries also show that it is not automatically easier for weaker countries to catch up on the output / impact side, as this implies serious re-organisation for the whole public research system. This appears to hold true for the now not so new New EU Member States but the issue is being challenged by a number of Asian countries.

In Europe, universities account for nearly a quarter of all public and private research expenditures; HERD, the total higher education spending for R&D, makes up for nearly 0.5% of EU28 GDP (Jongbloed and Lepori, 2015).

The PREF study (Reale, 2017) for public research funding gives an overview of the share of TPF versus institutional allocations across European countries (see also Jonkers and Zacharewicz, 2016, p. 17, with 2013 as a reference year for most countries). Note that the PREF study often shows the government appropriations to all kinds of research performers, including industry. The study complains the "… *lack of information on the breakdown of funding instruments by beneficiaries …"* (Reale, 2017, p. 25). For all kinds of recipients, we can see the whole range of shares, from 99% to 8% institutional allocations. A group of smaller countries with strong innovation performance falls in the range of 30% TPF and 70% institutional allocations, including Austria, Switzerland and the Netherlands. Other countries belonging to this group are closer to a 50:50 relation, including Finland, Denmark or Belgium: There is no obvious relation between funding shares and research performance.

Other studies also show that HERD breakdown into different sources is not easy to collect[11]. An eight-country comparison (European Commission, 2019) again reveals a great variety on the two axes research/teaching and block/performance-based.

Estimations by the Austrian Institute of Economic Research (WIFO) show that for a number of countries the share between TPF and Direct Appropriations for research cannot easily be retrieved. The six countries have different HERD / GDP ratios, ranging from approx. 0.35% (U.S.) to approx. 0.9% (Switzerland). The same is true for share of HERD in GERD, between approx. 15% (U.S.) to more than 30% (Netherlands). Table 4 shows within HERD the wide variations between different countries in this six-country comparison: The share of government is high, except for the U.S. and UK. Note the broad variation in share of agency- (i.e. RFC- *and* agency-) funded university research: This range goes from 8% to 46% of HERD.

This table also explains why the U.S. example cannot help us in discussing pros and cons of TPF vs. Direct Appropriations: *There are no Direct Appropriations.* The form of full cost TPF can in its impacts only in part be compared with European forms of project funding[12].

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[11] Discussion with OECD staff in February 2019. See also description of data problems in OECD, 2018a, p. 15. Here a small sample of countries is presented with the share of project funding in public R&D, ranging from 20% to 80%.

[12] Note that these data are taken from Janger, Schmidt and Strauss (2019), a six-country comparison on the modes of RFC project funding.

Table 4: Funding sources of HERD across countries, data based on conversion in USD PPP

	Sub-total government	General University Funds	Direct government	**Funds of agencies** (part of direct govt.)	Other
Austria	**88%**	65%	22%	**8%**	12% (various)
Germany	**81%**	N/A	N/A	**18%**	20% (industry!)
Switzerland	**81%**	64%	16%	**15%**	20% (industry)
Sweden	**76%***	44%	32%	**< 26%****	24% (foundations!)
Netherlands	**77%**	N/A	N/A	**20%**	23% (various)
UK	**62%**	30%	33%	**30%**	48% (abroad, foundations!)
U.S.	**58%**	0%	58%	**46%**	42% (incl. HE sector itself)

Source: WIFO, based on OECD statistics 2014/15; data based on conversion in USD PPP
*Sweden own calculation: * 76% incl. semi-public foundations + regional ,70% central govt. only*
*** without SSF, MISTRA etc.…*

The Aquameth project (Daraio et al., 2011) does not differentiate between faculty Appropriations and TPF but in a European nine-country comparison shows high shares of government funding in all those countries with low or no tuition fees. Due to a number of statistical problems the size and forms of private HE funding is difficult to compare. However, the UK stands out for high fees and high donations / philanthropic funding. Some researchers also stress the difficult "*apples and pears … category problems of research policy*" (Sandström and Heyman, 2016, pp. 39 ff., with a number of examples), i.e. the different categorisation of actors and funding streams across different countries. For challenges with categorisations, input and output measurement see van Steen (2012) and Aksnes et al. (2016).

Over a long period (Lepori et al., 2007; Paradeise, Reale and Goastellec, 2009, p. 213) we find less of a shift in sources than in instruments (see also Auranen and Nieminen, 2010, p. 829), with a decreasing Direct Appropriation share between 1980 and 2001 across countries. The private contributions to HEIs (both overall and for research) remain relatively low and the public contributions are still high. Within the public contributions, TPF has gained ground and within Direct Appropriations Blocks Funds have decreased with growing PRFS shares, although with big variations. For universities across Europe, this results in varying budgetary conditions: While Danish or Swiss university researchers can draw from both rich external and internal sources, Italian researchers have much less to expect from both. While UK universities can and have to draw from a variety of (although stagnating or shrinking) public and private sources, Scandinavian universities can to a high degree rely on the state as the dominant and quite generous funder, although with different degrees of Direct Appropriations.

- Direct Appropriations have decreased in relative – in some countries also in absolute terms – in the last decades. This has been a long-term trend, with various individual trajectories and events across time and space: Sweden for example faced a stagnation of the Direct Appropriations over a long period. The Research and Innovation Bills 2008 and 2012 changed this by increasing these allocations and also by introducing instruments like the Strategic

Research Areas (OECD, 2016 and → chapter 8). EUA data show that university funding across Europe has taken different paths, especially in the aftermath of the financial crisis. Some countries have seen universities and their research potential as a remedy while others have viewed them as a cost factor to be cut (Claeys-Kulik and Estermann, 2015, pp. 13 ff.).

- TPF as a research funding instrument has grown (Geuna, 2001) in absolute and relative terms over the last 50 years, increasingly with the motive to switch to demand-driven approaches and to internalize stakeholder interests (Paradeise, Reale and Goastellec, 2009, p. 208). In some countries these budgets grew in a massive way, although the growth of innovation- and mission-oriented instruments has been stronger than those of academic-oriented instruments. The latter saw a declining *share* within the TPF portfolio in a number of countries, in relation to the more applied schemes. RFCs and namely funding agencies developed a growing portfolio of instruments and programme types (for country examples see Lepori et al., 2007a).

The OECD its recent comparison of competitive funding schemes (2018b) has also observed the shift from Direct Appropriations to competitive mechanisms within public research budgets, with the hope to increase efficiency as the main motive. The share of project funding (again including all kinds of recipients) in public research budgets varies between 20% and 70%, with formidable definitional and data collection issues still unsolved.

A short note here: The output side of the global science system is growing exponentially (Fortunato et al., 2018). The input side is strongly shaped by the number, payroll cost and properties of academics themselves. Their salaries form a main cost category and their numbers, not only their productivity determine the output as much as the financial inflows do. Further, recruitment of talent has become a global market, from Post Docs to star professors (Stephan, 2012, with numbers). Students, often with a high willingness by their families to pay, look for the best places for their academic education across the world. The long-term development of PhD graduates and their career option has recently received much higher interest (European Science Foundation, 2015, with interesting results e.g. on the permanent – temporary divide). The very large global survey on important properties of working at universities is titled "*The Changing Academic Profession*", showing both large national differences and some mainstreaming trends (Teichler, Arimoto and Cummings, 2013).

Finally, another very large survey by Janger and Nowotny (2016) asks for scientists' job choice motives. The authors present a clear outcome: Tenure perspectives and (early) financial autonomy are very strong motives for younger researchers to decide where to work. More senior researchers prefer broader departments over smaller chair-based structures. Most researchers are ready to trade salary fractions for higher freedom and tenure. These are important results, as they directly point at the variety of recruitment and career development settings in universities and HE systems across the world. In Europe, many countries still have quite rigid "chair" and career systems, coming with many fixed-term contracts, late independence, passive recruitment (i.e. preferring locals, issuing calls for a professors' succession handled by broad committees), public sector style contracts (rigid salary structures), local languages for teaching etc. (see Estermann and Nokkala, 2009; Estermann, Nokkala and Steinel, 2011 and following EUA Scorecard exercises). Some countries and universities however recruit actively and internationally, at young age, with a clear tenure perspective guaranteeing both independence and a long-term view and with broad department structures.

The point for our exercise is simple: Direct Appropriations for universities with a modern recruitment and career structure are a something different from Direct Appropriations steering universities that do it in a more traditional way. Signals and indicators will have different impacts and intended as well as

unintended effects. In a less succinct way this is also true for effects of larger, career-linked TPF grants.

5.3 Conclusions for the Pros and Cons

- Input comparisons difficult, methodological issues
- No patterns for TPF and Direct Appropriations across countries except for a shift to more TPF nearly everywhere; the overall public-sector share remains strong
- Two thirds of output / impact growth appear to be determined by input growth, this puts the pros and cons debate into different perspective
- Outputs on a global scale are growing exponentially and the number of young researchers is also strongly growing.
- We need to know more about the relationship between outputs and impacts on the one side and the shape and rigor of recruitment and career models. However, there are correlations between different systems and scientific success.
- When demand driven funding and stakeholder inclusion are the goal, TPF might be the better choice
- Catch-up countries face a difficult choice as catch-up does not only mean more money but also quite fundamental organisational reforms

6 Properties, challenges and impacts of direct appropriations to universities

6.1 Historical evolution and current situation

The state has been providing for Direct Appropriations basically since the Middle Ages, namely for the education of medical doctors, legal experts and priests, plus a few scientists like astronomers. Science and empirical research evolved over a long period, from the 16th to the 18th century (e.g. Daston; 2014). This did not necessarily happen at universities (Geuna and Rossi, 2015, p. 3), but in a multitude of places, from private homes to public infrastructure providers and regulatory bodies. Wherever the Direct Appropriations for research appeared first, early 19th century German Prussia appears to have been the first state to structurally fund research at universities through such (block grant) appropriations. At first this was a matter of national prestige after a lost war against France, coupled to the Humboldtian higher education reforms. A home for scientists was created to perform basic research without any constraints. In the second half of the 19th century, research at (often technical) universities as well as research centres also served industrial policy, and in different form, again national prestige (Braun, 1997, p. 101). Here we encounter early technology policy. The German HE model proved influential as it served as an inspiration for many states, including the Nordic countries and, notably, the U.S. (Stokes, 1997, pp. 38 ff.)

Using the example of eleven European and Asia-Pacific countries, Geuna and Martin (2003) describe how university research evaluation evolved in the 1980s and 1990s. This development included a trend towards formal Performance Based Research Funding Systems (PRFS) and ended the HE consensus in the post war era with its strong growth in universities and in funding.

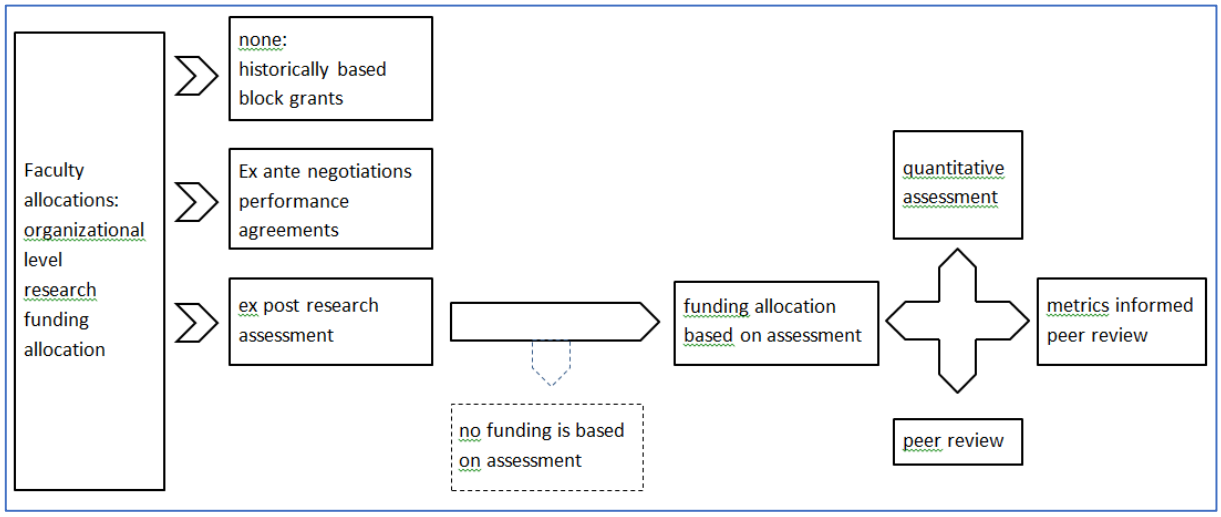
Two properties of the preceding post-war period appear striking: First, the level of trust the state and society in the West had for the universities, which was bolstered by success stories and the expanding state with growing budgets from burgeoning economies. Second, there seems to have been a kind of unwritten contract between the two sides: We give you money and in turn you deliver ideas that then will definitely transform into products and processes. This contract ran into trouble with stagnating resources, exploding student numbers, missing innovations and perhaps also due to social movements on the campus. This "*you academics know best*" attitude was more and more put into question, not at least because the universities did not deliver as expected. During the 1980s and 1990s there was a gradual change, leading to a number of reforms which transformed the allocation models towards more managed and performance-based systems. Apart from growing TPF shares the Block Funds were in part remodelled into allocations coupled either to expectations or to outcomes.

Hicks (2012) continues this narrative by presenting 14 PRFS systems globally, drawing lessons from the broad array of steering mechanisms used globally at the end of the first decade of the 21th century. For details see the individual instruments below. Claeys-Kulik and Estermann (2015), as well as Jonkers and Zacharewicz (2016) investigate performance-based funding systems across Europe using a broad definition including teaching and contractual arrangements like PAs. In this broad sense, performance-based funding is present in the majority of European states, with a number of borderline cases also termed performance-based. These authors also come forward with pros and cons and once more stress the impossibility to purify the causes and effects of such steering instruments in a HE world full of actors, regulations, long-term trajectories and funding sources. As Claeys-Kulik and Estermann work for the EUA it is no wonder that they also stress the need for stable long-term

expectations for universities, a relevant point that shall not be compromised by overly competitive performance-based funding instruments.

Across countries we find a variety of options how to steer Direct Appropriations through PRFS, either through funding or in form of other mechanisms. A short overview illustrates the main options: Self steering through historically based block grants (main model 1) or using ex post research assessments, either through metrics / indicators (main model 2a) or through peer review (main model 2b). The latter two approaches can be combined. A further option are ex ante oriented Performance, often coupled with indicators (main model 3). The options are discussed in this chapter and Figure 3 gives a first overview.

Figure 3: Main models to steer Direct Appropriations



Adapted from: Jonkers and Zacharewicz, 2016, p. 14

Some countries opted for the steering by future expectations and promises, namely through Performance Agreements (PAs) between the state and the universities. Others chose a variety of retrospective, outcome-based steering mechanisms including PRFS, rewarding publications, citation impact, TPF success and/or successful societal outreach. The trends over the last 50 years first show an increasing variety in instruments and approaches, coupled with feedback, learning and adaptation mechanisms, also to prevent strategic behaviour on the side of the academics[13] to "play" the system (Geuna and Martin, 2003). Second, there is a shift from more input- to more outcome-oriented policy instruments coupled with a second shift from more centralised and regulated to more decentralised, market-style approaches, the latter including TPF as a competitive funding stream. At the same time, PAs as a decentralised, input-oriented funding and steering instrument is also proliferating (Jongbloed, 2009; Jongbloed and Lepori, 2015). In the U.S. states, most governance instruments and PRFS arrangements focus on teaching, as research is mainly financed by full cost public TPF and a variety of private sources (Li and Zumeta, 2015).

[13] One beautiful complaint of policy makers is that academics are so intelligent and therefore quickly find ways to circumvent and play all kinds of steering mechanisms. Beware they were not!

The history and background of bibliometric indicators cannot be covered here but readers need to know that tools like the Journal Impact Factor and citation counts had been introduced from the 1970s on for different reasons than for which we do use it today. Originally the emphasis had been put more strongly on the record, status and prospects of scientific fields: The use to measure the record, status and prospects of individual researchers and their home organisations has become dominant only later (see De Bellis, 2014; Wouters, 2014).

The history of Direct Appropriations is therefore venerable and at the same time – when coupled to steering mechanisms – younger than organised TPF, which started over 100 years ago (→ chapter 7). The 1986 UK Research Assessment Exercise (RAE) marks the beginning of PRFS. 14 such systems have been installed until 2010 (Hicks, 2012, p. 252), followed by further initiatives in other countries as well. Each national solution is different. In the same way, PAs have been introduced in various other countries, in some cases coupled to PRFS models. The national systems of steering and funding are therefore as individual and complex as the universities they aim to steer.

This also has to do with the universities and their degree of transparency: TPF and peer review are often being criticized for their unfairness, hidden biases and vested interests. However, TPF has another "disadvantage": It's properties and procedures and propensity to be evaluated makes it definitely more transparent than often opaque inner-university power relations with their strong but often hidden turf wars for recognition, careers and money. In other words, it is much easier to criticise procedures that are more open and also more often subject to external evaluations, including non-academics as evaluators. In → chapter 10, we therefore argue for a level-playing field between the different forms of funding: It would be unfair to criticize TPF for its openness and at the same time ask for "trust-based" relations between state and universities, if different standards of transparency, accountability and evaluation practice would be established along these lines.

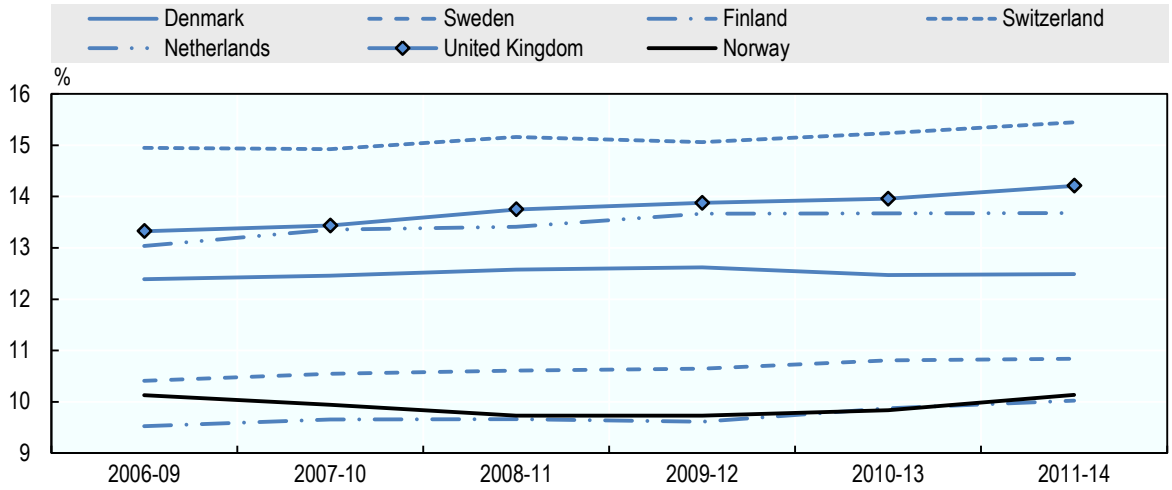
Looking at the allocation of U.S. state resources, Volk, Slaughter & Thomas (2001) show that while funding policy research tends to focus too broadly on overall faculty performance, individual departments' needs and strengths might be overlooked, since "… d*epartments powerfully mediate individual academics' chances to receive institutional resources*" (p. 406). Departments characterised by *"(male) full-time faculty, graduate degrees, grants, and contracts*" (ibid.) tend to receive more resources than those characterized by *"(female) faculty, high (female) adjunct use [...] and undergraduate degree granting*" (ibid.).

Taken together national systems are highly individual, see also European Commission (2019). Apparently successful approaches cannot be scaled up to a model working well everywhere, on a continental or global scale. However, there are learning processes and some approaches might be better transferrable than others (→ chapter 9). Jonkers and Zacharewicz (2016) highlight the fact that there are very successful countries without PRFS systems across Europe, but none of the truly weak performers – those lagging behind and not showing a consistent improvement in impact scores over a ten-year period – has PRFS in place.

Moreover, nearly all stronger EU countries could increase their global share of top 10% most cited global publications at least a little (and on a high level, in the face of growing global competition), with the relative growth of publication numbers varying strongly. The variation is also high when it comes to budget growth. In sum, no clear pattern can be discerned for the 2000s and early 2010s (Jonkers and Zacharewicz, 2016, pp. 32 ff.): The Netherlands have modest growth rates in their HE research budget, a well-developed evaluation system but no PRFS and a very good publication / top 10% citation performance. The UK budgets decreased, a strong PRFS is in place and the citation performance is very good. Sweden has growing HE research budgets, moderate PRFS steering

elements and no significant increase in citation performance. The situation is similar for Denmark or Switzerland, but with much better results on the publication and citation impact side. We can conclude that there are many formulae, but none of them appears to be the magic one. The existence of a few strong research universities might help for the national publication and citation record, e.g. in a clear binary system with a large polytechnics sector. Note that all the countries mentioned fare well or very well in international university rankings.

Figure 4: Share of top 10% most frequently cited articles in their respective fields by the top publishing universities in selected countries (2006-2014) (all sciences, fractional count)



Source: CWTS Leiden University, downloaded on 4 April 2017, figures of 2016, www.leidenranking.com/downloads. Used also for OECD (2017)

Outputs and impacts of academic research cover a broad variety of products, from publications to people to transferrable knowledge. Much, but not all can be measured; and some of the products are used as indicators for performance-based Direct Appropriation models. Figure 4 shows how some stronger European countries perform regarding one main indicator, share of top 10% most frequently cited articles. The differences are striking, and out of the top-3 countries, only the UK has a PRFS system in place.

6.2 Main Model 1: Unconditional Block Grants

Block Grants are specific insofar as they come without indicators or organised quality expectations. In general, they are allocations for both research *and* teaching. They constitute the most traditional form of Direct Appropriations. In the past they were used in practically all countries to fund the collegial, pre-management universities. Often, they were coupled to formal or informal earmarking, to allow for various ministerial wishes and policy goals. For Block Grants, history matters: the preceding years' budget is by far the most important denominator. Methodologically, Block Grants can be either seen as a very general term for all kinds of Direct Appropriations, or more precise, as those allocations without formal evaluation and management tools to set the next budget. In the latter meaning, the number of pure Block Grants is declining but they are still around and elements of it can be found in most funding systems.

Due to the nature of universities as loose or incomplete organisations with a lot of power resting at the level of the individual professor, this funding form will be probably always there, at least to a certain degree. Note that some very successful small European countries like Denmark, Sweden or Switzerland are among those who still use it as a prime mechanism according to an EUA classification (Claeys-Kulik and Estermann, 2015, p. 18) with funding formulae or in some cases PAs being used only as secondary mechanism.

Pros / Main advantages: The main advantage is the provision of a safe space for researchers to realise their own ideas, before proposals have to be written and peers are called in. New and seemingly crazy ideas often need time and a certain proof of concept. As this holds true for all kinds of Direct Appropriations to a certain extent, some literature and examples will be provided in Box 2.

Cons / Main disadvantages: The main disadvantage of the "old" Block Grant is that the real allocation and negotiation power stays with the individual professor or the head of department, in some countries in a quite exclusive form. It is difficult to set priorities and deadweight is high: The non-performers get a lot of resources and "just like yesterday" is a mixed blessing in a future-oriented activity like research[14].

Box 2: Free money for new research avenues

Peer review in Direct Appropriations, Assessments and TPF appears to have a tendency to favour established research disciplines and approaches over new and unproven avenues. Researchers often find it difficult to come forward with completely new proposals. There is a broad range of issues, from a lack of preliminary data in quite mainstream research to interdisciplinary experiments and new paradigms challenging old beliefs. Research funding agencies try to find solutions with programmes inviting for "ground-breaking" or "transformative" research (→ chapter 7 on TPF), but such formats are still small or work as pilot schemes. In mainstream funding both sides suffer: TPF providers get proposals they cannot get reviewed easily and they get too many proposals because of lack of money for research within universities. Researchers are frustrated as their new ideas often do not get appreciated and funded.

Block Grants as such are therefore important, both in unconditional and assessed form. Researchers need a safe space to develop and test all kinds of new ideas and approaches. Research shows that fresh ideas need this kind of resources and they can come as basic appropriation or internal seed funds. In their case study report on "creative", i.e. highly successful scientists, Heinze et al. (2009) see insufficient basic funding as a negative factor for creative research situations because "… *flexible research funds were found pivotal in several research breakthroughs in our set of cases. Flexibility means that funds are not earmarked for specific purposes … In particular, core institutional funds, which are independent from success in attracting external grant money from research countries, have been found highly important to supporting scientific accomplishments …*" (p. 618). On the other hand, the increase of TPF at the expense of Direct Appropriations is seen as a potential threat. Heinze et al. also state that smaller groups and small projects are a specifically productive way to perform research. In the same direction, team size matters. Wu, Wang and Evans (2019), in their impressive large scale

[14] And as Roger *Won't-get-fooled-again* Daltrey knew, it rhymes with: „I get on my knees and pray …".

analysis show what their headlines promises: "*Large teams develop and small teams disrupt science and technology".*

A review by Heinze (2008) discusses problems with traditional peer-review based funding and calls for flexible funding including organizational core funding to promote what he calls "*exploration mode research*" (pp. 305 f). Laudel (2006) discusses researchers' strategies to adapt to funding regimes, when lack of sufficient block funding hinders long-term orientation, interdisciplinarity, diversity and new and risky research (p. 490, quoting a number of studies): "*And then you do things you know*" (p. 495, an interview quote), avoiding risky research and being not able to change research trails (pp. 497 ff.; for this discussion see also OECD, 2016a). Gläser and Laudel (2016) return to this discussion and use the practice of bootlegging as an example, i.e. to start new ideas for future grants under the cover of existing ones.

A Dutch survey (Van der Weijden et al., 2012) shows for Dutch biomedical and health research that the composition of funding streams has an influence on the propensity to produce societal impacts: The more researchers can rely on Direct Appropriations, the more they produce clinical guidelines or participate in social committees. This stands in stark contrast to outcomes financed by a number of other funding sources, including ministries, charities and industry. When it comes to TPF, a lot depends on the signals the funders are sending: Traditional RFC selection mechanisms do not include criteria for societal impact and therefore such impact will be less produced, while a specific Dutch TPF source for medical research uses criteria for societal benefits, with some measurable success. For similar effects, this time through indicator-based funding, see Wouters (2014).

True TPF full cost funding can also help in this respect as massive overheads can allow for the financing of new research avenues (Jongbloed and Lepori, 2015).

6.3 Main Model 2: Performance Based research funding systems

Hicks (2012), lists the following properties for PRFS: (i) Research is being evaluated, not other university functions. (ii) The evaluation comes ex post, contrary to PAs and project evaluations. (iii) Research output must be evaluated, normally through publication data and citation impacts. (iv) Future government allocations must depend on the outcomes of the evaluation. (v) It has to be a national system.

PRFS shall increase productivity and make universities and their research efforts more efficient as well as more customer-oriented. They introduce market-style incentives and strengthen – together with other instruments – the discretionary power of university leadership, whose accountability has also been increased. Finally, PRFS shall contribute to policy goals, with *excellence* being the most prominent one (Hicks, 2012; Geuna and Martin, 2003; Geuna, Piolatto and Labini, 2015) PRFS can be conducted in many different ways (see also Jonkers and Zacharewicz, 2016; De Boer et al., 2015). Overall, the different forms of PRFS are very sensitive to all kind of context and therefore have to be designed carefully. According to an ERAC paper, it is key to guarantee consistency with the other incentives provided by the policy mix, to come forward with clear objectives and to balance it out with TPF and teaching funds, although "*… there seems to be no evidence to suggest the existence of an optimal share of institutional research funding to be allocated through PRFS.*" (European Commission, 2019, p. 7.)

PRFS: Peer review (plus indicators / metrics)

The UK model of university-department evaluations with field specific panels is the most prominent example for PRFS. The assessment has been in constant development since the beginnings in 1986 and the university system has undergone it half a dozen times since; for the evolvement of the RAE see Geuna, Piolatto and Labini (2015). A mix of peer review and (namely with the new REF) metrics applies and the university departments provide narratives and best results. The results of the assessments lead to a categorisation of departments or other units along a scale. Each rung on the ladder is linked to financial consequences that vary across different countries, both for share of Direct Appropriations tied to the assessment and for the distance between every rung. In the UK REF (and preceding RAEs) lower grades can make you really poor over time. Interestingly, the share of departments rated as excellent has increased over time in the RAE / REF cycles. This again can have various reasons: Improved quality as a direct cause of the assessment procedures is only one explanation, adaptation processes by all parties including the peers, trying not to punish their own field, another one.

Apart from financial consequences, steering processes like the RAE / REF trigger considerable prestige games across the country. Universities go far to be among the winners and "*star scientist*" has become a household name as well as a commodity in high demand on the academic "*cattle market*" (Geuna, Piolatto and Labini, 2015, p. 120). The concentration of resources at top universities is very high (Jonkers and Zacharewicz, 2016, p. 31) but as we can see from Table 5, it is even higher with TPF: The five English universities acquiring the largest research grants received 36% of QR funding for the 2014-2015 period, while the five universities receiving the largest sums of BIS Research Council funding concentrated 44% of funding. Note that TPF concentration is higher in all classes.

Table 5: Research income distribution of English universities 2014/15: PRFS and TPF concentration

	QR funding (PRFS)	**Income from Research Council grants (TPF)**
'Top 5' in size of research grant	36,4%	43,8%
'Top 10' in size of research grant	52,4%	60,7%
'Top 20' in size of research grant	72,1%	82,2%
'Top 50' in size of research grant	93,2%	97,8%

Source: UK Research and Innovation, sent upon request

Whitley and Martin (2010) in their analysis describe it as the strong impacts, leading to a much stronger role of the state and university managers in the vertical *authority relations.* This translated into higher levels of control also in academic questions, to more centralisation and to strong impacts on horizontal authority relations within and across universities in the form of ultra-competition, over-focussing, game-playing, reduction of trust and other deplorable developments: "… *how the current approach to research assessment in the UK universities is reductionistic …, and almost certainly counter-productive in terms of generating a wide variety of intellectual innovations in the longer term.* (p. 75). Analyses (Georghiou et al., 2000) showed that the RAE did not lead to "salami-slicing"

inflation of publications and neither to a decrease in quality but observed more selective strategies where to publish.

The RAE became more sophisticated over time, which also means more voluminous and more expensive. This pressure for increased sophistication mainly came from the scientific community and not from state ministries and agencies (Martin, 2011). We are tempted to repeat this sentence over again. It is not always "them" RFCs and state agencies that are responsible for a flood of rules and peer review processes. Often this choice is being made and successfully lobbied by academia itself.

The REF 2014 was formed through a broad discussion that renounced the switch to a pure metrics system. It came with less panels and a new composition of criteria: Quality of research output still had most weight with 65%, the research environment came with 15%, and impact on society, economy and culture were now rated with 20%, based on qualitative impact templates and case studies.

The UK experience drew interest from other countries, including Italy and Sweden. In Italy an RAE-style assessment called Valutazione Triennale delle Ricerca (VTR) was introduced through learning from the UK to help the traditional and less dynamic HE system become more quality-driven (Abramo, Cicero and D'Angelo, 2012; Geuna, Piolatto and Labini, 2015). The effort so far had some positive results, which is interesting, as an evaluation instrument was transferred with few changes from a very competitive HE system to a less competitive one that follows quite different signals. In Sweden the Swedish Research Council (VR) was commissioned with the task to develop a proposal for a Swedish REF-style assessment in 2015 ("FOKUS", Swedish Research Council, 2015). VR seemed to have done this with gusto and sailed into heavy seas with Swedish academia. The proposal was quickly sunk (also for reasons of cost and potential role conflicts, Swedish Government, 2016) and VR was criticized by parts of the scientific community for wilful impertinence. This story, by the way, stands for many other in our topic: trajectories and culture matter. Material interests are strongly interwoven with and formed by culture, and evidence comes later.

A review by Wouters (2014) shows, that PRFS indeed puts pressure on the scientists to meet the performance criteria. Financial shifts often might matter less than increasing differences in researcher reputation. Changes do in fact happen, in a mix of intended and some unintended effects. How researchers react and adapt regarding funding and careers however is completely uncharted territory, as many inner-university dynamics are (Wouters, 2014, pp. 55 f.).

One often overlooked productive element are the organised feedback and discussion processes *between* the individual evaluations which take place every five years or so (Hicks, 2012, pp. 255 f.). Such consultations and evaluations of the evaluation process itself can allow for important collective learning steps, perhaps more for others than for university leadership. Their *informed authority* (Gläser et al., 2010) might definitely improve and profit from existing assessments, as case studies show. These learning steps however can be compromised by over-sophistication, too many indicators and game-playing (Martin, 2011, with examples from UK and Australia).

Cost-benefit ratios of these huge exercises are difficult to assess properly. However, direct costs are measurable and indirect costs can be estimated, mounting up to considerable (UK) and very high (Italy) costs relative to the amount of money steered through these instruments (Geuna, Piolatto and Labini, 2015; Martin, 2011, with estimation of 100 million GBP mainly indirect cost for certain RAE rounds each; Geuna and Piolatto 2015, with a comparison showing for the UK that both PRFS and TPF come with high cost). As mentioned before, competition and prestige are important factors, but measurement and attribution of causal effects prove to be very difficult. Researchers (Geuna and Martin, 2003, Hicks 2012) argue that there might be decreasing returns and overall cost exceeding the

benefits. This might be true in a system with no real input growth. In → chapters 5 and 8, evidence is presented showing that two thirds of increased outcomes can be linked to increased input. If everybody competes fiercely for the same resources over and over, assessment exercises might end up resembling a rat race, albeit on a highly intellectual level, with productivity gains perhaps being exhausted one day.

Pros / Main advantages: Value for money and resources directed towards high past performers; organised feedback; Share of excellently rated researchers increase over time but do we find causality? There is a link between instrument and behaviour, this can be interpreted as a welcome impact or as considerable pressure on researchers.

Cons / Main disadvantage: If not executed strictly, with a rating system that doesn't hurt, moderate changes could be more than offset by high financial and social cost. If executed strictly and punishing the weaker organisations and less central fields, then strong geographic and other concentration tendencies can follow.

PRFS: Indicator based, funding formula.

Indicator-based evaluations are an easier and cheaper way to perform ex-post assessment instrument than peer-based models, as they rely on a mathematical formula. They can be done annually and inform next years' budgets for each university. They can also be part of a multiannual budgeting design and often add a competitive twist to an otherwise historical / negotiation-based funding model. In some countries like Sweden there is also a cap or a minimum baseline to lower the reallocation effects also within the formula. A number of countries use the "close envelope" approach, where rewards for success comes at the cost of the less successful within a fixed budget. Many countries use these kinds of funding formulae for teaching allocations but they are also present in research funding (Claeys-Kulik and Estermann, 2015; Hicks, 2012). For the latter, past financial success (TPF and industry income) is an important metric[15]. Formulae based on publications might tend to treat certain disciplines like humanities less well, even if field normalisation is being used. Similarly, interdisciplinary research might face a bias as less of it *might* make it into better-ranked journals due to bias and due to properties of peer review (see Rafols et al., 2012, who also see peer review and REF style exercises critically in that respect).

Simply counting papers might be too simple as an evaluation approach. Australia has learnt from this experience (see Butler, 2003 for the original design, but see also the critical view of Van den Besselaar et al., 2017) and so have other countries, either by using citation impacts or by implementing a "top paper" category (Hicks, 2012, p. 254, with a number of examples for different designs). In the Netherlands, student and PhD degrees are largest variable factor in the research Direct Appropriation (Koier et al., 2016). Norway has relatively large Direct Appropriations, with 30% of it tied to indicators. While the teaching indicators make up 5/6 of the 30% (and allow for overall budget growth), research only stands for 1/6 and consists of four indicators including publications. Here a "close envelope", fixed-line budget applies, without overall budget growth (OECD, 2017, p. 92). Originally publications were more important. A categorisation into high-level and other papers had ambiguous, yet not negative effects on publication outputs and some, yet in part unwanted steering effects: The number of authors per paper grew massively, publication output per researcher grew and

[15] Past financial TPF success, at least in close envelope systems, might be a difficult indicator, because it might start a rat race to RFCs and to Brussels, with even lower success rates and at the end nobody wins.

the share of the high-level publications remained the same (Bloch and Schneider, 2015); a zero-sum game?

Other studies like Sivertsen and Schneider (2012) or Ingwersen and Larsen (2014) show for Norway and Denmark that this approach works better in the short- and mid-term for increasing outputs than for increasing impacts. In Denmark a number of universities have introduced incentives based on the national publication indicator. Finland also uses journal-based impact assessments plus TPF success for Direct Appropriations (Jonkers and Zacharewicz, 2016). For all these studies, however there are concerns whether causality can really be found or if other, parallel policy actions have (also) caused changes in outputs and impacts (Gläser and Laudel, 2016, noting that the Norwegian study is very transparent about other influencing factors).

Other countries also use such a system. Sweden has introduced performance indicators with the 2008 Research and Innovation Bill, with the explicit goals to maintain high scientific quality and to improve Swedish universities' competitive position through specialisation, priority setting and research profiles (OECD, 2016a; OECD, 2012, p. 175). The two indicators – normalised publications / citations and TPF success – were tied to 10% of the GUF part for research from 2008 onwards, although with a generous minimum allocation acting as a very soft cushion. The 10% indicator-based funding was mirrored by a similar funding increase (GUF and also other instruments), so nobody could lose. The ambitious goal was not at all matched by these soft indicators and at the end, nobody won or lost indeed. The 2012 Research and Innovation Bill then provided again for growing Direct Appropriations and other funding sources for the universities; the performance indicator was increased to 20%. This time the argument was to improve in the top segment and to find a balance between allocation sources to promote excellence as well as to address societal challenges (OECD, 2016a, p. 63). Again, the redistribution effects first were very modest. Note that the TPF part in Swedish HERD is very high with 56% (all sources, large philanthropic sector but low industry funding for universities).

> Pros / Main advantages: Relatively easy and cheap, also smaller-scale signals seem to work; some goals can be realistically achieved; can be coupled to other instruments
>
> Cons / Main disadvantage: often focus on one or two indicators only, cannot capture the full realm of university research, can also crowd out less mainstream work; can make believe that a real competition is going on while in fact it is not

6.4 Main model 3: Performance Agreements

PAs are forward-oriented instruments in form of multiannual contracts between individual universities and the state. As a rule, the state gives additional funds and the university promises additional activities or changes, e.g. improving quality or performing third mission activities. PAs can have the following aims (De Boer et al., 2015, pp. 13 ff.): (i) Institutional profiling, i.e. encouragement of organisations to better position themselves and across the board, allowing for greater diversity in the university system; (ii) establishment of a recurrent strategic dialogue between the state and the (autonomous) universities; (iii) quality improvement of the universities' core activities; (iv) to help improve efficiency and to (v) increase transparency and accountability. For most of these aims there is mixed evidence: Profiling through PAs in some countries means "profiling" universities in the same direction, therefore not increasing diversity. The goal to improve quality, productivity and efficiency appears to yield mixed results, as all PRFS systems and methods do.

However, softer goals however seem to be attainable: There is evidence on the improvement of the dialogue between the state and the universities in some countries with transparency as well as accountability having improved as well (De Boer et al., 2015).

This goes along with another lesson learnt: PAs seem to work better when their scope is not too broad. For the Swiss Federal ETH sector, truly lean PAs have been used to negotiate the surplus for the next period and how it shall be used; a similar approach can be found in the German State of Bavaria, and recent attempts in Finland appear to go in the same direction. Contrary to this, the Austrian PA system in the last 15 years has been voluminous, comprehensive, extremely time-consuming and without any financial consequences. The state claimed that the whole university system was subject to negotiations and therefore steered by a performance-based instrument. However not much steering has happened, as priority setting, focussing activities, robust indicators or financial incentives were largely missing. The comprehensive character does not help the ministry to set priorities and makes any prioritisation efforts difficult for university leaders. In addition, such comprehensive PAs lead to massive workload not only in the negotiations between the state and the universities. In addition, they can and often do trigger a whole cascade of comprehensive agreements within the university (Stampfer, 2017; For a broader context and a description of change needed in the Austrian HE system see Janger, 2012). For the PA period 2019-21 some improvements can be expected (OECD, 2018a).

The Luxembourg PA system is also broad but closer tied to performance indicators. This small country has PAs in place for the single university, all three PROs and two funding agencies. Every four years there is a big national performance negotiation *kermesse* (OECD, 2016b). Another case for PAs is Scotland and its Outcome Agreements between each university and the Scottish Funding Council. These put a strong emphasis on education targets (including diversity and access for students from less-favoured backgrounds) but also set gender and work place goals. Further innovation and transfer targets are being included as well as research-related targets: "*Delivering internationally competitive and impactful research*" (Scottish Funding Council, 2018, p. 1) is one of five goals the universities currently have agreed to intensify their contribution to. The *Progress and Ambitions Report* is continually being issued for all university outcome agreements. It shows that the main indicator is the amount of research council and other TPF acquired by the universities, and another indicator is how Scottish universities fare in the REF compared to the UK average.

PAs can be coupled with other PRFS instruments, mainly indicator-based funding. Norway has recently started a pilot phase with PAs (OECD, 2017) and Austria has introduced some metrics for teaching and research success, formally within the PAs, de facto in parallel to the contracts (OECD, 2018a). A number of other countries like Denmark or Australia (De Boer et al., 2015) also combine PAs with metrics and assessments. In the Netherlands, a smaller part of the future university budget depends on individual PA indicators, although for teaching goals (OECD, 2014b; Claeys-Kulik and Estermann, 2015; Elken, Frolich and Reymert, 2016), and they can lose a small fraction of their overall Direct Appropriations if the goal is not reached. Across countries, penalization happens to be a very rare outcome. The trick with PAs seems that nobody ever leaves the negotiation table, therefore allowing for constant dialogue and the *feeling* of progress.

Therefore, different sub-forms of PAs exist, (i) comprehensive, (ii) strategic and focussed and (iii) as part of an output-based funding system (Elken, Frolich and Reymert, 2016). If PAs are comprehensive (even more if they are negotiated in a state with a detailed legal and regulatory environment), what becomes of university autonomy? This is a serious question as it might invite the state to cherry-pick: The universities then are responsible for cumbersome goals they have not set for themselves but "together" with the authority representing the state. The state might keep its

prerogative by setting thematic priorities or by picking more attractive agendas, leaving the more unpleasant aspects to the university leadership to deal with (see De Boer et al., 2015, Stampfer, 2017). If on the other hand a lean ministry with few expert staff negotiates with university leaders without considerable power to act, then strong academic communities will probably be the winners: Everything is negotiated and the academic communities can forward their interests well.

> Pros / Main advantages: individual contracts providing for individual next developmental steps, allowing for profiling and negotiated co-development. Works well when surplus is being negotiated in a focussed way. Can help to improve dialogue, transparency and accountability. Can be coupled to other instruments.
>
> Cons / Main disadvantages: A *steering instrument* called "contract" carries some ambiguities that could hollow out university autonomy and it can be a process binding a lot of resources. Goals are difficult to set (comfort vs. survival). Workload with less focussed PAs huge.

6.5 Conclusions for the Pros and Cons

The pros and cons of the individual forms of Direct Appropriations have been described in the individual sections above. They vary strongly, as the incentive structures of PRFS, PAs and Block Grants also do.

Going one level higher, we can ask whether there is a common feature of Direct Appropriations. This feature can be termed as "*depth*" or structural effects (not necessarily always structural *change*). Direct Appropriations, if successful, can over a longer time period affect deeper changes in behaviour, rules and norms. Successful in this case means "intended" *and* "working". Therefore, it is important not to set too many targets at the same time to avoid fuzzy or conflicting signals. Depth means also that the whole university system of a given country follows the same signals (with the exception of some forms of PAs).

A lot of studies have been performed to see whether (i) a specific performance-based funding set-up works in specific countries, and (ii) whether there are innovation systems using performance-based funding (and most do use them) works better than others because of the sticks and carrots coming with performance-based instruments. For (ii) there is clearly no answer, because it always depends as systems are so different. But even (i) is a question hard to answer, as there are often too many hard-to-control variables to determine causality (Gläser and Laudel, 2016, pp. 129 ff.). Specifically, measuring PRFS impact on universities easily invites us to enter a multi-level, multi-actor, culturally laden quagmire, at least if *one clear form of causality* is what we are looking for. The question about impacts here is whether lasting intended changes have been caused by the (performance-based) funding model. If not: A high degree of sunk costs might result.

Finally it has to be reminded that competition for funds and grant-writing (for settings and effects e.g. Scholten et al., 2018) is not the only way how active researchers compete. Incentives have to be in place but we can rely on a significant part of the scientific community to want to compete for solving a puzzle or being first with a publication anyway. For examples see Stephan (2012, pp. 29 ff.).

7 Properties, challenges and impacts of project funding

7.1 The making and workings of a second funding stream

History of TPF

Historically, universities came first, with different degrees of state appropriations and autonomy while research funding systems, including RFCs and agencies, were created much later. In the 19th century, industrialisation and increasing societal complexity led to stronger state interventions, targeting areas like industry, health or higher education. The major industrial countries developed various forms of interventions to strengthen research and to integrate its structures and outcomes into the policy portfolio. A number of policy instruments were created in the civilian and military spheres, from boards to specific research institutes and first experiments with organized research funding. Among the first real RFCs were the Medical Research Council (MRC) in England or the *Notgemeinschaft für die Wissenschaft* in Germany, both created after World War I. France followed in the 1930s with the predecessor of the funding arm of the CNRS, while the U.S. made its biggest step into research funding with the creation of the NSF in 1950, establishing the science paradigm after a long period of more applied research (Braun, 1997; Stokes, 1997).

Various actor constellations emerged with different patterns in different countries, depending on the strength of the scientific community and the readiness of the state to actively intervene. The introduction of research funding in the larger "first mover" countries was nearly always triggered by scientific elites: Often *policy entrepreneurs* from science had successfully campaigned for flexible and autonomous research funds, in some cases hand in hand with individual policy makers. However, the state reacted quickly and different forms of balance of power emerged (Braun, 1997): In the UK the initial "distance model" was the result of a strong academic sector and a liberal hands-off state. In Germany, strong academics encountered an interventionist state leading to strong interaction *and* strong self-administration, while the situation in France was characterised by an originally fragmented scientific community and an interventionist state. The U.S. started with less well organised actors on both sides, but managed to build up interactive communities, originally around more applied research questions. The German university model was taken up and further developed in the U.S.

While some small countries like Austria first chose an imitator strategy and waited until the late 1960s to set up RFCs (Stampfer et al., 2010), others were more eager to keep pace. After WWII they wanted to improve industry, as well as using *science for welfare and warfare* (that is how Lundin et al., 2010, titled their book on technology and state initiative in Cold War Sweden), through university-based research and its support by dedicated RFCs and other state agents. One prominent example is Switzerland, first with the Commission for Technology and Innovation (CTI) from 1943 onwards and the Swiss National Science Fund SNF a few years later in 1952, as a foundation created by the Swiss Scientific Academies (OECD, 2006, p. 27). Norway followed suit with the Norwegian Council for Scientific and Industrial Research (NTNF; OECD, 2017, p. 188).

Sweden was among these ambitious smaller countries. The Technical Research Council (TFR; OECD, 2012, p. 222) was founded in the early 1940s, followed by a various RFCs. Implementing the results

of the 1942 Malm Commission, Swedish policy made a clear decision (OECD, 2016a, pp. 60 ff.) to position its universities as the dominant providers of scientific and other research-based knowledge and therefore early on implemented a two-track RFC system. Traditional research councils had early counterparts like STU for technical-industrial research and science-industry collaboration. This led to various fault lines and turf wars, as parts of the academic elite often managed to successfully lobby for better endowed block-grant-plus-pure-science-RFC-models at the expense of innovation policy funding (OECD, 2016a; Arnold et al., 2008b).

Overall, the TPF portfolio and financial incentives switched to a strong *science push model* in most countries after World War II. This was followed by periods with strong mission-orientation, thematic programmes, more bottom-up based paradigms, including funding policies with an impetus on network, cluster and tech transfer mechanisms, and from the late 2000s onward towards a new challenge- and mission-driven policy (for the latter see the *Lund Declaration*, 2009). Today most countries – including regions and supra-national levels – possess a broad array of funding sources and incentives, ranging from basic science funding to various use-inspired activities. As indicated in → chapter 3, the rationale for university research funding has been changing (Geuna, 2001) and TPF has grown considerably.

Current situation

The literature on project funding is extremely rich as the instruments and impacts are attractive to study in addition to the large stock of evaluations commissioned by those who sponsor this kind of research. In their comparative study Lepori et al. (2007b) identified a lack of systematic comparisons across countries and over time. Many TPF studies were (and still are) evaluations of one programme in one country within a limited time period under specific framework conditions. Since then the picture has become more nuanced, thanks to the work of European Networks like PRIME, the emergence of a few long-term impact evaluations or efforts like OECD innovation reviews.

Nonetheless, it is possible to identify two ways in which TPF is situated within national systemic idiosyncrasies and trajectories: First, similar to the case of Direct Appropriations, there is no dominant model and no common pattern across countries (and over time). Each country has its different actor set and instruments, although there are some TPF instruments like RFCs and innovation agencies that can be found in virtually all countries. However, the French ANR is definitely different from Research England and the Swedish funding landscape not comparable to the "singular" Research Council of Norway (RCN) across the border, although they all offer similar funding opportunities.

Second, the ongoing discussions and occasional turf wars over resources follow long historical trajectories: Sweden is a prominent example but definitely not an outlier[16]. It is interesting notice the differences in smaller countries: While in Austria industrial interests constantly triumph over academic needs in TPF allocation, the Swedish academic elite appears to regularly defeat the

[16] In Sweden – as described – the STU / NUTEK / VINNOVA management and their few innovation policy allies always had difficulties acquiring appropriate budgets and platforms for their efforts. In the post war era there were the development pairs at hand (Dahmen, 1970). These combinations of state monopolies and large suppliers could invest into long term innovations and integrate university research into these ventures. As these platforms found their end in times of globalisation and European competition law, Swedish innovation policy had a difficult time and not all policy experiments were equally leading to short-term success (with parts of academia saying: „*I told you so, give the money to us*"). In the last years new challenge driven and other instruments give rise to hope that a new success period of innovation policy has started in Sweden.

innovation policy actors (with Swedish industry apparently fighting less for direct R&D subsidies than industry associations in some other countries) and safeguard university TPF through a variety of sources. Finland has two strong poles with the Academy of Finland and TEKES, albeit with various shifts in budgets over time. In the Netherlands the state has introduced a very active thematic top down policy to strengthen selected industry sectors by using also the funding sources for academia, thus strongly steering the national RFC NWO, the Netherlands Organisation for Scientific Research. In Switzerland there is overall consensus that strong universities and science funding are the best policy choice for all purposes, including industry development. In addition, the national RFC SNF never had a real problem with some top down inspired policy instruments in its portfolio (Benninghoff and Braun, 2010). In Norway a variety of policy goals and instruments are bundled through the RCN and the strong consensus principle. The latter also characterises Denmark, where a larger number of TPF providers including strong foundations come forward with many funding opportunities and instruments (Slipersaeter et al., 2007; Reale, 2017; OECD 2012; OECD, 2014b; OECD, 2016a; OECD, 2017).

Except for a few countries with mixed organisations (Braun 1997 or Lepori et al., 2007b for the case of France), TPF can be quite well delimited from other forms of funding, in our case Direct Appropriations.

Table 6: Comparison of main TPF sources for science and innovation in smaller countries

	Inhabitants (millions)	"Basic" research funding (m €)		Applied research funding (m €)		Total (m €)	Budget p. capita EUR)
Norway	5	RCN (estimated 2/3 for "applied" research funding)			850		170
Austria	8.5	FWF	200	FFG (HEI get fraction)	520	720	85
Finland (volatile in last 10 years)	5.5	AKA	440	TEKES (HEI get fraction)	380	820	149
Switzerland	8	SNF	800	CTI (HEI get most of it)	150	950	119

Note: All numbers are approximate and refer to the years 2014/2015.
Source: own compilation, used in OECD (2017). p. 193

The size of TPF funding available and the distribution along RFCs and innovation agencies varies considerably, see Table 6. It makes a big difference to be an Austrian university researcher having to rely on one main RFC source only (Austrian Science Fund, FWF), whose budget per capita is a third of the Finnish Academy or a quarter of the Swiss SNF. It also makes a difference if you are able to turn to a multitude of RFCs and private foundations, like Swedish and Danish university researchers can. Other funders and countries can boast a bigger budget, although for more sizeable constituencies: Annual U.S. federal science funding, mainly through the U.S. National Science Foundation (NSF) and the U.S. National Institutes of Health (NIH), can add up to more than 30 billion USD. By comparison, the new EU Research Framework Programme will allocate 100 billion € over a time period of seven years. However, no matter how large a TPF system is, researchers in most countries are or feel under

pressure, as Direct Appropriations have decreased, numbers of researchers increased and success rates are lower than ever (Stephan, 2012; Koier et al., 2016 for the Netherlands).

Properties and governance questions

Although there are various forms of single projects, networks, centres and initiatives funding people and their careers, TPF always includes a limited time period, budget and scope, a clear subject matter and PIs that promise to do the proposed work in the future. Before funding, such proposals are being assessed by experts. In case of public TPF, aiming to support university-based research, this happens as a rule through peer review in various forms. RFCs like VR, Formas, the NSF or the European Research Council (ERC) are typical organisers of such peer review.

In the relation between public budgets and the research community, RFCs are the agents, getting money from the state as principal (for a rich literature Braun 1997; Braun and Guston, 2003), because they have *and* can organise domain knowledge the principal definitely has not. The state entrusts these agents through delegation and applies certain control mechanisms. RFCs have to take care neither to be overly captured by the communities they serve nor getting too closely and feverishly steered by the principal for short-term political reasons. For *innovation agencies* in many countries the latter is the greater challenge. The degree of autonomy and responsiveness to either level (Slipersaeter et al., 2007) is often depending on the mission and on the funding instruments.

RFCs (and indirectly the principal) have to take care not to be taken over in many small steps by their constituencies, as RFCs with high autonomy are often *governed by representatives of the scientific community*. Moreover, they often have a strong bottom-up project share in their portfolio and often identify themselves with the needs and beliefs of academics rather than with those of the treasury and the responsible research ministry. If this is the case RFCs might face the challenge of conservatism, with a possible bias towards mono-disciplinary, more-of-the-same funding decisions.

The bulk of researchers however come in as *applicants and recipients* of funding. They adapt to the signals of RFCs and funding agencies to varying degrees (Laudel and Gläser, 2016). While RFCs with strong bottom up agendas do not require much adaptation except for the production of preliminary data before submission, most targeted thematic or mission-oriented programmes trigger a variety of reactions. These range from inspiring and funding new research lines and partnerships and allowing fields to grow (lots of impact), to masking and step-wise adaptation (less impact). As with Direct Appropriations, gaming, “bootlegging” and adaptation strategies are prevalent with TPF also: A “project” is a different thing for researchers and for TPF programme officers; and researchers can promise and write a lot to obtain funding necessary for keeping up their own research.

A first view on Pros and Cons

In general, competitive funding schemes have the following advantages or pros (see also OECD, 2018b, p. 7; Gläser and Laudel, 2014):

- Increase quality and relevance of research proposals through invitation to apply, funding criteria and reviewing.
- Ensuring minimum quality standards through planning a project along a structured template, and through reviewing; this is also a path to efficiency as many proposals are indeed of weak quality.

- Testing ideas with peers: Peer review has clear advantages here, as many scientists review to see what their colleagues are planning to do. A majority of them gives advice (for free) how to improve the proposed project. Although there seem to be no studies on peer behaviour, it appears that most peers act with the motive to be helpful. In this context it is important to avoid over-competition and small or local peer pools.
- Building trust along fair procedures. This is a core task of RFCs and funding agencies.
- Sending thematic, structural or quality signals to the relevant communities with the funding programmes. Here a broad variety can be observed, but there are a lot of success stories around.
- Sending the funds precisely where they should go to: The researchers who won the grant actually receive the money; and if overheads come with the grants the university even gets a visible inflow causal to the efforts of certain researchers. This is in contrast to Direct Appropriations that are distributed in other forms; e.g. systems that have *one* funding stream for research and teaching might subsidize the latter with funds for the former. Underfunded universities and systems running without a full-cost accounting are in danger to fall into such – largely unseen – habits.

The disadvantages / Cons of competitive funding schemes include (again OECD, 2018b, p. 7):

- Falling into short-termism due to increased competition and to the nature of fixed term grants, which inter alia makes if difficult for hiring of PhDs, a crucial stage for young academics in their career track;
- Mainstreaming and funding less-risky proposals (with mixed evidence), truly novel ideas struggle with TPF (and vice versa, Fortunato et al., 2018). In a comparison between high profile TPF (NIH) and long-term Howard Hughes Medical Institute funding, the latter allows for more interdisciplinary research and combinations (Azoulay et al., 2011);
- Inducing considerable (hidden) costs of writing, processing and appraising proposals (Stephan, 2012). These costs explode when many formal rules meet low acceptance rates.
- Becoming a *research hotel* without proper integration of projects and people into the realm of the university: This can happen in combination of generous TPF and underfunded and/or weakly organised universities.
- Gaming as a strategy can be substantial (as with Direct Appropriations)
- Sucking off Direct Appropriations in absence of underlying strategies: In Europe there are practically no cases of true full cost TPF. Therefore, TPF research needs co-funding by the university. This can become dangerous, if (i) Direct Appropriations are meagre and / or if (ii) there is an uncontrolled stream of new staff into the universities with TPF means *and* TPF track records are of advantage to obtain a permanent position: Then TPF might invalid any university research strategy. No matter by how much Direct Appropriations increase (OECD, 2012; OECD, 2016a), the central cash box is always empty.

TPF and gender

When it comes to gender equality and fairness, serious and justified concerns have been raised with regard to TPF, namely in many kinds of RFCs and programmes with strong academic peer review (→ see section on peer review). While a lot has been changing since the beginning of this overdue debate (for problems and progress in the 2000s see European Commission, 2009: see also Wenneras and Wold, 1997), there is still considerable evidence for gender discrimination: Women obtain smaller grants than men, and the odds to get funded are still

against women in a number of funding programmes, when comparing applicant and grantee numbers (Boyle et al., 2015). Such effects are due to still prevalent biases and practices in funding programmes (van der Lee and Ellemers, 2015, for NWO excellence grants). They often affect women in early career stages (Fortunato et al., 2018), when their propensity to leave science or to opt for less ambitious paths appears to be highest.

On the other hand, there are encouraging examples that most biases can be avoided if TPF is being properly curated, with appropriate policies and awareness measures in place; with panels specifically composed and briefed; and with criteria and guidelines developed in a gender-sensitive way. TPF can draw from a whole arsenal, ranging from specific funding initiatives to promote women to gender mainstreaming or affirmative elements within more general funding programmes. Boyle et al. (2015, p. 183) show for social science research funding in the UK, that such mainstreaming approaches can work well and lead to superior results compared to other discipline-specific forms of TPF.

The authors however emphasize the importance that both sides have to be active. Measures within the universities are at least as important: Nurturing talents with a diversity approach, allowing for work-life balance, shaping recruitment, career and promotion models and practices, fighting wage gaps, awareness in the selection of leaders etc. All these are not primarily TPF issues but truly organisational tasks. This might be another example where the practices within universities (and funded through Direct Appropriations) are more of a black-box-nature than TPF, and properly designed TPF can help to shed some light into it. In a large-scale analysis of Swedish academic research output, van den Besselaar and Sandström (2017), show that there is still a gender gap, not in quality but in quantity: There are just less female researchers and the gap persists also due to gender differences in age, authorship position and academic rank. This is mainly homework of the universities and change has to come through Direct Appropriations and HE regulations, and not primarily a TPF task. Funding programmes however have also to close their own remaining "funding gap" quickly.

7.2 How does TPF function? Peer review as main method

A proven method …

Peer review is the main method to decide on university research TPF allocation (OECD, 2018b). It comes in different forms, open or blind, remote and / or in form of juries, as single instrument or combined with other mechanisms. It is also used in scientific publishing, for career decisions, further in evaluations of ongoing and past research, among others (Langfeldt and Kyvik, 2016). Strongly intertwined with analysis of metrics, it is also part of some forms of PRFS like in UK or Italy (Geuna, Piolatto and Labini, 2015, pp. 102 ff.), where panels go beyond individual research proposals / activities and give their judgement on whole departments and fields (→ chapter 6). Peer review for TPF funding has many advantages as it combines external judgement with domain knowledge. It is still widely trusted by the scientific community and therefore enjoying legitimacy in the scientific community (OECD, 2018b). Being used in many different forms across different programmes and countries makes common standard practices difficult to identify (Langfeldt, 2006).

The mechanism comes with reasonable direct financial cost as peers work for free for many RFCs. At the same time the hours spent on writing and assessing proposals amount to large numbers: Geuna and Piolatto (2015, p. 269) report an overall cost estimation of 13.5-15% of TPF for all UK research councils in UK for the mid-2000s, including agency cost, cost of reviewing and cost to write

proposals. Direct agency costs might account for only a few percent of the overall cost – mainly in monetarized time – of the whole TPF process: The estimation for the much larger rest are three quarters preparation and submission cost and one quarter referee time cost. This becomes more relevant in times of decreasing acceptance rates in RFCs (Geuna, Piolatto and Labini, 2015; Geuna and Piolatto, 2016; for Norway similar estimations in Langfeldt and Kyvik, 2016, pp. 141 f.). For the high U.S. researchers' workload in grant preparation see also the calculations of Gross and Bergstrom (2019), who also use a discount in their model: Proposal writing also sharpens ideas, so not the full time is being lost.

Peer review still keeps the growing global science production going. As TPF shares grow as well, there are concerns about the viability of the global peer militia system. The considerable rise of data-driven methods like bibliometrics has not yet been able to provide an alternative for the task of appraising proposals, ideas and people. It has however added a new and valuable dimension to judge past merit and has often been added to support peer review, either voluntarily (for "informed peer review") or involuntarily, as peers tend to use the h-index and other metrics as a convenient marker.

… under fire

Indeed peer review indeed needs support, constant critical reflection and reform. The *"guardians of science*" (the title of H.D. Daniels'1993 critical book peer review) and their "*curious world of academic judgement*" (the sub-title of M. Lamonts' 2009 exploratory book on peer review and juries) appear to have serious flaws (Langfeldt, 2006; Langfeldt and Kyvik, 2016, Luukkonen, 2012): It can and often does lead to conservatism, preference of established research and people, bias towards mono-disciplinary proposals and sometimes to outright sexism, nepotism and other unfair individual and group behaviour (Wenneras and Wold, 1997). Uncertainties are everywhere and assessments are error-prone when it comes to future potential of proposed research, a fact that appears to be underestimated by academics and funding organisations (Härlin, 2016). All this seems to stem from a mix of (i) human nature with its bounded rationality, (ii) individual procedural and governance issues in funding organisations and programmes and (iii) also from individual and collective interests, biases and traits of academics, i.e. how professors can behave also at home in their departments, collegial commissions and other arenas.

Overall, the scientific community, governments and RFCs are increasingly aware of the issues of peer review and work on it. The gender issue has been taken care of by many funding organisations and specific programmes. Adapted criteria and mainstreaming activities have been introduced from the 2000s onwards, see the section above. Langfeldt, 2006, states that many flaws can be mitigated or prevented through pre-meditation and adaptation to the individual context. The awareness of funders has grown with the rising number of proposals and the sinking acceptance rates that are leaving juries and funders with many good proposals but only a fraction of them to fund.

One serious argument against this form of assessment is that peers are not always very good in selecting future high performers and projects that are breeding grounds for high performers. From the early 1980s onwards, various experiments with parallel evaluations (e.g. Cole, 1981) have been conducted as well as ex post evaluations whether the winners or the "best ranked losers" perform better, with different but not always heart-warming results. Studies testing peer procedures with bibliometric past performance data reveal big differences in who was selected, leading to questions how strongly past performance shall count (van den Besselaar and Leydesdorff, 2009).

Recent studies include the EMBO long term postdoctoral fellowship showed that "… *the peer review system is not substantially better than random selection in identifying the best candidates once an initial pre-selection of the most promising ones is performed … (and) … the information available at the time of application is not sufficiently predictive of career progression."* (Klaus and del Alamo, 2019). An evaluation of the Emmy Noether programme of the DFG, another high-profile programme for young researchers (Neufeld, 2015) comes to comparable conclusions. The reports list a number of similar past evaluations with a variety of outcomes: In some programmes the funded PIs perform better than those not funded (respectively the *nearly funded* cohort), in some others, the evaluation can observe no better performance of those getting the high profile funding; the Emmy Noether evaluation itself only finds "*little evidence for a substantial effect of … funding on grantees' subsequent publication performance"* (Neufeld, 2015, p. 7). The existence of a rich funding landscape in some countries can serve as a partial explanation: The "best" rejected researchers get funded quickly elsewhere.

However, as the acceptance rates have come down to 10-20% in many funding agencies and RFCs (OECD, 2018b), the system faces three increasing problems: First, it becomes more difficult to receive funding and many unsuccessful proposals have to be written to finally score and stay in the hyper-competitive race (Fochler, Felt and Müller, 2016; Roumbanis, 2017, with examples from Sweden and Australia). Second, peers in all kinds of procedures find it harder to select those proposals that shall clearly be funded, as too many good researchers submit too many good proposals. This is perhaps the greatest challenge for peer review and one main reason for the unrest and for the results of the evaluations presented above. Third everybody is being kept busy with activities that is not research in itself.

One proposal that has been put forth is to make the grants smaller while increasing the acceptance rate (at least in the short run) as more applications can be funded with the same amount of money. The idea stems from Canadian research claiming that more but smaller grants are more efficient (Fortin and Currie, 2013). The authors analysed a sample of grants issued by the Natural Sciences and Engineering Council of Canada (NSERC) in regards to whether large grants lead to disproportionately higher impact, finding that they do not, at least not in a significant way. Fortin and Currie also provide further evidence that peer panels do not necessarily identify those applicants that are most productive in the future. In times of large allocations like NIH01 (see Azoulay et al., 2011) or ERC grants such results deserve discussion and more research would be needed to see which TPF instruments lead to which level of scientific productivity. We will come back to this issue when we discuss the Matthew effect within large scale grants for younger group leaders later in this chapter.

Alternative approaches

In response to the problems outlined above, various alternatives have been put forth. One is to take all the available competitive funds (TFP and REF-style) for research and spread them evenly. All researchers with a minimum record or a certain career position receive the same amount. The authors of the proposal (Vaesen and Katzav, 2017) claim that nobody would starve and all the negative effects of the rat race would vanish: hyper-competition, bloated labs, researchers as full-time administrators / grant writers, the post-doc inflation, even fraud. At first glance, at least two arguments speak against this approach: The authors might underestimate the cost to run a lab, and they might also underestimate that most of their colleagues would not like to live in a world without competition for funds. The lesson the authors teach us, however, is to search for clearer and simple solutions, as their diagnosis of growing dissatisfaction appears to be true.

Another idea is to include an aleatory element in selection procedures. Lotteries are known since ancient times, when they had a positive connotation also beyond the possibility of getting rich with the right combination of numbers. The argument of the advocates like Roumbanis (2017) or Gross and Bergstrom (2019) is simple: If human rational arguments cannot provide a fair decision then a lottery is better, because under such circumstances it *is* fairer, less biased regarding big names, neutral regarding the future outlook and finally also much cheaper. Peers or programme officers can do a pre-selection and / or a parallel selection of a second cohort of funded projects. Some smaller scale experiments like the "Experiment!" programme of the German Volkswagen Foundation and the "Explorer Grants" of the Health Research Council of New Zealand have shown that such an approach is feasible, without researchers fainting or programme officers put on the dole. It remains to be seen whether this approach will become a mainstream instrument as there are also arguments against lotteries, like how such an instrument might impact public opinion about research.

A third idea is crowdsourcing. Many programmes and funders currently explore the world of open innovation and open science. One approach is to let broader groups of stakeholders co-develop ideas for a programme or another initiative, and / or to co-decide on the selection of proposals. This happens in a multi-step process, where peers also have their role. As an example, the Austrian Ludwig Boltzmann Society has developed successful models for such broader processes to create new research groups in clinical care or mental health (OECD, 2018a; Beck and Pötz, 2018).

A fourth line of ideas tries to find remedies when peer review is too conservative, namely when dealing with proposals putting forth radically new and transformative ideas. This is an exciting avenue in the world of research funding and the notion of radical and transformative innovations is an inspiring task (contrary to the "excellence claim" which seems ubiquitous and rather difficult to define and to calibrate; for a critical approach see also Scholten et al., 2018). A number of research funders experiment with high-risk and transformative calls as well as specific calls for specific communities and groups etc. (Luukkonen, Stampfer and Strassnig, 2015; OECD, 2018b). Further ideas to fund new and potentially transformative ideas include so-called sandpits (e.g. to co-create and rate proposals in a workshop and to fund the best-rated ones) or other mechanisms where invited applicants cross-evaluate other proposals or anonymized short proposals for transformative ideas are being put forward to a "sift panel" (Warta and Dudenbostel, 2016; Kolarz et al., 2016; Luukkonen, 2019). A prominent and long-standing example for funding risky and potentially ground-breaking projects is DARPA, an agency of the U.S. Department of Defence. DARPA entrusts experienced programme managers, hired from industry or academia, to decide which proposals and ideas to fund from a portfolio of ideas (OECD, 2018b). A few more considerations and evidence will be provided in this chapter when the instruments are being discussed.

Fortunato et al. (in their 2018 Science of Science review) also emphasize that placing novel ideas into the context of established knowledge is not only a good strategy to obtain TPF grants, but also to enhance citation impact. To succeed with TPF *and* with audience appreciation *and* with career advancement, researchers have to strategically play their game. The name of this game is: How to win over your relevant community which is overnewsed, overworked and sceptical, and all this for good reasons. *This is a core point*: TPF and peer review is not some outer-world process gone wild, but very similar to other mechanisms in academia for selecting and adopting ideas as well as for gaining attention and increasing reputation.

These are just a few examples how procedural "cons" of the main TPF process can be discussed and also mitigated. The key point for this analysis is this: Peer review is laden with considerable issues and sometimes flaws. However, it is a cornerstone of the autonomy of the academic sphere, it works well

enough and it is a global and still indispensable practice to fund (university-based) research. The issues and flaws are increasingly taken seriously by many actors. There is evidence that peer review properly "conditioned" for the specific purpose and context works quite well (Langfeldt, 2006; Gläser and Laudel, 2016, p. 123, with further sources).

Further remedies for flaws include (i) a variety of funding instruments for different purposes, (ii) the improvement of middle-of-the-road processes on the mechanistic and awareness level e.g. by composing balanced juries or better dealing with outlier applications or opinions, (iii) experiments with new hybrid forms and (iv) a prudent use of quantitative instruments as additional source for information and decision making. Finally, (v) there should be considerable Direct Appropriations in place which should not be outgrown and completely stripped by new researcher inflow.

What Peer Review tells us for the pros and cons

Pros / Advantages with peer review: There is a lot of criticism, but peer review is still working and seen as a comparatively fair and rational way to allocate resources to extremely specialised people and proposals. Peer review ideally allows for a two-way communication with feedback. Criticism leads to (i) many new experiments and approaches within the peer review paradigm and to (ii) the design of alternative approaches (and some of them will survive and grow). Peer review gives TPF and also peer-style PRFS a strong rational basis.

Cons / Disadvantages with peer review: It is quite expensive mainly in non-monetary terms and it has some properties which can dampen or hinder risky, outlier or interdisciplinary research. Moreover, it can discriminate against women, younger researchers and those who work in less well-known research environments, while conversely leading to Matthew effects (see Box 3 for a brief discussion). Peer review needs therefore strong curation and contextualisation.

Box 3: For whosoever hath, to him shall be given

There are arguments in favour as well as against the Matthew effect. Large grant allocations, centres of excellence and the power of track record lead to concentration in resource allocations. It depends how we view it: on the one hand ERC grants contribute to this concentration, on the other hand nearly 10.000 such grants have been issued to many thousands of recipients, quite a broad *faculty* of both stars and newcomers across Europe. For Sweden Hallonsten and Hugander (2014) describe a quite limited group of aspiring younger top researchers that win two or three "super grants" like ERC funding within a short time period, while other researchers with very good publications do not get a single one of them. There are TPF systems with a number of funding sources offering similar "super grant" schemes as they are not only attractive for the recipients but also for the RFCs and agencies that provide these opportunities as a kind of window display. On the other hand, we know that the role of such grants as selection modes for scientific careers is far from being proven (Klaus and del Alamo, 2019) and the mainstreaming of the excellence-label is criticised as dangerous (Scholten et al., 2018).

In an analysis of Nordic CoE schemes, Langfeldt et al. (2015) do not see any comparable over-concentration, but a *modified* Matthew effect with ceilings and limits. This applies both for winning CoEs in itself and for then getting more other grants: A CoE-label does not seem to guarantee easier access to other funds.

There are different arguments circulating: Undoubtedly too many too small grants would put even more burden on everybody and make it difficult to run a sizeable research endeavour. Large grants on the other hand do not appear to result in better publication impacts of the research funded. Quite on the contrary, there seems to be evidence that funding smaller groups and a variety of individuals has benefits (Härlin, 2016; Fortin and Currie, 2013; Wu et al., 2019). Further, for less well-endowed universities the young *super-grant* recipients prove to be a challenge for their organisational balance (e.g. Edler et al., 2014; Bonaccorsi, 2015), a phenomenon that has its pros and cons: On the one hand there is trouble, on the other hand some dynamics can be expected to shake entrenched research environments through the imbalances caused by high-flyers with strong negotiation power. The researchers themselves can run into considerable difficulties how to sustain their high-flying labs once the grant periods are over (Laudel, 2013).

7.3 Which kinds of TPF instruments?

In a recent survey, the OECD (2018b) has compared 75 competitive funding schemes for research across 21 countries. The instruments implemented across OECD member countries do not differ too much when using broad categories; they range from individual investigator grants, to centre and network funding and to grants in the context of tackling societal challenges. The five main purposes of all these schemes taken together are the following: Funding interdisciplinary research was named most often (!) in the survey, followed by PI-led individual projects, the exploration of new scientific domains, capacity building and funding blue sky research (OECD, 2018b, p. 17). In a matrix showing who (persons or organisations) can apply for what (blue sky or missions), there is a broad variety and no strong clustering of schemes.

75 schemes, this is just the tip of the funding iceberg. Globally there must be thousands of research and innovation funding mechanisms, provided by scores of RFCs and innovation agencies on all levels. Many of these programmes and institutions have been evaluated and if we search long enough we will also find thousands of evaluations. Therefore, the presentation of typical funding modes will come forward with a few simple examples since otherwise we would drown in numbers, modes and details.

This analysis has put its focus on TPF in Europe and not on the U.S., as (i) the literature and stock of evaluations is that voluminous and (ii) the patterns cannot be properly compared for our task: When there are no Faculty Appropriations for research and TPF comes with full overhead cost covered, the whole interactions and incentive structures are different. However, the U.S. evaluation literature on the effects of project funding is very rich, including econometric and other quantitative studies. They reveal many correlations and some causal impacts. In March 2019, a very substantial comparative review on RFC funding has been published, listing the U.S. literature on the pros and cons of project funding (mainly from biomedical research funding like NIH). This review (Janger et al., 2019[17]) includes a lot of evidence also in favour of TPF and complements our analysis.

Individual, PI-centered, bottom up projects

[17] https://www.e-fi.de/fileadmin/Innovationsstudien_2019/StuDIS_09_2019.pdf

Such projects are the basic product of practically all RFCs and many agencies. They fund the research activities of one PI or the collaboration of a few core people for a few years. Costs accrue mainly for personnel including PhD students, Post Docs, Technicians and in some cases the PI herself, if she has no funded position in her home institution. The size of the grant can vary but is usually within the mid six-digit € range, although there are also larger grants, like in U.S. federal agencies for instance. Traditionally these proposals are being submitted in open, bottom up formats, i.e. whenever the PI was ready to submit and without any thematic restrictions. In the last decades, programmes with cut-off dates and thematic or other focus have gained prominence.

Example: The Norwegian FRIPRO programme. This bottom up funding programme is one of the main instruments of RCN as the countries' comprehensive research funder. It targets mainly universities and is the most important source for bottom up, quality-as-main-criterion research. The resources amount to approx. 1 billion NOK annually and they are divided in three sub-lines, one for each of the three big research fields Bio/Med, Humanities/Social Sciences and Natural Sciences/Engineering. The instruments include projects, mobility grants and special lines for younger researchers. The programme is very competitive with only about 10% of the proposals are being granted. This is even more remarkable as allegedly only 20% of tenured university staff applies at all (the same phenomenon exists also in Austria). The FRIPRO evaluation (Langfeldt et al., 2012) showed inter alia following programme *impacts:*

- FRIPRO funds and increases high quality research
- Its grants serve as preparatory grounds for successfully obtaining larger funding.

The evaluation gave food for thought on how to better fund interdisciplinary and high-risk projects in the future and how to increase the budgets that are very tight in international comparison. RCN and the government took up both recommendations (Langfeldt et al., 2012; Warta and Dudenbostel, 2016; OECD, 2017).

Pros / Main advantage of bottom up projects: "Fri" means free in Norwegian and this is the main advantage of such programmes. Bottom up projects are needed in substantial numbers to allow the researchers develop their ideas (without having to set up networks or follow thematic signals), checked by the RFCs quality control.

Cons / Main disadvantage of bottom up projects: Not a strong one. Single projects often run for two to four years only and they are often not linked to a greater context or any kind of user sphere.

Funding of large person-centred grants, namely Young Investigator programmes

Instruments to fund high potentials and other kinds of researchers with large grants have gained prominence over the last two decades. Programmes like the ESF EURYI scheme in the 2000s were role models and taken up on the EU level on a large scale with the ERC Starting Grants. At national level such grants can be found in many countries, provided by RFCs or foundations in order to promote the careers of young researchers with an identified extraordinary potential. These programmes are mostly organised as competitions, often with hearings and a certain institutional commitment needed. Some programmes focus more on the existing talents, others bring in young researchers from abroad, while others again fund experienced researchers. The winners often get seven-digit € (starter) packages and are often put in a very good position for negotiating or – in case of young researchers – directly starting a career track.

Such programmes exist in many countries, e.g. Germany (Heisenberg Professorships, Emmy Noether Programme by DFG), The Netherlands (NWO's Veni-Vidi-Vici Programme), Switzerland (SNF Eccellenza programme), Austria (Start Programme and Wittgenstein Prize) or Canada (The Canadian Research Chairs). Such programmes can also be found on a transnational level, like the EMBO fellowships or to a certain extent the Human Frontier Science Programme (HFSP). The most spectacular policy in(ter)vention was the European Research Council, as it helped change the rationale for research funding in Europe (Nedeva and Stampfer, 2012) and made top-level researchers a real hot topic while quite effortlessly introducing a transparent benchmarking system where top research takes place. It is also another example of scientists as *policy entrepreneurs* as this programme was not a Brussels brainchild (König, 2016): The strong Scientific Council, steering the programme and the ERC EU agency, still bears witness for this extraordinary policy move.

Example: The EU ERC Grants. In 2007, the ERC started its funding activities as a quite unusual part of the EU Framework Programme, becoming the landmark initiative for the newly added *European Added Value* competition and excellence. The first two funding lines were Starting Grants for young researchers and Advanced Grants for experienced ones, later a few other funding lines like Consolidator Grants were added. Selected through panels (with peer review added) along broad thematic areas (Luukkonen, 2012), ERC grants come with large budgets (1.5 to 3.5 million €) and considerable freedom and negotiation power, due to the size, prestige and portability of the grants. Since 2007, the ERC has become a strong pillar of European research funding (1.8 billion € budget in 2017; 17% of H2020 overall budget) and about 10.000 grants have been approved since. Among many others the following *impacts* can be found*:*

- Researchers could improve their independence and their ability to start outstanding research work (Nedeva et al., 2012; Neufeld, Huber and Wegner, 2013); they could enter new fields and approach larger questions.
- Through its sheer existence, the ERC has changed the debate about outstanding science in Europe and has triggered a number of organisational reforms on university level as well as in the RFC landscape: As analysed by Luukkonen in the EURECIA project, new RFCs e.g. in Poland or France (ANR) have been established with the argument to improve the odds of the national research community at the ERC. Their set-up has been inspired by the ERC as organisation. This is also a part of the ERC mission: "*to create leverage towards structural improvements in the research system of Europe"* (cited in Nedeva et al., 2012, S. 26). Note that the European Commission talks of the *system*, singular.
- Universities and research organisations have taken a number of steps to improve their performance through improvement of organisational and support structures, again: "*…supporting the research organisations … of Europe to develop their research strategies …*" (*ibid*., p. 26).

A number of evaluations have taken place in the first 10 years of the ERC: In the MERCI study, Neufeld, Huber and Wegner (2013) did a large-scale survey to analyse the impacts on Starting Grantees. They found significant increases in their autonomy, time for research and the ability to go into new fields. At the time of the evaluation, the *past* publication performance of approved and rejected StG applicants differed only moderately. After a few years most of the StG applicants showed an above-average output compared to the time prior to the application. In the EURECIA study (Nedeva et al., 2012) a whole array of early impacts was identified, for both kinds of funded researchers as well as for the ERC itself: On the reputational side this organisation influenced the whole discussion on excellence, funding and ambition in Europe. The ERC has become an

acknowledged marker for quality across the continent, see also the link between university rankings and number of ERC grants, with few outliers only (Bonaccorsi, 2015, pp. 12 f.). On the organisational level, there have been different but manifold answers (see also Edler et al., 2014; Cruz-Castro, Benitez-Amado and Sanz-Menendez, 2016).

A survey plus a fine-tuned case study (by Gläser and Laudel) within the EURECIA project revealed that researchers could do different things *and* things differently on a considerable scale through ERC grants. Both the MERCI and the EURECIA evaluations state that it is still too early for career impacts but this might also prove the most difficult part of the ERC funding as the various old-style career systems do not just go away because of a new funding programme. On the other hand, studies on other programmes have shown that such grants are good for the career and not necessarily so for an increased scientific output (see Gläser and Laudel, 2016, p. 124).

Bonaccorsi (2015) states in his meta-study on the ERC for the FP7 final evaluation that measures to foster scientific leadership had been missing in Europe, as autonomy and funding levels of individuals had been too low. ERC through its properties and the Europe-wide competition had been the right answer. In this vein the ERC can also contribute to a strong European position globally through its quality signals and stratification processes.

> Pros / Main advantages of large / early stage super-grants: Increased (early) autonomy for top researchers, considerable funding for new avenues and bigger ideas, challenge for organisations and systems through mechanism and existence. With the ERC came the aspiration to enhance the capacity of universities to develop and execute strategies, together with some incentives and early impacts showing that such an impact does exist. Further reputation effects of large scale interventions like the ERC have a structuring effect across Europe.
>
> Cons / Main disadvantages of large / early stage super-grants: Not sure whether future best performers are selected (see evaluations of long-running programmes like EMBO fellowships). For the ERC this was still too early up to now. On the other hand there is a tendency in funding agencies and RFC to board this train. In countries with many RFCs and agencies, many younger researchers get two or three such excellence grants. This leads to serious questions (see Hallonsten and Hugander, 2014) regarding fairness, Matthew effects and a potential Ikarus effect once these generous grants end.

Strategic and mission-oriented programmes

Such programmes act as *focussed* change agents. They are placed where a need is being perceived but no other organisation thinks it attractive to go. This happens because RFCs and funding agencies like to cluster in certain kinds of activity fields and prefer to apply similar instruments, also in systems with many actors and low coordination levels (see OECD 2012; Hallonsten and Hugander, 2014). Strategic and mission-oriented programmes are designed to intervene through longer term funding, linking different actor sets and sometimes active portfolio management. The rationale begins with a problem that won't go away even if every single actor gets support for their individual next steps. Therefore, such programmes start with the real-world problems and not on the supply side. Again, there is a variety of examples like the Austrian Christian Doppler Society with its industry co-sponsored labs at universities, Swedish Vinnova with its Challenge Driven Innovation programmes or NESTA in the UK with a broad variety of problem-centred interventions like innovation challenges.

Example: The programmes of the Swedish Foundation for Strategic Research (SSF). The SSF is one of the semi-private foundations stemming from the abolition of the wage-earner funds in the early 1990s and their conversion into various research supporting foundations. SSF runs programmes in natural sciences, engineering and medicine to link science to industrial needs by supporting university-based research that shall tackle serious challenges relevant for key industries. As the public research funders had to focus on other kinds of programmes in the 1990s and 2000s (Aström et al., 2014), SSF had a vital role to provide hinges between academia and industry. Although it was and is a modest funder with an annual budget of a few hundred million SEK, its programmes had a number of *impacts:*

- Researchers can successfully pursue their academic careers and publish on a high level. New and fundamental research questions arise from problems in the "real world".
- Transfer of ideas to industry happens in various forms, from solutions to graduates, from spin offs and patents to common platforms for pre-competitive research issues.

The evaluation of SSF (Aström et al., 2014) shows that for the funding period under review the problems and ideas mostly originated from the industry labs. Research, while being done at the universities, was co-designed in collaboration with companies and led to tangible results like prototypes or processes, as well as spin off companies. In this context interdisciplinary work was performed on a very high-quality level, leading to top publications. A lot of know-how was transferred through graduates and PhDs going into industry. Due to the timing of the evaluation and the long-term nature of the pre-competitive SSF-funded research, real financial benefits of companies (like substantial revenues from new research-induced products) could be found only in a few cases.

> Pros / Main advantage of focussed strategic programmes: Easy to implement form e.g. of science-industry collaborations, leading to fruitful outcomes for both academia and industry.
>
> Cons / Main disadvantage of focussed strategic programmes (but not a strong one): The "real" results in business take a long time to be generated and yield profit and the appropriation of impacts is difficult. Too much happens afterwards within the company and with third parties.

Complex multi-actor programmes

A number of funding programmes and interventions were triggered by the rise of the innovation system paradigm, new societal and technological complexities and governance modes with less strict command structures. To a certain degree, complex funding programmes were the answer of choice for all kinds of needs, from cluster funding in the 1980s to open innovation in the 2010s. Actors can exchange ideas and collaborate, with various barriers lowered by public funding. Universities always play a strong role as knowledge providers, as a strand in a multiple helix, or as anchor organisations in both stronger and weaker regions. The bandwidth of such programmes is high: collaborative centres, network initiatives, mixed consortia are just a few of the chosen forms. Examples range from the Finnish SHOK experiment to Vinnova's regional Vinnväxt programme, from German Competence Networks to RCN's large-scale funding programmes for vital industrial sectors in Norway, like Oil and Gas or the Marine Economy. Many of these programmes do start with high expectations and very ambitious goals.

Universities get funding for providing a broad range of activities: Educating students for employment opportunities, producing useful results like prototypes, specifications, all forms of knowledge embodied in intellectual property, and developing reflexive knowledge about ethics or trade-offs, the creation of new companies and more. Public funding through programmes therefore widens the scope

and spectrum of academic activities. It comes with great expectations but as a rule, input-output relations are difficult to draw and both directions of the impact are hard to identify: How do such programmes change attitudes, activities and outcomes of universities and how do universities help change the outside world?

In an effort to understand the impact of its funding programmes, Vinnova has analysed a number of impact studies of collaborative funding programmes in the 2000s (Elg and Hakansson, 2012). As (larger) companies join such consortia primarily to look for (often a broad range of) competence and reduction of uncertainty and less for their core competences, universities are research environments where different pre-competitive approaches and new fields can be tested. This needs trust and understanding of the "other" world, therefore such networks can span over decades (Arnold et al., 2008b), take different shapes from informal collaborations to formalized multi-firm competence centres funded for a decade.

This anchoring shall also contribute to tie globalised, increasingly mobile companies to their home base. Universities can play important roles not only in problem-solving but in finding out and co-designing what alternative technological paths may be interesting to follow, or what might become a next industry standard. All such activities take considerable time and involve many actors. While it *might* be easier to see the effects on the universities and how they could become more entrepreneurial, the impacts of university action in such long-time, real world consortia need long-term impact studies. Also, in this context it is true what Elg and Hakansson (2012, p. 18) state: "*To then try and quantify what proportion of* (company, MS) *earnings is attributable to the various support activities will make little sense. The various interventions are not cumulative; they have played different roles in a historical process."*

Example: Consortia funding in the EU Framework Programmes (FPs). Since the early 1980s, research and technology funding has been part of the pan-European policy agenda, with an increasing number of goals and perceived European Added Values, including European industrial competitiveness and tackling societal issues too big for national action. These two – of many – *added values* then translate into two main pillars of recurring EU FPs. They mainly use consortia as the instrument of choice, often large multi-actor settings that can steer a whole agenda within the limits of the EU funding. Universities are a main beneficiary: around a third of current H2020 funding goes to the HE sector. The pillar Excellent Science currently accounts for approx. 9 billion € received funding in H2020 for universities, but the two other main pillars Industrial leadership and Societal Challenges together account for 5 billion € also[18], a considerable amount of money. Again, we find some *impacts:*

- Impacts produced by university researchers within EU-funded projects go across the whole board, from high level publications to new standards and pre-competitive work for industry.
- Impacts on universities through the two pillars Industrial leadership and Societal Challenges are less of a strategic nature and more an extra source of money including a widening of thematic options for academics (see below).

[18] Retrieved 10 Jan 2019: https://eu-pm.ffg.at/ui/wss/?_=eJxlkEFPwzAMhf8K8rkoXXfbGY6gXrhFqtzILJXSpnKcVmPqf8cZhYE45X1%2Bjp%2BTK6wpwekKy0ArcVEySCA4wYUSVDDSlHvkH5YYw29OgpJ1AkyxkCeSROFuO47hjh8xjl%2B921YBznOhnDS4grUvTqPqzLNK1uOo5Nkp%2BYPKSS5zWY3fGUdKJFpbujQzOl%2FqT5QlOX%2BrutxTfex0P5TON3VTa0MZwi2KV22NNc9vj%2B2LNW1kwWDNKy7DGWWI0249fDv%2Fp1lzsGaPtmZP%2FnsNbk%2FUqPLH2yeryXR%2B&user=Yje0vjO0qvy6&pass=OhbmAa7ncFjpWR%2BO%2FygD7g%3D%3D#jrw2q0db

The immediate FP ex post evaluations (Rietschel et al., 2009, for FP6; Fresco et al., 2015, for FP7) constitute strong efforts to grasp the impacts of the programmes funded and they definitely suffer from the short period between the end of most of the funded projects and the schedule of the evaluations. However, these evaluations can leave the reader slightly dissatisfied: Definitely there is a lot of high quality output and some spectacular success stories, but when put in relation to the amount of money spent, questions may arise how efficient and effective these pan-European consortia-based research projects are. Further there is evidence that FP networks are not strongly reflected in the publication networks. So EU FP funding does not lead to fundamental change: Many researchers continue with the same collaboration networks, at least measured by output, they had before the funding (Mattsson, 2011). The issue is: Are the visible impacts worth that much money?

If this is a relevant question, a different viewpoint can help: This means to look for long-term trajectories and success stories that cannot be found immediately but need an extended perspective to evolve: *Understanding long-term impacts of R&D funding* is the title of a meta-evaluation to see what has been achieved over a series of Framework Programmes (Arnold, 2012). In this overall analysis more long-term effects and impacts can be indeed identified, mostly around important issues like capacity-building, pre-competitive research results finding their way into industry and society or common standards for whole industries. As the intervention logic of the FPs has become very broad with around a dozen forms of "European Added Value" (Arnold, 2012, p. 336), so the impacts are manifold. All these impacts have been achieved with the active involvement of university researchers.

This long-term impact search was started in Sweden, with a study to explore the *impacts of the Framework Programmes in Sweden* (Arnold et al., 2008a). This evaluation explored how four important sectors of the Swedish industrial / innovation system were affected through their involvement in European programmes. For universities the analysis showed that they went into the FPs without strong institutional or thematic strategies, and what they got was additional money (and some more options for their researchers) but they did not profit when it comes to strategy or building critical mass.

> Pros / Main advantage of complex multi-actor programmes: Pre-competitive platforms can be created and maintained over longer periods, they exert influence on expectations, norms, standards and on joint outputs, lowering barriers in multi-actor arenas. Further the spectrum of university activities can be widened, contributing to industrial and societal challenges.
>
> Pros / Main disadvantage of complex multi-actor programmes: Deadweight, high cost of collaboration, probably nurturing the illusion that such collaborative consortia can achieve what normally only strong competition can achieve. Over-complexity is an imminent danger, as well as bureaucracy and fuzzy impacts.

Centres of Excellence (CoEs)

Most countries through their RFCs run such programmes to create critical mass in fields where many top-class researchers already exist. The notion of excellence is an important driver in science and research for many countries. The more *abstract* idea behind it is the competition among countries that has inspired and sometimes haunted policy makers everywhere. However, in the sections (→ chapter 6) about PRFS-style allocation mechanisms but also in the literature about Peer Review we could see that not all instruments are equally suited to identify and fund future excellence. The excellence concept itself can be also problematic as there is not too much meaning in the word that can be subject to clear criteria. Therefore, many funders have embarked on *transformational*, *ground-breaking* or

frontier research (Kolarz et al., 2016; Warta and Dudenbostel, 2016; Luukkonen, 2019; Luukkonen, Stampfer and Strassnig, 2015; Nedeva et al., 2012), as this can be operationalised in a better way. The more *concrete* idea behind CoEs is to strengthen strengths and give clusters of researchers with a common vision and strong track records a long-term perspective, often ten years or more, to run interwoven strands of research lines. Note there is a parallel co-evolution of CoEs and team size in science: Number of authors and team members have been constantly growing. Variety matters as "… *[r]esearch suggests that small teams tend to disrupt science and technology with new ideas and opportunities, whereas large teams develop existing ones …*", the latter having more impact (Fortunato et al., 2018; Wu, Wang and Evans, 2019).

These competitive programmes (OECD, 2014a) are equipped with international panel-based evaluation systems and serious funding, e.g. an average Norwegian CoE gets the equivalent of 1.6 million € RCN funding annually. For Norway the CoE evaluation (Langfeldt et al., 2010) reports positive impacts regarding talent attraction, interdisciplinary research and internationalisation, as well as considerable research outputs. The host organisations have to contribute at least in-kind contributions, which comes in larger (e.g. Sweden) or smaller (e.g. Austria) amounts. CoEs have a certain autonomy but are normally no distinct legal entities. Nearly nowhere the question of the afterlife has been solved. The RFC says: "*We funded you for ten years now you have to take care and continue*." The university answers: "*We are too poor and there are so many other excellent researchers waiting in line*."). Langfeldt et al. (2015) also show in a comparative study of Scandinavian CoE programmes that no excessive Matthew effect can be observed with CoEs: Neither do research environments *collect* them nor do they magnetically attract scores of other funding: In this regard "…*they experience only marginal effects in the wider 'funding market'."*

Example: The CoE programme of the Danish National Research Foundation (DNRF): The Danish research policy was an early mover in setting up explicit approaches and instruments to create critical mass *and* excellence through dedicated and trust-based funding. The DNRF was established in 1991. Their flagship activity over 25 years has been to fund outstanding researchers on large scale through CoEs. These have the typical CoE properties regarding size (some PIs and a larger number of younger researchers) and duration (two stages, ten years in all) were granted in large numbers since 1993: 88 centres have received around 5.4 billion DNK until 2013 (Krull et al., 2013, see also Langfeldt et al., 2015), and further centres and funding have been added since. The programme was evaluated in 2013 by a panel. It found evidence for a strong scientific output of the centres, backed by earlier DNRF evaluations and a bibliometric study by the Danish research ministry. The citation impacts and other publication records show a very strong performance. The *impacts* (Krull et al., 2013, also with an international benchmarking) are manifold:

- An analysis of 66 DNRF-funded CoEs reveals that 20% of their publications are among the top-10% impact papers globally. This by far surpasses the very good national impacts of Danish research. Further, DNRF-publications (or publications related to the programme) constitute 7% of all Danish publications, which is a lot for a niche funders' programme; but they accumulate 10% of all Danish citations.
- The CoEs attract further funding from different sources and they are prolific in producing young top researchers.

CoEs according to this evaluation are well-embedded in their host institutions and managed lightly and on trust-base by DNRF.

Pros / Main advantages of CoEs: Pooling of resources; long-term funding for important topics, platform for disciplinary and cross-disciplinary interaction, in some programmes very high scientific outputs and impacts.

Cons / Main disadvantages of CoEs: Some programmes cannot show that "their" CoE research funded produces higher impact than research funded through normal grants. Afterlife is often difficult and "*... the expectation that CoE grants would remodel the research landscape has not been fulfilled*" (Langfeldt et al., 2015).

7.4 Conclusions

As in the Faculty Appropriation chapter, the pros and cons of the individual forms of TPF have been described in the individual sections above. They again vary strongly, as the incentive structures of large network grants, personal excellence grants and CoE funding also do.

Going again one level higher, we can also ask whether there is a common feature of TPF. This feature can be termed as *flexibility* as TPF comes from outside and through different doors. It is made to induce *partial change through limited interventions*, but quicker and more visible. With its flexibility and adaptability TPF funding treats different things differently. TPF has a change agenda, at least "raise quality levels", at most "save a whole continent". This change agenda comes – or should come – with clear intervention logic and goals, to measure outcomes and impacts. Much depends on the clarity and simplicity of the impact logic, as multi-goal funding programmes tend to come with fuzzy assumptions and outcomes. Similarly, a country with 100 funding programmes does send many signals which all might be too weak. Some also might interfere with others and produce great workload.

With programmes they are (or should be) measured more easily than with any kind of block funding.

- When it comes to funding *excellence*, many schemes deliver meaningful impacts but many others struggle to show better performance: In a number of cases, researchers funded do not achieve better impacts than a kind of control group (like those who nearly got funded). As shown in this chapter and with some of the examples, there are procedural and structural reasons serving for explanation. There are promising efforts to add other approaches, e.g. for transformative or for cross-disciplinary research. Some larger programmes like the ERC are transformative also through their set-up, reputation and organisational impact.
- When we talk about *relevance* we see that without collaborative programmes of all kinds, university researchers would probably not engage themselves that much in all kinds of activities. Challenge driven innovation therefore challenges also university researchers and open innovation programmes can make universities more open. Funding programmes helps make universities to be broader, richer and brings them new fundamental research questions through real-world problems. Cooperation in general can be stimulated through programmes quite well. The dangers and downsides of such programmes are always with fuzzy programme- and impact-logics, over-ambition and over-steering through complex funding interventions.

Risk is being reduced for both sides and trust built through structured and repeated collaboration. As a policy maker (if you have options) it is one point whether the funding comes through a programme or through Faculty Appropriations. A second point is how to design the programme intervention. The third point however is perhaps the most important one and definitely undervalued in research and innovation policy: Do we need a programme at all? Do we come forward with a programme as we shy

away from structural changes? Often a new career model or a new environmental regulation can be much more effective and impactful than another multi-actor, multi-goal funding programme.

This leads us to the potentially greatest downside / con of TFP: Another next programme (Nr. 101) is designed and implemented easily. It makes everybody happy, there is action … and the structural problems remain …

8 Tracing interactions in studies and funding initiatives

8.1 Introduction

This chapter takes a look on different instruments and approaches combining and comparing the various forms of allocations. At least three pools exist: First there is academic literature comparing instruments across portfolios and countries, both quantitative studies and qualitative research. Some of these studies are being presented in some detail. Second, a few selected policy tools combining elements of both allocation forms will be described. Finally, we look at a few phenomena where the *continental shelfs* of Direct Appropriations and TPF touch each other. In many ways this can be uncharted land.

8.2 Studies looking on the interaction between TPF and Direct Appropriations

There is no safe ground when analysing whole systems of university research funding in a country and cross-country comparisons lead into even more slippery fields. This holds true for all kinds of approaches. There are *at least* five kinds of reasons for that:

- First most universities and funding interventions differ from each other within a given country: different trajectories, different missions, different inner mechanisms, different budgets etc., and the NPM-style university reforms have only to a certain degree changed this. Comparisons between countries are even more ambitious as even countries of similar size and economic performance have all their own history and their own university laws, governance structures and funding systems: *"... national policy frameworks are still fragmented and the empirical evidence supporting competitive allocation mechanisms as a tool to enhance an efficient allocation is mixed."* (Jonkers and Zacharewicz, 2016, p. 8). In a literature review on how instruments, levels of competition and research impacts interact, the OECD (2018b, p. 21) concludes that "… *while increased competition in research funding allocations is associated with higher performance, the underlying situation is complex and is subject to other incentives and contextual factors … leaving unanswered the question of what the most effective ways to improve research performance are."* Organisations, including universities, have to strike a balance between Direct Appropriations and TPF, but again, there is no evidence for an optimal balance.
- Second, different viewpoints mean different interests. The development of steering and funding mechanisms within and across countries and universities mirrors also the constant conflicts and negotiations between actors of all kinds. We are talking about resources and their allocation. Therefore all sides are armed. We can refer to decade-long discussions like the RAE / REF debate but can bring also more everyday examples of no-one being really free to act: "*Insofar as universities wish to establish distinctive research goals as strategic priorities, then, they are constrained by both research funding agencies' choices and elite preferences in different disciplines"* (Whitley and Gläser, 2014, p. 37).

- Third, we can understand university systems probably best by also taking the bottom-up perspective of the researchers and what drives them. However, a number of factors like bounded rationality, expert status, difficulty to assess future developments and success, individual and group trajectories, different interests and ensuing conflicts make it difficult to come forward with unambiguous analysis.
- Fourth, even when there are no explicit conflicts, we find massive trade-offs and turn again to the UK example: Martin (2011) argues that PRFS like RAE / REF come with high hidden cost and misleading signals. More sophistication, more differentiation to grasp the reality of different organisations, disciplines and settings are invariably laden with higher complexity, more indicators and less steering power. The assessments get fatter and more expensive. On the TPF side, the EU Framework Programmes tell a similar story, and the same holds true for smaller countries with 50 or more different funding programmes.
- Fifth, there are just too many too fuzzy impact pathways around. Correlation instead of causality is not the main problem but the following may cause worries: The more sophisticated our interventions are the more we get lost in all kinds of complexity and just cannot manage what we want to manage. Newer generations of helix-style, societal-challenge and multi-actor programmes are very vulnerable to the question: "What are you doing here?" A more complex world does invite for more complex interventions, but this might be a completely wrong avenue to go. For example, see the quite indigestible approaches and proposals in Arnold et al. (2018), for tackling societal challenges through funding programmes that just cannot be explained anymore: Before venturing into super-complex funding programmes, it might be better not to do it and consider other policy options, from nudges to taxes to new laws.

This all could go in the direction of "we don't know". To know at least something, a number of researchers has studied interactions between system elements, inputs, outputs and namely the two funding streams. These studies are presented in the following; they have been selected because they try to understand systems and interactions within and across countries:

Aghion et al. (2010): The rich, the free and the competitive

In their both *qualitative* and *quantitative* study, Aghion et al. (2010) show evidence from U.S. public universities and European countries that high budgets *plus* competitive institutional and TPF systems *plus* higher degree of organisational autonomy lead to systems with higher research outputs. The outputs are being measured in form of patenting and, as a composite indicator, international university rankings. These are put in relation to indicators for governance, autonomy and competition for funding. The level of autonomy and other information was gathered in a survey and together with ranking and funding data put in a model that allows for showing correlations between the outputs and the budget composition: Higher TPF shares go along with higher outputs and higher Direct Appropriations with lower outputs. Similarly, higher levels of autonomy lead to higher outputs. The method was criticized by authors like Sandström and van den Besselaar (2018) who inter alia argue that rankings are a most problematic indicator for comparisons like this.

> Lesson for pros and cons: Competition including rich TFP sources plus autonomous universities are a promising combination

Dialogic and Empirica: No Archimedean Point, all is in the context

The *quantitative* 'policy brief' study by Dialogic and Empirica (2014) shows that on the basis of current and verifiable indicators there is no strong evidence for competitive funding having a direct positive effect on research performance. Their review of the existing literature also shows no clear evidence for such links. Competitive funding is just one variable and other mechanisms are more important with regard to research performance: "*Other contextual factors like path dependency, the political system or the quality of the educational system might be as important or even more important in predicting the research performance of a country*" (Dialogic and Empirica, 2014, p. 3). Namely the strategic behaviour and adaptation moves of the various actors within and around organisations matter strongly. The example of countries like Switzerland and the Netherlands show that a reliance on largely non-competitive Direct Appropriations (and considerable TPF) can come together with top ranks regarding scientific outputs and inputs.

> Lesson for pros and cons: It's all in the context. So other factors might matter more than the whole funding question as such.

Auranen and Nieminen (2010): Some countries probably on less competitive levels, but how does it matter?

An experimental *quantitative* work by Auranen and Nieminen (2010) take a step towards categorizing countries by analysing the degree of competitiveness of overall HE funding systems in the 1980s and 1990s. The authors combined the share of external funding for university research with the orientation of Direct Appropriations (input orientation means mainly block grants, output orientation mainly PRFS), leading to a simple matrix: (i) Output oriented Direct Appropriations, much TPF: UK; (ii) Input oriented Direct Appropriations, much TPF: Sweden, Finland; (iii) Output oriented Direct Appropriations, less TPF: Australia; (iv) Input oriented Direct Appropriations, less TPF: Norway, the Netherlands, Germany, Denmark. These four models with eight countries in it were described analytically and then tested how good they are in producing publications with citation impact. While the latter was easy to retrieve, comparable funding data were difficult to collect. In their model they found no clear *causal* link between publication performance and efficiency on the one hand and the degree of competitiveness on the other. In the eight-country comparison, Norway, Finland and the Netherlands represent a middle group. The most competitive ones are UK and Australia, while Sweden, Denmark and Germany are characterised as less competitive. The study offers some evidence that less competitive systems can also be very efficient, measured on a HERD per publication scale. This study did not pretend to carry the ultimate truth and a few weak points indeed exist. They include (i) omitting many governance properties that existed before and / or in parallel; (ii) the use of HERD as an artefact without looking at the composition of the research landscape, e.g. the existence of large, expensive fields; (iii) the share of the "formula" or "performance" part in Direct Appropriations is not taken into account. Nevertheless, the authors tried to contextualise and presented interesting correlations.

Another study by Cimini et al. (2016) comes forward with a three-dimensional space and 35 (!) countries, combining HERD/GDP as input, citation success as output and international co-publications as third variable. The usual small countries with high performance come top and due to their size, they are also very international.

> Lesson for pros and cons: No clear-cut lesson, but no system automatically better than others

Sandström and van den Besselaar (2018): Thy beliefs shall be shattered or: the non-competitive rulez!

Another, more recent *quantitative* study by Sandström and van den Besselaar (2018) has also tried to find meaningful relations between *funding, evaluation and the performance of* 18 (!) *national research systems.* To overcome the considerable data problems, the authors focus on relative change over time as an indicator and benchmark for the efficiency of public research systems and the "stable" 2000s as time period. Output increase is defined through growth in highly cited papers, and input through funding: Which country is on which output trajectory with the funding allocated? This is a simple measure for efficiency. The large differences are explained with a number of structural factors like level of autonomy in different forms or level of competition or the form of Direct Appropriations. The conclusions differ from other studies, like Aghion et al. (2010, above) and Öquist and Benner (2012, below), who are also criticized by the authors (see also Sandström and Heyman, 2015).

The remarkable results are: (i) Two thirds of output change is explained by input change. (ii) A well-developed output-based national Research Evaluation System correlates with the growth in citations, while other steering instruments do not. (iii) Generous block grants and low autonomy / weaker managements also do positively correlate with the growth in outputs and "… *it suggests that institutional funding is essential for a research system*" (p. 374). The logic model goes like this: First, the existence of a national Research Evaluation System has positive impacts on the performance (found true). Second, more competitive TPF through higher stratification and increased academic freedom leads to positive impacts on the performance (found not true and leads to peer review bashing by the authors). Third, more autonomy directly and through more academic freedom is again positive (again found not true and leads to a plea for variety as well as to criticism of academic-managerial elites as ubiquitous gatekeepers). The authors seem to know that their results rock the boat and claim therefore that better indicators and data are also needed. Potential downsides of this study include competitive mechanisms like REF-style PRFS treated as black box and as a maybe less useful indicator for top 10% impact paper growth (Sandström and van den Besselaar themselves claim that peer review can sort out weaker competitors but cannot distinguish the excellent from the good, p. 379). Further it is not fully explained what a national research evaluation system is (but see Gläser et al., 2010; Koier at al. for this) and how it interacts with Direct Appropriations.

> Lesson for pros and cons: Do not underestimate levels of input and do not overestimate competition

Abramo et al. (2012): How to create a more competitive university system in Italy?

Quantitative work by Abramo et al. (2012) presents an Italian case study in the context of the national PRFS system VTR. With a strong database they look at performance differences between and within universities, as they see (i) greater stratification of universities and (ii) more homogeneous quality within them as a proper move in a non-competitive system. Alas, top researchers were found to be evenly distributed across the country, while within universities the quality differences are in most places very high. They see a need for more competitive funding systems.

> Lesson for pros and cons: No clear lessons (hypotheses criticised by other authors)

Ingwersen and Larsen (2014): Small effects of indicator systems and a jungle of context

In their *quantitative* study with *qualitative* elements, Ingwersen and Larsen (2014) studied the effects of publication indicators in Danish university financing. The results, in their tendency neutral to positive, are described in → chapter 6. This study was conducted without looking at major changes in

competitive funding including the start of the large DNRF Centre of Excellence programme in the same year as the indicator funding was introduced → chapter 7. In the same vein, the parallel Norwegian PRFS study missed to integrate a number of other factors that might explain a great part of the increase in publications, like input growth, time effects or structural changes in the system (Gläser and Laudel, 2014).

Lesson for pros and cons: Again, context matters and other factors perhaps stronger

Öquist and Benner (2012): Leadership required for Swedish universities

Another Scandinavian study was done with *qualitative* methods by Öquist and Benner (2012) for Sweden, supported by *bibliometric* work from the Swedish Research Council (Karlsson and Persson, 2012). This work raised some discussions as it broached the issue of the relatively low scientific performance of the venerable Swedish university system, compared to other small successful European countries like Denmark or Switzerland. The bibliometric work showed the considerable distance in top layers like 10% and 1% top citations and other indicators; Öquist and Benner then made a qualitative country comparison mainly based on interviews and document reviews as a foundation for their alarm cry: "*A nation that fails to make its contribution to ground-breaking research will also become marginalised in terms of coming up with new ways of bringing about a sustainable society in the long term*" (Öquist and Benner, 2012, p. 10). They see three weaknesses in Sweden: (i) priority setting at national level, (ii) direction and funding of research, and (iii) governance of universities and notably university leadership. Shortly afterwards they performed a similar exercise in Norway (Öquist and Benner, 2014). Some authors like Sandström and Heyman (2015) were critical of some methods used and suspected ex ante beliefs of the qualitative study.

Lesson for pros and cons: It takes universities with strong leadership, strategies and good career systems to make breakthrough science happen

Gläser and Laudel (2016): Arguments for well-designed TPF systems (and much more)

In a *review* of mainly *qualitative* but also *quantitative* literature, Laudel and Gläser (2016) look at governance and funding modes shaping research content and research fields: While the evidence for targeted funding programmes to create (and sometimes at the same time regulate) emerging fields is mixed, crowding out effects for less prioritized fields in highly competitive funding systems becomes visible. Their extensive review nevertheless shows that a well-endowed TPF system, with bottom-up but also top-down funding elements, can help develop a broad and quality-oriented portfolio of vibrant research fields.

- For seeding and developing ideas, Direct Appropriations have to be in place without too many strings attached, if thematic signals shall lead to virtuous circles and "*help their specialty grow above the national average*." Using Dutch and Canadian examples, they try to show that overly tight faculty budgets might in fact prevent what thematic TPF aspires to help grow: A *real* specialisation (i.e. other approaches are not prevented) instead of scarcity, masking of research and using thematic funding just as another source for somehow continuing existing research lines (Gläser and Laudel, 2016, p. 127; based on Laudel and Weyer, 2014; and Leydesdorff and Gauthier, 1996). Countries with a very competitive system and strong thematic priorities at the end do alter their landscape of scientific fields. Whether the intended effect of clearer profiles for organisations and higher competitiveness for the country will materialise, is a question still open. Losses are of course visible, with non-prioritized research fields shrinking and some specialties vanishing (Laudel and Weyer, 2014; for other examples see Whitley, Gläser and Laudel, 2018).

- Further, they ask which kinds of allocations attract the attention of researchers more strongly when it comes to specialisation and thematic priorities: It is TPF as it sends more clear and direct signals to the researchers than Direct Appropriations do. Such TPF can come also from a sector policy request, e.g. a health or education ministry seeing a need for policy evidence that a reluctant scientific community still doesn't see or doesn't want to see (e.g. Whitley, Gläser and Laudel, 2018, on the case of empirical PISA-style education research in Germany). TPF can send clear signals: *You get money for these specific goals and tasks.* In a quite different way, Direct Appropriations are trickling down (at least part of them), mediated and transformed through various levels of other mechanisms and interests.
- If Direct Appropriations come in with strong thematic preferences as in the Dutch case, there is of course a clear signal; the researchers either get money or not, which might change their options to a more profound "can do research / cannot do it at all" level. On the other hand, it should never be forgotten that freedom and self-motivation is one of the greatest strengths of science and often a gift to the world that should not be marginalised by policy steering.

Lesson for pros and cons: Top down TPF comes with unintended impacts. Strong TPF important for vibrant research landscape.

Luukkonen and Thomas (2016): Full House – The researcher at the poker table

In a similar vein, a *qualitative survey* study explored the room for manoeuvre of researchers within their organisations and financial sources to pursue their research agenda. The *negotiated space* (Luukkonen and Thomas, 2016) depends on different variables and funding is one of them, as investigations by Heinze et al. (2009) or Laudel (2006) have shown: A world with too meagre block grants is no good place to be, neither for the researchers nor for external funders who want to contribute to the production of top-class research. The *negotiated space* leads us first to what researchers want, what drives them to spend long hours in windowless labs (e.g. Lam, 2011) and to fight countless small turf wars for the advancement of their causes and careers. The *mediating funding and university-environment influences* in this negotiated space range from (i) inner motivation, (ii) to performance, success and number and size of the reputation *tokens* collected and (iii) to the properties and opportunities coming with the specific research field, this time also including number and size of funding *tokens,* finally (iv) to the properties and reputation provided by the university as home institution: Here different universities in different settings provide for more or less reputational and financial *tokens*. Overall, perhaps *chips* would be an even better term[19], and there are strong capital accumulation metaphors around in sociology studies on academics and their fields (see Fochler, 2016 and Fortunato, 2018, with salient examples).

- Which factors influence researches more? In their survey, the authors show that intra-scientific factors and societal goals matter more than funding opportunities, but the latter again are more important than signals from university governance. TPF does not appear to completely track-change research agendas, both due to the motivation and thematic persistence of the researchers and to the mechanisms of TPF itself, putting emphasis on track

[19] It is probably against the intentions of the authors to stress the Gambling Casino as an analogy here. The point that might be worth doing it, is putting oneself into the position of the individual researcher, with her constant need to collect as many chips (money, reputation, gatekeeper functions, staff etc.) to be able to sit as long as possible at the table, to put the chips on the table to win more of them and try to play a grand game from time to time. For the analogy let's think more of a serious poker game than of roulette; and of Max Webers' famous gambling analogy for young researchers' career perspective ("… *ein wildes Hazard* …"; Weber, 1917).

record and sound project design. All these elements vary across thematic fields (Luukkonen and Thomas, 2016, pp. 113 f.).

- University governance factors, here the use of Direct Appropriations, do sometimes include internal financial incentive programmes for certain areas but the main mechanism for reallocation is the negotiating power of strong academics within their university: To come back to the *tokens*: For the strong, the successful and the well-connected (which is not always the same), organisations like universities often provide whole *stacks* to individual players. In this context it is important for the university to have a strategy and some priorities, otherwise the internal allocation game is anarchic and random. Further, previous decisions like investing into infrastructures can also determine future allocations and thematic orientations (see also Whitley, Gläser and Laudel, 2016, e.g. on different country trajectories in the field of Bose-Einstein-Condition research).
- In such a survey, the question of state intervention has to remain open, i.e. how strongly performance-based approaches like PRFS or PA can incentivise such strategy formulation and priority setting (→ chapter 6). The authors however come forward with evidence that priority setting (in Finland; Luukkonen and Thomas, 2016, p. 116) follows by and large past TPF success: Therefore, externally induced priorities are often more important than internally set priorities. The decisive difference is the level, where the signals are sent, received and where they do create reality through incorporation: With TPF it is seldom the top organisational layer but the stronger researchers on the ground floor. They go out, acquire various TPF grants, hire staff and grow their field that then has better chances to become a priority within their own university. As Direct Appropriations in part serve to co-fund these TPF projects and TPF-triggered activities, this is a significant phenomenon in many countries[20].

Lesson for pros and cons: Strong role of TPF, but motivation and negotiation for resources probably the stronger shaping factor; on the contrary governance mechanisms have less strong impacts.

Koier et al. (2016): Juggling is the art to run faculties with various funding streams

This is a mainly *qualitative* work and one of the few studies that try to find out what really happens within universities in the constant effort to acquire, combine and process various funding sources along a strategy. Koier et al. (2016) study Dutch universities which are interesting due to the following factors: (i) Strong scientific performance and competition-driven environments, for downsides see also Scholten et al., 2018. (ii) Explicit policy framework with a top-down thematic policy, namely the TOP-sectors. (iii) NWO as national RFC has to comply with this approach *and* TPF play an important role in research funding. (iv) Existence of a strong evaluation culture plus PAs but no PRFS system in place. (v) Deans have a key role in planning and executing research strategies: They are the jugglers of the many *spinning plates.* The authors have made a document analysis, conducted interviews and used a comprehensive survey as a main information source. One finding is that the competitive part of

[20] … including Sweden (OECD, 2012; OECD, 2016a). In Sweden like in many other countries, the thematic and prioritisation agenda appears to be driven much more bottom-up than top down. The state and its agents have more influence through TPF than through Faculty Appropriations. If there are fifteen TPF sources, each with their agenda, the various signals might neutralise each other; and at the end of the day strong academics end up as the most important influencers of a system that as a consequence has a broad variety of priorities within each university.

university research funding is usually underestimated as TPF binds part of the Direct Appropriations (→ see below section on overheads / full cost / matching). The main mechanisms are the following:

- The Direct Appropriation for research is being calculated according to a few parameters: The factor that can change most strongly is the number of students, as student numbers and degrees make up for 40% of the research allocation, while the "research provision part" in the Direct Appropriations is mostly fixed historically: This is interesting as the number of students (incl. PhDs) co-determine the research budgets: You have to be attractive for students to get research funded.
- As the Direct Appropriations are block grants the universities are free to act. University boards can and to a certain degree do establish parameters for their use. As a rule, the faculties as *pivots* have the strongest decision power over these research allocations. The full-time deans organise the planning: Which priorities shall apply? How to bring this together with sufficient student numbers? How to link it to recruitment and career advancement? How to fund the research work through a mix of TPF and Direct Appropriations? The authors in their survey find a large variety of approaches, but most of them contain an active approach to strategy, management and steering.
- The impact of top-down and other policies can therefore be studied in some detail. More top-down does not necessarily make the life of the planning deans easier as it can conflict with their own strategies and lead to uncertainties. Note also that universities' overall orientation and strategy and EU Framework Programmes play a stronger role than the encompassing national TOP programmes.
- When do deans amend the faculty strategy? There are three triggers: (i) improving the strategic profile to attract outstanding researchers and/or develop new fields; (ii) to assist efforts to obtain competitive funding, e.g. with H2020; (iii) to adapt to changes when more or less students enrol. The authors conclude that "*…strategic positioning clearly takes place, but that it is fuelled mainly by local interaction between different trends and opportunities. … the first funding stream appears to play mainly a facilitating role in the above … (it) allows the dean to key into the dynamic forces of research and teaching and into external funding opportunities. … national priorities … are virtually never a decisive factor."* (Koier et al., 2016, p. 95).

Lesson for pros and cons: Strong strategies emerge on middle layers; Direct Appropriations are important but can shrink / vanish through two phenomena: matching (e.g. when rich TPF is not managed with active strategy) and trickling down (e.g. factors like cross-subsidising or slack; strong when no clear full cost accounting in place). A large variety of university responses to steering through Direct Appropriations and TPF can be found.

Fridholm and Melin (2012): We, the universities, would like to do more but life is terribly complicated

In a similar approach but based on interviews, Fridholm and Melin have analysed how Swedish universities internally manage research funding streams. This study is in Swedish language and covers the ten most research-intensive universities. They see a growing capacity of university leaders to steer and strategize but there is still a lack of understanding how the different funding mechanisms really interact. Direct Appropriations are mostly historically driven, the older a university, the better off it is. The authors find examples for the implementation of strategic projects, infrastructures and some thematic new initiatives, often with large TPF shares. Direct Appropriations incl. indicator-based funding are first allocated to the universities and then down to faculties who implement more and

more strategies themselves and allocate money e.g. to thematic and career-oriented initiatives. Internal evaluations and assessments have been increasingly used, some processes still lack transparency. There is a wide variety between universities regarding strategic capabilities (see also OECD, 2016). Those who had a strategy, fared better with the Strategic Research Areas (SRA) initiative, namely specialised universities (→ see next section).

Lesson for pros and cons: Specialised universities might develop strategies more easily. Large variety of university responses to steering through Direct Appropriations and TPF.

Bolli and Somogyi: Which university outputs are increased through which kind of funding

In the context of Swiss university departments and public research institutions, Bolli and Somogyi (2011) find that while TPF has no measurable impact on teaching productivity, "*the share of both private and public third-party funding improves publication productivity*" (p. 146). In addition, technology transfer productivity is increased by private funding but independent of public third-party funding.

Lesson for pros and cons: positive effects of both funding streams.

8.3 Hybrid instruments combining properties of both funding streams

Some allocation instruments are beyond categorization as they unite elements of Direct Appropriation and programme character. They differ strongly in shape, size and process. Basically, they all want to combine the advantages of competitive TPF funding with some longer-term stability. Three examples show the breadth of these hybrid instruments across Europe:

- The **Swedish** government in its 2008 Research Bill started the **Strategic Research Areas** (SRAs also called SFOs), continued by the 2012 Bill. Universities could apply for longer term, larger scale thematic priorities. SRAs are a hybrid instrument, coupling elements of a TPF programme (priority setting / structured applications / competitive selection / subject to evaluation) and of a dedicated, extra Direct Appropriation funding: Once universities got the funding the organisations resp. the researchers in charge were quite free how to use them. Note also that this funding came in parallel with increases in the normal Direct Appropriations for research and teaching. In a first round 43 SRAs were funded in 20 thematic areas were granted. Four RFCs / agencies organised the selection process. Each SRA got a five-year funding with around 100 million SEK. Overall this meant a considerable 8% increase in Swedish university research budgets (OECD, 2016a). The 2015 evaluation by the Swedish Research Council brought a mixed result: SRAs had been specifically effective in new and emerging fields, and in cases where the strategic thinking was already strong, like in the leading technical and medical universities. This however can be read both sides. Further, the large number of SRAs and the low degree of incentives to improve governance structures raised some questions how this instrument can help Sweden to play a strong role in the global scientific competition. SRA apparently were counted on the TPF side, increasing the already large share of this stream in Sweden and leading to discussions about the form of allocations as well as to the question how quickly TPF should be spent be universities.
- The **German Excellence Initiative** is a long-term, massive and recurrent funding instrument for the German universities regarding research, teaching and collaboration, run by DFG. It has basically two rationales: One is the German research system with its strong non-

university actors like the Max Planck Society, the shared responsibilities between the Federal and the *Länder* level and the even spread of many good – but neither top-ranked nor financially not too well endowed – universities across the country. The second rationale stems from this fact and contains the wish to help develop a few German universities to become world class research performers through top research and differentiation. Competitive excellence funding comes in large chunks, for research excellence clusters, PhD schools and career positions etc., also for empowering whole universities. The subsequent periods of this big package (around 400-500 million € annually, around 3-4% of the overall German HE research budgets, Hornbostel and Möller, 2015; Expertenkommission Exzellenzinitiative, 2016) have produced different winners, although around a dozen universities seem to really have profited on a larger scale from the *Initiative*. Overall the publication impacts of German university research have grown and the Exzellenzinitiative has increased a long term positive trend, stabilizing German research. The international context. It has however not created a trend or electrified the university sector as a whole (Hornbostel and Möller, 2015). The Exzellenzinitiative is on-going and the *Expertenkommission* has raised some issues about long-term effects, i.e. whether universities are able to structurally and financially incorporate the extra funding into their governance, organisational set up and afterwards into their core budgets. This challenge is huge when seeing how conservative continental universities can act and often have to act.

- The **Slovenian Research Agency** as national TPF is entrusted with the **funding of research programmes** (or research groups) since 1999[21]. This programme comes in addition to the usual TPF project and programme funding. It contains practically the whole amount of Direct Appropriations for public research in Slovenia and is handed out over six-year periods, after which an evaluation based on publication indicators takes place. More than 90% of these appropriations are approved. The applicants are the research leaders and their fields; these groups have the normal lab size, i.e. each senior researcher applies for her own "Direct Appropriation". Introduced for maintaining quality in the allocation of core funding, this model has advantages but might prevent any research strategies on the level of the universities and research organisations and provokes some governance questions (OECD, 2011). It might further hamper the growth of new fields and interdisciplinary collaboration.

It is difficult to extract learnings here as the instruments are extremely context-specific. Hybrid programmes can combine elements of both funding streams, but the main advantage of electrifying whole organisations is more difficult than perceived (but leads to some strategic developments, Germany). It can lead to short-circuits shutting off the strategy power of whole organisations (Slovenia). The correlation between SRA success (at least success in winning SRAs in the Swedish funding competition) and explicit strategies in place is one encouraging factor.

8.4 Interaction through overhead payment and other TPF incentives

True cost of research

[21] http://www.arrs.si/en/progproj/rprog/

TPF in Europe do not come with full cost coverage for the host organisation. 20-25% overhead costs are the best most European universities can hope for when TPF is coming in. The real cost for conducting research is much higher. In contrary to U.S. research universities profiting from full-cost federal TPF, European universities therefore have to co-fund such projects, mainly through shouldering (in-kind) facility and administration cost, often also putting real money on the table. The earmarking of Direct Appropriations through TPF appears to be considerable (Koier et al., 2016; Jongbloed and Lepori, 2015). For the cost of science see Stephan (2012), with detailed analyses of all categories. The author also provides a description of the effects of the U.S. TPF full-cost model, leading to specific investment and recruiting patterns of research universities.

As shown in Box 4, a full cost calculation can reveal how little of the Direct Appropriations remain after "matching" incoming TPF (and most of TPF before and after matching is not free money but used for salaries of additional staff, for infrastructure or consumables).

For the pros and cons we learn that managing research portfolios and a strategic approach to TPF sources is important to start a virtuous circle not only for researchers and their groups, but also for large departments, faculties and whole universities. This goes far beyond signing or vetoing research proposals but needs proper a long-term planning culture and instruments.

Box 4: An effort to find out the "true" relations between TPF and Direct Appropriations

For the Dutch university system Koier et al. (2016, pp. 21 ff. and 90 ff.) propose a re-classification to show the "real" size of the various funding streams and to make their dynamics more transparent. The Dutch system foresees a block grant for all major university activities. For research and teaching approx. the same shares are foreseen (each around 1.7 billion € annually, numbers for 2014). The universities and university hospitals in 2014 received around 500 million € national public TPF (mainly NWO funding) and around 1.6 billion € all other TPF; plus there is other operating income.

Koier et al. (2016) propose another form to structure the funding sources, putting all public (incl. EU) TPF under one heading. Then Direct Appropriations for research grow due to other ministry funding (more than 2.4 billion €). Public TPF ("competitive public funding") according to this calculation is now much higher (more than 1.2 billion €), the ratio between the two being 1:0.44.

Then they carry out a "matching" exercise by using calculations of an Ernst and Young study that every TPF Euro has to be matched by the university with 0.74 € in a full cost model, including cost of libraries, research facilities, space etc. needed for research. This calculation is a mean for all universities; there are large differences across disciplines and universities. After this matching exercise the picture changes completely. All public and private TPF plus the matching parts of the Direct Appropriations for research are now three times higher than the unmatched rest of the research Direct Appropriations. (3.7 vs. 1.2 billion €). Even the matched "second stream" of NWO-style funding ("only" 0.9 billion €) is now nearly as large as the unmatched rest.

This has spurred discussion, with some calling it TPF leverage and others restriction of leeway. The authors (p. 57) connect this to the way how universities might use it. It depends on having a research strategy: "*If the various second- and third-stream funding sources are geared to supporting that research, then the first funding stream will provide leverage. But if acquiring second- and third-stream funding means undertaking research other than originally intended, then matching has a restrictive effect."*

Such a perspective puts strong pressure on those who are responsible for research planning, in the Dutch case mainly the deans. The Dutch case shows that active portfolio building is in fact possible. In a more general view one might say that the pressure becomes even higher if there is no proper planning. The reality, as in most European countries, is the following: All TPF comes in as the individual researchers set out to acquire them and then the matching happens automatically and much less Direct Appropriations are left for structured action. As it is nonsense to prohibit researchers from writing proposals (and in the Dutch case there are no uniform standards who signs the TPF applications for the university), there must be other instruments in place, like common planning, strategic recruitment, larger platforms etc.

Pro / Main advantage: Steering of part of Direct Appropriation allows for stronger signals. If these core funds are properly managed and a strong strategy (where to go, which priorities) is in place, then a virtual circle can be kept going.

Con / Main disadvantage: The main issue is that TPF is normally being driven, submitted and administered by individual researchers and their departments and centralised internal accounting systems do not appear to have changed this. All the researchers trying to get TPF have their own priorities. If they succeed they need resources from the Direct Appropriations, therefore reducing the room for manoeuvre on higher levels, for strategic allocation and planning. To a certain extent this does not hurt the organisation as universities are loose entities with a lot of power and freedom on the lower levels. If, however, TPF sucks off most of the Direct Appropriations for research *and* TPF funded staff can achieve permanent positions in greater numbers, the main advantage of Block Funding of all kinds does vanish: In extreme cases there might be no more resources for strategic action and new / strengthened research priorities, while all the way ministries and policy experts remind university leaders of their responsibility for renewal and strategic action.

Career paths and recruiting

Many TPF sources come forward with incentives for career paths. One instrument applied are Young Investigator programmes (→ chapter 6) where funding is linked to a certain career promise by the university formally getting the funding. The variety is broad: There are by-pass solutions like the Catalan ICREA programme, where the incoming funded professors formally become ICREA foundation staff, as university employment contracts come with too many side-effects unattractive to international top talent. There are funding programmes like German Lichtenberg Professorships (Volkswagen Foundation), the German Helmholtz Junior Groups or the Vienna Research Groups funded by WWTF (Laudel, 2013), who only hand out funding when the university promises a tenure track position[22]. Others like the DFG Emmy Noether Programme or the Sofia Kovalevskaja professorships by the Humboldt Foundation do not require such a track position (for the examples see Warta et al., 2016b). The ERC for its Starting Grants equips researchers with portability of their grants, giving them negotiation power vis-à-vis the universities.

As mentioned already several times in this analysis, tenure track or similar career paths facilitating early independence and merit-based promotion is a key element. This has two dimensions: Short-term

[22] https://www.volkswagenstiftung.de/unsere-foerderung/beendet/lichtenberg-professuren

contracts are dangerous for researchers and can lead to sudden career and idea death (Fortunato et al., 2018). On the other hand, there is a strong correlation between the scientific productivity and impact of nations and the dominant forms of recruitment and career advancement. There are of course other explanatory factors, but the "tenure-track nations" (those countries that either have full tenure track like the U.S. or provide for career paths facilitating early independence and merit-based promotion, like the UK) lead the pack in university rankings and other metrics. Opaque and local recruiting and career practices together with narrow "chair" systems often lead to local solutions, lengthy procedures, late independence and to selections that do not aim at first class people (or they do aim at, but do not attract them in sufficient numbers). RFCs and agencies then receive the applications of those people who have been selected years before by university recruitment committees.

> Pro / Main advantage: helping to reform and improve the recruitment and career structures as the perhaps most important factor shaping research and quality in universities: how people are recruited, how young researchers become independent early on and how they can enter a clear tenure track or other merit-based career path
>
> Con / Main disadvantage: Sticky rules and traditions in universities

9 A list of pros and cons

The Formas commission includes the requirement to formulate pros and cons of different forms of university research funding streams. The requirement is very useful as it forces us to make simple and hopefully clear statements. It is at the same time difficult as the academic and evaluation literature for good reasons is laden with "*nobody knows*", "*more research is needed*", "*depends on the individual context*", "*is interdependent with other funding streams*", "*there are eleven sub-categories*" and "*seen through the lens of the sub-discipline xy …*". This is all true.

For this analysis an extremely simple form of listing has been chosen, always juxtaposing effects of Direct Allocations and TPF. The question is simple and therefore we can neither try to answer it in terms of "*if ... then ...*", nor can we contextualise it too much. The arguments and observed effects come in two columns each, one for "opportunities" and one for "challenges": The headers are less crude than "pro" and "con". While at the carrying basically the same message, they bear more attention to the grey world of interdependencies and subtle differences. The different tables illustrate different dimensions like "*output and impact*" or "*supporting breakthrough / transformative research*" to identify which instrument has positive or negative consequences for which phenomenon (to avoid the word causality). Note that the different individual instruments like "indicator funding", "Performance Agreements (PAs)" or "Centres of Excellence" are listed in the same column and marked **bold**. As a result, what can be a TPF advantage with instrument A might be a challenge with TPF instrument B for the same phenomenon. Wherever possible, the messages in the table are linked to a source, except for broadly accepted stock of knowledge.

The thing that can at least be done with such a crude approach is to note a few caveats:

- The literature is rich and broad. Academic contributions often contain very specific terminology and models. Where evidence and empirical work is presented, the context plays an extremely strong role. Evaluations are in general more directed to outputs, outcomes and impacts.
- Everything is connected with everything. Laws, budgets and general rules are often interdependent and determine organizational behaviour, leadership action, interaction between universities, funding organizations and other actors. These are all again interdependent and influence the behaviour and opportunities of individuals, groups, departments and communities, again with interdependencies. There is a bottom up influence of action and structures on higher levels through collective and group behaviour. There is history and historical trajectories are usually very strong and characterised by longevity in the university world. There is multi-level governance.
- Often three or more instruments are combined in one country, e.g. indicators and PAs and TPF, making it nearly impossible to present simplified answers and relationships. Sometimes two or more instruments are coupled within one intervention, like indicator funding and PAs.
- Each country has its own actor set, rules, norms and organisations.
- Each organisation has its own history, mission, rules, organisational set-up and culture.
- It depends who looks at phenomena, the treasury, the parliament, the science ministry, an RFC, a university researcher, an evaluator or an STS scholar.

Table 7: Efficiency, value for money (mainly for institutional and organisational factors)

Opportunities coming with Direct Appropriations (which, context)	**Challenges coming with Direct Appropriations (which, context)**	**Opportunities coming with TPF (which, context)**	**Challenges coming with TPF (which, context)**
Meritocratic, rewarding good research, pressure to improve, **PRFS** (Geuna & Martin, 2003)	High cost and labour intensive, **PRFS, peer style** and **comprehensive PAs**, decreasing benefits (Geuna & Martin, 2001)	External ex ante evaluations allow for quality control, increasing quality and relevance through proposals + review, **all kinds of TPF** (OECD, 2018b)	High (indirect) cost and labour intensive, **all kinds of TPF** (Geuna et al. 2015, Langfeldt and Kyvik, 2016)
Provides public accountability for public funding, **PRFS** (Geuna & Martin, 2003). None of weak research performing countries has it (Jonkers & Zacharewicz) (2)	Researchers and universities can "game" the system over repeated periods, **PRFS** (Hicks, 2012; Geuna & Martin, 2001)	Flexible instruments for various policy and sector needs, **all kinds of TPF** (broad evidence from evaluations), can be coupled with quant. information ("informed peer review")	Difficult-to-control inflow of TPF funded staff, getting permanent positions if no rigorous recruitment and career policy **all kinds of TPF** (OECD, 2012; OECD, 2016a)
Re-allocation to high performers, works against moral hazard, **PRFS, indicator funding** (Herbst, 2007; Schubert, 2009)	Cost and benefits of the evaluations cannot be truly assessed, **PRFS** (Hicks, 2012)	"Next day, next game": no memory overload of the system; assessment of *future* research, **all kinds** (Martin, 2011)	Huge network oriented programmes come with high admin and transaction costs and less direct impacts, **Multi-Actor Programmes** (indirectly: Rietschel et al., 2009; Fresco et al., 2015)
Assessment of future, dialogic form, efficient if focussed, **PAs** (De Boer et al., 2015; Stampfer, 2017)	"Fattening": Increasing sophistication and overload with each round, **PRFS** and **PAs** (Martin, 2011)	Methods and approaches for *programme* evaluation in place, also beyond peer panels. **all kinds** (OECD, 2018b)	
Safe space for new ideas, **Block Grants, Fac.Appr. in general** (Laudel, 2006; Heinze et al., 2009)	Past determining the future **PRFS, indicator funding**, (various authors, ex post assessment)	Quantitative analyses possible, although difficult, **e.g. Strategic Programmes** (U.S. evaluation tradition)	
Cheap, easy to adapt and researchers follow the signals, **indicator funding** (for good or bad; Butler, 2003)		High TPF funding brings more university research output (with other factors) **All kind** (Aghion et al., 2010)	

Comments: (1), note that these was written through a UK lens before criticism of RAE became stronger; (2) No weak (research performing) European country has a PRFS, but the strong ones all go their own way, variety from PRFS to Block Grants.

Table 8: Outputs and impacts (for institutional, environmental, organisational and individual factors)

Opportunities coming with Direct Appropriations (which, context)	**Challenges coming with Direct Appropriations (which, context)**	**Opportunities coming with TPF (which, context)**	**Challenges coming with TPF (which, context)**
Certain outputs can be effectively increased through PRFS but what is causal? E.g. growth of Nr. of "excellent" researchers, **PRFS** (Geuna et al., 2015)	May encourage publication inflation, more outputs than impacts, **PRFS, indicator funding** (Sivertsen & Schneider, 2012; Butler, 2003 → but critically Van den Besselaar et al., 2017)	Clear links to impacts **in many programmes types feasible**; e.g. matched pairs or multi-method (OECD, 2018b)	Attribution problems, whose funding made it possible? **All kinds** (broad evidence from evaluations), but: partial impacts like "faster" or "more" also ok. Issue of sunk costs
Lower levels of competition might be efficient and good for output and impact, **all kind** (Sandström & van den Besselaar, 2018)	Efforts from scientific community to "play" the system. Constant adaptations needed, namely **PRFS** (Geuna & Martin, 2003)	Impacts on epistemic fields, funding landscape and organisations through large scale intervention ERC, *with causal links*, **excellence programmes** (Nedeva et al, 2012; Edler et al., 2014; Bonaccorsi, 2015)	Does not necessarily identify future leaders and top research **Excellence programmes** (Klaus & del Alamo, 2019; Neufeld, 2015)
Plans and ideas about future impacts can be negotiated, **PAs** (De Boer et al., 2015)	Impacts sometimes low in comprehensive **PAs** (OECD, 2018a)	Strong impacts through **CoE funding** but with mixed evidence regarding highest publication impacts (Langfeldt et al., 2010; Krull et al., 2013)	Appropriation of effects very difficult in most cases, often no control groups possible, **all kinds of TPF** (Daniel, 1993)

Table 9: Collaborations, interdisciplinary research, societal impact (for institutional, environmental, organisational and individual factors)

Opportunities coming with Direct Appropriations (which, context)	**Challenges coming with Direct Appropriations (which, context)**	**Opportunities coming with TPF (which, context)**	**Challenges coming with TPF (which, context)**
Potential impact of impact stories (societal impact part of REF in UK; **PRFS** but Martin (2011) → "Frankenstein"	Over-competition might trigger reduction of 'non-core' activities **PRFS** (Martin, 2011)	If academics shall contribute to explicit missions, TPF offers structures**, strat. + mission oriented programmes** (Van der Weijden et al., 2012; Arnold, 2012)	Peer review if not curated can suffer from bounded rationality and various forms of bias **all kind** (Daniel, …; Klaus and del Alamo, 2019).
Sufficient Direct Appropriations seem to support the production of societally valuable output and impact, **Block Funds** (Van der Weijden et al., 2012) (1)	Might just happen less due to pressures **All kind**	Various specific programmes tailored to foster interdisciplinary and collaborative research, **strat. + mission oriented programmes, CoEs** (broad eval. Evidence, Arnold et al., 2008b)	Peer review easily captured by narrow academic interests, e.g. disfavouring interdisciplinary research, **bottom up single project funding** (Lamont, 2009)
For local interactions FacAppr. play a facilitating role**, all kind** (Koier et al., 2016)		One main way to bring outer world into universities, **cooperative programmes** (Arnold et al., 2008b; Elg & Hakansson, 2012)	Pressure to focus on high-impact journals becomes incorporated, **bottom up single project funding** (Müller and de Rijke, 2019)
		Influence of state somewhat bigger than in Fac.Appr., if needed, an advantage, **mission oriented programmes** (Luukkonen and Thomas, 2016)	

Comments: (1) for biomed. and health research

Table 10: Supporting breakthroughs / transformative science (for institutional, organisational and individual factors)

Opportunities coming with Direct Appropriations (which, context)	**Challenges coming with Direct Appropriations (which, context)**	**Opportunities coming with TPF (which, context)**	**Challenges coming with TPF (which, context)**
Provides opportunity for risky, unconventional research, start of new research lines, **Block Grants** (Laudel, 2006; Heinze et al., 2009) (1)	Might encourage more traditional and safe forms of research, **PRFS** Geuna and Martin (2003);	Specific Funding programmes can be designed and are increasingly being used, **transformative programmes**; (Luukkonen, 2019)	RFC leaning too strongly towards "their" academic constituencies, **all kind**, but mainly classical **RFC** funding (Braun and Guston, 2003)
Increasing the temperature in the system increases the quality observed, **UK PRFS** (Geuna et al., 2015)	Often just not enough resources in the basic budget (a true challenge, not a downside) **All kinds of Fac.appr.**	TPF as agent of change; challenges can be overcome by proper design, **all kind** (Luukkonen, Stampfer & Strassnig, 2015; Warta & Dudenbostel, 2016; Kolarz, 2016)	Mainstreaming and short-termism, if not overcome by specific programme design, **all kind**, but often classical **RFC** funding (OECD, 2018b)
	"Almost certainly counter-productive in terms of generating a wide variety of intellectual innovations in the longer term", **PRFS** (Whitley and Martin, 2010)		Peer review if not curated can suffer from bounded rationality and various forms of bias. **All kind**

Comments: (1) As organisational research shows (Hollingsworth, 2002; Hage and Mote, 2010), there are important conditions for breakthrough success being more than random

Table 11: Organisational resilience and critical mass (mainly organisational factors)

Opportunities coming with Direct Appropriations (which, context)	**Challenges coming with Direct Appropriations (which, context)**	**Opportunities coming with TPF (which, context)**	**Challenges coming with TPF (which, context)**
Encourages strategy formulation on top and mid-level in universities, with cascade within university, **PRFS** (Geuna and Martin, 2003)	Threatens to overly weaken a large part of the university landscape, **PRFS** (Jonkers & Zacharewicz, 2016)	Allows for critical mass; **CoE** and hybrid instruments like Excellence Initiative or SRA (e.g. Experten-kommission, 2016)	Might suck off too much of Direct Appropriation by not providing full cost; if no strategy **All kind** (Koier et al., 2016)
Allows for critical mass and reallocations, **PRFS** (Hicks, 2012, Geuna and Martin; 2003)	Can hollow out university autonomy if too comprehensive and state too pushy, e.g. **PA**s (De Boer et al., 2015)	U.S. model of real full cost for TPF increases transparency and reduces deadweight, **all kind**, NSF etc. (Stephan, 2012).	Question of afterlife of large TPF funding like **CoE** (OECD, 2012; Langfeldt et al.)
Allows for organised learning in between exercises, **PRFS** (Hicks, 2012)	**Block Grants** resilient in a negative sense, individual negotiation power too high (not enough research on this)	Quick changes in environment need quick responses, TPF can offer, **strat. Programmes** (Aström et al., 2014; OECD, 2018b)	Might erode critical mass through too many, too various TPF projects and sources, **All kind** (e.g. Koier et al., 2016)
Negotiated co-development to strengthen individual universities, again cascade, **PAs** (De Boer et al. (2015)	Formula funding difficult, even with normalisation across fields, **Indicator funding** (Rafols et al., 2012)	Resilient innovation system with various quality-based funding sources, this increases variety **All kind**	
	Problems coming with Matthew principle, **PRFS** (Geuna et al., 2015), geographic and thematic concentration potentially too high		
	Can further over-competition, over-focussing, game-playing, reduction of trust; reductionistic tendencies, **PRFS** (Whitley and Martin, 2010)		

Comments: As the UK PRFS is the most-researched and discussed form of university steering, there is a lot of work about it. So some effects might be over-emphasized as everybody looks upon it; similar thing with peer review in TPF: Everybody looks at it

Table 12: People, careers and opportunities, including Gender (for institutional, environmental, organisational and individual factors)

Opportunities coming with Direct Appropriations (which, context)	**Challenges coming with Direct Appropriations (which, context)**	**Opportunities coming with TPF (which, context)**	**Challenges coming with TPF (which, context)**
Fits well to research autonomy of university researchers, space for "exploration mode research", **all kinds** (Laudel 2006; Heinze et al., 2009)	Fits too well with research autonomy of university researchers. Moral hazard: they remain too much within their realm, their speed and their epistemic context, **Block Grants (**Schubert, 2009)	Empowering of researchers to realise their ideas, money directly to PI. **Indiv. grants, large grants, CoEs; early careers (**Various evaluations)	A gender policy should come with TPF, but things can be done and curated, **All kind** (Wenneras & Wold, 1997, Boyle et al.,2015; Van der Lee & Ellemers, 2015)
Gender equality and other important goals can be transported, **Fac.Appr. (e.g. PAs)**	Gender issues and other biases remain often unseen in black box university, potentially bias-driven allocation within university **All kind** (Boyle et al., 2015; Volk et al., 2001)	Linking researchers to challenges and missions, **multi actor and strategic programmes** (e.g. Fresco et al., 2015)	Matthew effect strong in **super-grants for young researchers** but **weak in CoEs** (Hallonsten & Hugander, 2014; Langfeldt et al., 2015)
Gender budgeting is possible, **All kinds** (Steinthorsdottir et al., 2016)		Experimenting with new instruments possible, like lotteries or other forms, **Smaller programmes, project funding, risky projects** (Roubanis, 2017)	
		Peer Review can sort out the weaker ones, **all kind** (Sandström & van den Besselaar, 2018)	

10 Conclusions

In this chapter, we will come forward with the conclusions and summarize the main pros and cons of each main funding instrument and selected forms of combined approaches. This will include proposals how to frame future discussions about this topic in the given context. There are at least three levels that will be covered in a section each:

- The first, *macro-section* tries to see some mechanisms when TPF and Direct Appropriations interact in a few successful countries. This has to include a certain degree of simplification, as otherwise we drown again in context and "can't say"- dilemmas.
- The second, *super-macro*-section deals with the issue of transparency and comparability on a more abstract or normative level. It leads to the simple question whether and where we find a level playing field in our discussion and the answer is: "*not necessarily so*".
- The third, *meso*-section then takes the phenomena *research quality issues, career related questions* and *real-world interactions* and tries to find out which instruments come with which kinds of pros and cons for these phenomena.

10.1 Comparing the incomparable? What do we see

Inputs come first. They are difficult to determine and to compare across countries, even the seemingly simple question of Direct Appropriation and TPF shares in public research funding across countries. For public research funding, the main messages on the input side are:

- There seems to be a strong correlation between input and output: Across countries, two thirds of output growth correlates with input growth.
- There are no clear correlations between how the inputs are being allocated and the size of outputs and impacts. Therefore, there is no clear "winning mechanism".
- Over time no shift between public and private sources can be observed across European countries. What can be observed is a shift from Direct Appropriations to TPF sources within the public allocations; as well as the emergence of various forms of peer- or indicator-based steering mechanisms within the Direct Appropriations.
- The best performing systems in Europe either have a very strict PRFS *re*-allocation system in place (UK) or their universities can draw from large Direct Appropriations plus considerable TPF sources, and no big financial steering mechanism exists (Switzerland, Netherlands, to a certain degree Denmark).
- University systems share one property with individual universities and with rich people: In principle, a lot can happen to those on the top echelon. However, it is usually much easier to stay rich and famous than to make it to the top, and it is extremely difficult to make it to the top from down below. The rich then say to the poor: "Don't give up. Work harder, you can make it!"

Inputs are being quickly absorbed: Outputs on a global scale are growing exponentially and the number of young researchers is also strongly growing. Therefore, some questions keep policy makers, university leadership, the treasury and scholars occupied: (i) How can increasing demands be matched by appropriate input? (ii) Which form of inflow – instruments, amounts and incentives – might help to

obtain relatively higher output and the desired impacts? (iii) Can this additional input translate into room for manoeuvre – strengthening strengths, starting new things, recruiting top people – or is it just drained immediately by growth drivers of the current systemic set-up?

The first question addresses the daily or every-four-years fight for higher public research budgets for the universities and we have provided a few examples in the analyses, where such mechanisms have been studied. The second question will be revisited in the → *meso*-section further below.

The third question concerns the daily life of university leaders (on all levels) and constitutes an important discourse between them, RFC managers, ministries, and the researchers that want to create their optimal portfolio to get famous or survive with their research work and with their group. Here we see different worlds indeed, with the example of four strong countries (→ figure 4 in chapter 6) that all put their innovation policy emphasis strongly on university research[23]:

The case of Switzerland

- The Swiss science policy system provides for strong Direct Appropriations and for strong TPF, in the absence of global steering instruments. There are examples of well-working PAs in place. The ratio between Direct Appropriations and national public TPF is approx. 4:1. The HE funding growth has been stronger than student numbers' growth since 2008 and HERD / GDP is very high.
- Career models and resources make the Swiss system attractive for young top researchers. Within the regionally-governed, three-tier HE system the two Federal technical universities stand out for their large budgets, active recruitment policies and clear career tracks. As resources are plentiful and strong research already in place, virtuous circles can be upheld. The levels of research outputs and impacts are very high.
- The level of competition is not overly high between universities, while competitive elements are high in recruitment, career progression and internal and external funding sources.

The case of the Netherlands

- The Dutch system in a similar form comes forward with strong Direct Appropriations and well-endowed public TPF. The ratio between Direct Appropriations and national public TPF is approx. 3.5:1. Overall, growth in student numbers has been stronger than HE funding growth since 2008 and HERD / GDP is medium-high.
- Career models and excellence funding go hand in hand, and also other factors provide for a very competitive system. Such competition comes rather through inner-university mechanisms: Funding allocation is only to a small degree based on PRFS mechanisms, but the strong Research Evaluation System influences the behaviour of the actors. University leaders and namely deans have a certain strategic leeway and options; where strategies exist, this leeway is much greater. There are internal allocation mechanisms in place. The strong thematic top-down policy of the government provides clear signals but mixed results. The levels of research outputs and impacts are very high.
- The level of competition is medium-high between universities and very high for researchers to obtain career positions and funding.

[23] In contrary to other countries like Norway or Austria.

The case of the United Kingdom

- The UK system consists of medium-high Direct Appropriations and considerable public TPF, the ratio between Direct Appropriations and national public TPF being approx. 1:1. The HERD / GDP ratio in the UK is comparatively low, as a tight efficiency regime is in place (and the HERD / GDP ratio is relatively low in most larger countries). Overall, HE funding is decreasing, with stable student numbers. The traditional HEI independence from the state has been overruled by many interventions and micro-management (Broucker and De Wit, 2015, p. 66).
- In the UK we find one of the worlds' most thorough PRFS mechanisms with strong past-merit based reallocation mechanisms in place. The REF results translate into reallocation mechanisms within HEIs, leading to a certain strategic leeway for leadership levels in the high-performing universities. No U.S.-style tenure track exists, but strong competition for very good researchers on all career levels as well as opportunities for early independence.
- The level of competition is very high between and within universities.

The case of Sweden

- The Swedish system has considerable Direct Appropriations, that have been growing in the last years after long stagnation; and a wealth of public TPF sources. The ratio between Direct Appropriations and national public TPF is approx. 5:3 (44% vs. 27%). The overall HE funding growth has been much stronger than the growth of students; and HERD / GDP is very high.
- The indicator-based PRFS elements in Direct Appropriations do not translate into any considerable shifts in university funding. The strategic room for manoeuvre appears to be rather low for university leadership as the system has strong bottom up elements in place. This holds true both for the allocation / use of funding and for recruitment and career promotion. There are indications for interactions between the many TPF signals and for a less strict policy when it comes to recruitment and career promotion, leading to a notion of crowded but underfunded research landscapes with high inputs.
- The level of competition is low between universities, although the smaller and younger universities might view this differently. The level of competition within universities and among researchers is definitely lower than in the UK (… to make a safe statement).

What can we see?

Taking a view on these four countries we see the following: (i) Input levels matter. (ii) Fierce competition between universities within a country is not a *sine qua non* for university funding, when high outputs and impacts are the goal. (iii) In absence of input growth, a comprehensive PRFS with strong reallocation mechanisms can sustain the power and efficiency of an already strong university system (coming with a cost). (iv) Strong competition between researchers might depend strongly on the quality of research staff (recruitment and promotion) and on competitive spirit within universities. (iv) How the latter can be achieved is not easy to determine but might be influenced by a balance between sufficient basic allocations and growth opportunities for researchers, both through TPF and internal mechanisms. (v) TPF can contribute to HE strategy execution, if there are strategies in place. TPF (coming with a cost) can further drive virtuous circles in competition but this depends on the way TPF is being provided (→ chapter 7 and below), further on the number of applicants compared to

funding available. (vi) We need to know more about the relationship between outputs and impacts on the one side and the shape and rigor of recruitment and career models. However, there are correlations between different systems and scientific success.

10.2 Are the actors on the same level-playing field?

TPF is currently under pressure to show how well competitive research funding mechanisms perform. There is no reason to pity RFCs and funding agencies, as universities themselves had to prove their value to society in the last fifty years along phenomena like mass higher education, NPM (and other tools to make them *complete organisations*) or technology transfer as well as third mission quests[24]. The universities have not become ordinary organisations like companies, but the management narrative did have an impact and the social contract is in place: European universities obtain public money and they have to deliver many outputs, no matter how *autonomous* they are. The concept of autonomy has its ambiguities and the concept of academic freedom has related and still relates more to the individual researcher than to the university as such.

TPFs have flourished over the last decades, from the huge U.S. NIH to smaller research councils and agencies across Europe. They have profited from the efficiency-, output- and competition-related narratives of the last decades. The promise was and still is: We come forward with transparent and competitive instruments, ask non-involved domain experts for objective judgement and fund clearly-shaped projects. This we do in an efficient way. Finally: The state and the public have interests to get societal problems solved. They want certain missions accomplished and have preferences for certain topics. This has been translated into various funding programmes for structuring reasons.

On a first view, all this has been very successful: Ever more researchers are applying and doing their work with external funding. Many impacts through TPF can be clearly traced, both for excellence and relevance, with funding being responsible for new ideas, products and solutions as well as for careers, development of fields and organisations. The review procedures are (still) working and the whole world seems to be parcelled into projects. Many research programmes have had their missions accomplished.

On a second view, pressing questions do arise: Applicant numbers and cost have grown much faster than budgets, therefore TPF often cannot draw clear lines anymore to which of the many, very good applications the available funding should be allocated. Peer review has been subject to criticism, both for limited availability to pick the winners in highly contested funding procedures and for all kinds of sometimes inherent biases. Some funding lines have been criticised for being too crude and others for over-complexity. Some research programmes did not have had their missions accomplished. While there is ample evidence for better performance and superior outputs through TPF, there is also other evidence showing that such better performance cannot be found. A clearly shaped project is what at the same time scholars call the *project fallacy*: The researcher does not structure her work along TPF instalments. The efficiency melts away when counting non-monetary cost of TPF including all the writing of non-successful applications.

[24] This is altogether no new phenomenon. Universities take pride in being old organisations and a lot has happened on the way. Thinking of my own *Alma Mater* Rudolphina (*1365), it was many times bullied, silenced or closed by the crown and the state, for a long time taken over by the Jesuit Order (definitely a kind of third mission!) and financially starved over the centuries.

We can now add a third view: The most astounding property of TPF is its flexibility and ability to adapt. An RFC or a programme can change its criteria, focus and mechanisms. Peer review can be much stronger curated and adapted than most critics are willing to concede. Gender bias or mono-disciplinary conservatism can be treated through appropriate changes and mechanisms, including highly experimental designs. Transparency can be increased. Societal or technological goals can be translated into targeted funding. At least three issues however won't go away: TPF will remain quite *costly* and – related to this – *over-subscribed*, as the many researchers applying will not just disappear somehow. Even if a reallocation towards Direct Appropriations takes place, the researchers will still flood the then-poorer TPFs with applications, as scientists are ambitious and competitive individuals. Finally, the *outputs and impacts* of a certain TPF source will often but not regularly surpass those of other funding instruments.

Due to its clarity, structured content and procedures, TPF is standing in the light. It is being challenged also because it *can* be challenged, it is even designed to be challenged. Most programmes have an intervention logic, explicit criteria and selection procedures and they are subject to external evaluations as well as to independent, scholarly scrutiny. This leads to the following effect: As evaluators and scholars find a lot of evidence they can handle, the pile of critical evidence is constantly growing, and that is how it should be. TPF is (more often than not) a "*can say*" business. If research councils or funding agencies might dare to ask for being treated in a trust-based form, they know at least in principle that they have to *earn trust before*.

When comparing pros and cons of Direct Appropriations and TPF, do we find a level-playing field? Do we measure criteria, procedures and outcomes with the same kind of rigour? These questions are relevant for obvious reasons: If one side – TPF – stands more in the light than the other one, then we all can find challenges, biases and downsides more easily than on the other, less brightly-lit side.

How to approach such an issue? First, we put strong PRFS mechanisms like REF on the side: Such merit- and peer-based evaluation systems indeed shed a lot of light into university research and how input relates to output. Next, we might remind ourselves what the scholarly literature tells us about universities: All are different. Bounded rationality rules. Research of how universities work shows ambiguous results and has only scarcely revealed the internal mechanisms how resources are allocated, digested and transformed into impactful results. Only few studies exist that constitute a specific causal link between structural HEI properties and their research outputs and impacts. Core procedures including recruitment, career promotion and thematic focussing often remain opaque.

Universities and the analysis of their performance is often a *"can't say"* business and it would be also unwise to constantly scrutinize everything. We might have to live with universities as grey boxes also in the future. On the other hand, we will also not stop observing that some boxes produce more efficiently or more meaningful output than others. For reasons of fairness it must be admitted that also some RFCs do not enjoy having social scientists to study their panel procedures (Lamont, 2009).

Some academics might tend to come forward with: *Trust us, we are academics*. They even might have a reason for that, as being an academic researcher is a specific business requiring high levels of trust and freedom. There is also no clear relationship between the intensity of university management and levels of output and impact.

With regard to Direct Appropriations, a clear relationship between allocation mechanisms and the existence of strategies under operation might be helpful. There might be also a need for finding out how strict recruitment and career models might lead to better outputs and impacts. All this is prone to the "*can't say*" dilemma. What counts for a pro and con discussion is only the following: For criticism

and improvement, the same rigour has to be applied on both parts of the system. In current discussions this doesn't always seem to be the case. Calls for trust-based management become more convincing if trust is being earned before.

It should also not be forgotten that groups of university professors invented and dominate many TPFs, have been in favour of disciplinary boundaries and have been active lobbyists for all kinds of peer review, ideally excluding non-academic involvement in selection procedures. This list can be continued with age-, gender-, tribe-related and other preferences nurtured in the corridors of universities.

Finally, we should bear in mind that the functionality of the two main funding streams is different: TPF can act more quickly and in a flexible way to reach individual goals, Direct Appropriations serve the task to support more fundamental change in a slower way.

10.3 (How) does the form of funding influence individual phenomena?

In this last section we come back to chapters 6 to 9, including the pros and cons tables. This is a difficult task as programmes, countries, universities and context come in such variety and in different contexts. For very special cases like hybrid instruments (→ section 8.3) the reader has to refer to the full text.

Research quality and impacts on science …

… through Direct Appropriations

Direct Appropriations are the backbone of university research funding. They are embodied in most academics' payrolls, in rooms that have to be lit and heated, in machines and indirectly as a part in administration and teaching efforts. They are part of most TPF projects, as these come without full cost. They ideally are available for internal projects and initiatives, again embodied as research assistants, PhD students and other knowledgeable people, or in the form of competitive or non-competitive internal funds. All *TPF staff* should hope that they do not come too scarcely, as most good and targeted funding applications need proper intermural preparation, testing and safe-space risk-taking.

A high number of academics show considerable intrinsic motivation and want to compete with the other researchers in their epistemic communities, most often on a global scale. That is how the world in principle should be: An organisation obtains basic funding for its core tasks. As shown at large in this analysis, the world is a little more complex than that and we find all forms of endeavours that should happen but do not (sufficiently) happen. So basic funding *and* specific incentives are needed.

- Block Grants, i.e. research funding without incentives and punishment, have become much less prominent over the last decades. However, it has an important function in many countries and analyses show that non-competitive funding does not necessarily lead to non-competitive research (Sandström and van den Besselaar, 2018), e.g. when combined to Research Evaluation Systems. Block Grants help researchers to develop non-conventional ideas that later lead to high impact research with different forms of funding and recognition (Heinze et al., 2009; Laudel, 2006).
- Peer-based PRFS have been critically reviewed (Whitley and Martin, 2010), but the UK system and even some other countries (Geuna et al., 2015) reveal quality growth and also

reallocation to high performers (Herbst, 2007), although with question marks on causal effects and cost/benefit ratios. A high degree of competition is being spurred between and within universities. Not all effects are well understood, but the correlation between high competition, relatively low input and strong output is a fact in the UK.

- Indicator-based PRFS have a strong positive effect on outputs and a much less visible one on impacts (Ingwersen and Larsen, 2014; Sivertsen and Schneider, 2012; Butler, 2003). In many cases it might rather influence the way research (more papers, more co-authors) is being structured than high quality outputs are being increased. Indicators however are effective and often part of a broader funding regime, i.e. they come along with other instruments like PAs.
- PAs do not seem to have a decisive impact on the quality of research as they either negotiate marginal parts or try to cover the whole university without proper resources. They might be helpful through stabilisation of expectations and dedicated extra funding for specific activities (De Boer et al., 2015).

… through TPF

The quality of research can be raised through various programmes but it is never a safe bet whether measurable "better" research is the result of a TPF activity. Some programmes score better than comparator groups: Those are sometimes "rest of the world", sometimes "all the researchers funded by other programmes of this RFC", sometimes those who were on a reserve list and did not get funding. Sometimes the selection mechanisms are the object of an evaluation, sometimes it is the research results attributable to the funding.

The OECD review on competitive funding schemes lists the following advantages for TPF (OECD, 2018b, p. 7): Tendency to increase quality and relevance of research proposals; ensuring minimum quality standards; testing ideas with peers; building trust along fair procedures. Aghion et al. (2010) see a positive correlation between TPF and research output. Disadvantages include short-termism due to increased competition and to the nature of fixed term grants; mainstreaming and funding of less-risky proposals (with mixed evidence); considerable (hidden) costs.

- Individual grants: Some authors (Roubanis et al., 2017; Fortin and Currie, 2013) come forward with evidence that smaller grants may be a better option to raise overall research quality and outputs; or support breakthroughs (Wu, Wang and Evans, 2019). Other authors observe the overly focussing on top-journal papers (Müller and de Rijcke, 2019).
- Centres of Excellence can raise the quality of output and impacts as evaluations show (Krull et al., 2013, and there are other evaluations of CoE programmes finding positive impacts). However, there is no automatism, as a comparison of different Nordic CoE pr
- ogrammes shows (Langfeldt et al., 2015). CoE programmes are very good in helping areas grow that are already established but are still not in full bloom and they help to create critical mass through linking of similar or complementary research groups. CoE programmes do not reshape research landscapes or expectations in a fundamental way.
- Very large grants, mainly for young people, can do reshape expectations, as they challenge existing views on early independence, career structures and new research avenues. Such grants like the ERC- or larger NIH grants spur competition and induce changes on the material and reputational levels. However, while these properties can be traced by evaluations (for the ERC Nedeva et al., 2012; Neufeld, Huber and Wegner, 2013) there is mixed evidence whether "better" research in terms of publications and citation impact results from these grants, compared to those who missed funding by a narrow margin (Klaus and del Alamo, 2019; Neufeld, 2015).

- Risky grants, are a new kind of funding where the RFC or agency asks for less pre-existing data, new combinations and daring research questions (e.g. Luukkonen, 2019). The stakes are high for both sides, as in Venture Capitalism: Although the portfolio approach metaphor for funders might fit, the serial entrepreneur has perhaps no counterpart in the serial junior scientist. Other challenges can be overcome by design, but there are still not many ex post evaluations around. In the U.S. the DARPA approach has proven to be a valuable and very specific instrument to fund risky research.

Developing people, and gender equality …

… through Direct Appropriations

In this section we speak about younger researchers and opportunities for careers and we speak about gender fairness. Here it is less important how Direct Appropriations are being structured. The more important parts are the rules and practices for recruitment and career models. Although linked to the ways and amount of funding, this is a category of its own that matters strongly. For researchers, preferences are clear: They prefer early independence over many other factors and incentives (Janger and Nowotny, 2016). There is perhaps no greater determinant for the quality, outputs and relevance of a university than its recruitment and career progression record. It is mainly the successive cohorts of researchers who shape the content, the quality, the relevance and the reputation of each university and each research nation.

For gender equality, Direct Appropriations can (and have to, see van den Besselaar and Sandström, 2017) include several measures, e.g. through gender budgeting (Steinthorsdottir et al., 2016) or link to career measures (Boyle et al., 2015).

- Block grants therefore are quite neutral and depend on explicit links to other policy instruments.
- Peer-based PRFS can spur competition for talent in quite a considerable way and can impact on the determination and ability of universities to hire strong researchers, young and experienced (Geuna et al., 2015). However, there are countries using peer-based PRFS without apparent impacts on recruitment and career systems. Such systems are meritocratic in general and therefore support high-quality research(ers) (Geuna and Martin, 2003). This in turn might be followed by a discussion what "high-quality research" is and who in fact defines it.
- Indicator-based PRFS rarely use career- or gender-oriented indicators, but when it comes to research funding, they focus on TPF success, outputs, sometimes student and graduate numbers and similar indicators. The "high-quality research" argument applies here also, albeit to a weaker extent.
- PAs can and often do include career- and gender-oriented elements: The university promises to change ratios or introduce new procedural or internal support measures (De Boer et al., 2015). For such encompassing topics PAs can be useful as they are open to measures on the borderline research/teaching or research/career development or research/gender equality.

… through TPF

TPF is an external push factor, and in this case, it touches one of the most sensitive spots of universities, the way a HEI selects and promotes its next generation of academics. TPF come along with a number of direct and indirect career promotion instruments and the same is true for gender equality. If adapted to career models and recruitment practices of universities, all kinds of

interventions – from very junior staff to endowed star professors – can work well. Some funding programmes even expect universities to provide a career track position in case of large grants for young people, while others do not on purpose (Warta et al., 2016b). Some programmes have had an impact on career models in university systems and others have used bypass models. The ERC has chosen to equip grantees with portability of grants to increase their negotiation power.

The degree of gender equality can be improved either through targeted TPF programmes or through mainstreaming all kinds of TPF, the latter with success (Boyle et al., 2015). Biases are still existent (Van der Lee and Ellemers, 2015; Fortunato et al., 2018) but perhaps less ubiquitous and blatant than twenty years ago (Wenneras and Wold, 1997).

- Individual grants are usually too small to influence career decisions but can be designed to support young talent or have gender-specific properties.
- Very large grants can but not necessarily have to open avenues to better and faster careers. While in some systems (Koier et al., 2016 or Scholten et al., 2018 for the Netherlands) excellence grants have become markers for career decisions, evaluations for other countries and programmes doubt that significant links between large grants, decision quality and subsequent performance and career path do exist (Klaus and del Alamo, 2019). The ERC has had early impacts on career and recruitment models in various countries (Nedeva et al., 2012). Some countries show signs of overly strong Matthew effects (Hallonsten and Hugander, 2014, for Sweden).
- Strategic and mission-oriented grants, complex multi-actor programmes and Centres of Excellence all include career opportunities for younger people as they are part of a larger venture where expectations might be clearer and considerable mentoring structures in place. Younger researchers in strategic science-industry collaborations can profit from "real world" ideas and therefore have a broader basis for their careers.

Going for relevance and "real-world" connections …

… through Direct Appropriations

Universities and their research have always been in an area of conflict between pure, disinterested science and real-world questions. Over time, however (and taking a closer look), these conflicts often prove artificial: Many researchers are successful in theory development *and* applications and their work cannot be put into a single category (Nowotny, Scott and Gibbons, 2003), many fundamental research questions stem from very applied problems and most potential conflicts can solved through clear arrangements. The large UK technology transfer study (Hughes et al., 2016) has shown that a broad variety of useful impacts emerge in large numbers through different channels. Universities are not aloof from the rest of the world and Direct Appropriations for research therefore also carry a promise for usefulness. As with research productivity, a lot depends on intrinsic motivation, and researchers are often free to ignore any form of social contract obligation or real-world contacts (Schubert, 2009). All kinds of Direct Appropriations can help to start and increase local collaboration (Koier et al., 2016). In general, clustering and arrangements around local strengths appears to be a promising way (For Norwegian regions see OECD, 2017).

- Block grants appear to relieve pressure from researchers to produce only journal articles and other kinds of results directly linked to the academic career and reputation system. Some studies show that Block Grants seem to allow other forms of societally relevant research work and diffusion (Van der Weijden et al., 2012).

- Peer-based PRFS has in principle a tendency to shift the focus of work on topics with the potential for publication in high impact journals (Martin, 2011). However, Hughes et al., 2016, show the broad variety of transfer modes. In the 2014 REF, commercial and societal impacts have become an important category for the assessment.
- Some indicator-based PRFS have industry income as one element in place. Not much seems to be known whether they spur contract research.
- PAs can and often do include societal and business transfer goals: The university promises to change ratios or introduce new procedural or internal support measures (De Boer et al., 2015).

… through TPF

When university research(ers) shall meet the "real world" this can happen in various forms. Public research funding is only one of many pathways. Others include the State as organiser of larger missions (Dahmen, 1970; Lundin et al., 2010), industry directly contracting research, spin-offs and other ways of valorisation and last but not least the engagement of academics in the world, for various reasons and in different ways (Lam, 2011). Within this range, programmes are an important driver for linking universities and their research to societal actors and to the economy.

- Individual grants offer interesting possibilities. Curated and targeted funding programmes can also support the creation of various outputs and diffusion pathways with societal relevance. In this case funding criteria and selection procedures must be properly curated otherwise it is: more journal papers (Van der Weijden et al., 2012). Open innovation can be driven through curated funding programmes (Beck and Pötz, 2018)
- Strategic and mission-oriented programmes and grants can provide a clear link between industry (needs, problems, resources) and university. Strategic programmes can lead to longer-term research based on relevant industrial problems (Aström et al., 2014). Vinnovas' innovation programmes have been subject to long-term impact studies (Elg and Hakansson, 2012; Arnold, 2008b), they show the necessity to build up trust as pre-requisite and capabilities for the innovation system as a main output. When it comes to mission-oriented programmes, the state can influence the agenda in a stronger way than through Direct Appropriations.
- Complex multi-actor programmes come with high administration and transaction costs and outputs and impacts seem sometimes modest when compared to the often very large input (indirectly: Rietschel et al., 2009; Fresco et al., 2015). Again, here capabilities can be built up and standard setting work can be done (Arnold et al., 2012).

This short concluding section has revisited the stock of literature along main rationales of research and research funding. Again, no silver bullet could be found and no clear winner, but different functionalities of different main instruments.

11 References

11.1 Literature

Abramo, G., T. Cicero and C.A. D'Angelo (2012), *The dispersion of research performance within and between universities as a potential indicator of the competitive intensity of higher education systems.* Journal of Infometrics 6, pp. 155-168

Aghion, P., M. Dewatripont, C. Hoxby, A. Mas-Colell and A. Sapir (2010), *The governance and performance of universities: evidence from Europe and the US.* Economic Policy, 25(61), 7–59

Aksnes, D.W., G. Sivertsen, T.N. van Leeuwen and K.K. Wendt (2016), *Measuring the productivity of national R&D-systems: Challenges in cross-national comparisons of R&D-input and publication output indicators.* Science and Public Policy 44 (2), pp. 246-258

Aoun, J.E. (2017), *Robot-Proof. Higher Education in the Age of Artificial Intelligence.* The MIT Press, Cambridge/MA-London

Arnold, E., Aström, T., Boekholt, P., Brown, N., … and van der Veen, G. (2008a), *Impacts of the Framework Programme in Sweden*. Vinnova Analysis. Retrieved from https://ec.europa.eu/research/evaluations/pdf/archive/fp6-evidence-base/national_impact_studies/sweden.pdf

Arnold, E., B. Good and E. Segerpalm (2008b), *Effects of Research on Swedish Mobile Telephone Developments: The GSM Story.* VA 2008:04, Vinnova, Stockholm

Arnold, E. (2012), *Understanding long-term impacts of R&D funding: The EU framework programme.* Research Evaluation 21, pp. 332-343

Arnold, E., T. Aström, C. Glass and M. De Scalzi (2018), *How should we evaluate complex programmes for innovation and socio-technical transitions?* Brighton, Technopolis

Aström, T., E. Arnold, P. Stern, M. Jondell Assbring, M. Terrell … and M. Grudin (2014), *The Swedish Foundation for Strategic Research: An analysis of its impact and systemic role.* Technopolis

Auranen, O. and M. Nieminen (2010), *University research funding and publication performance: An international comparison,* Research Policy, Vol. 39/6, pp. 822-834

Azoulay, P., J.S. Graff Zivin and G. Manso (2011), *Incentives and Creativity: evidence from the academic life sciences.* The RAND Journal of Economics, 42 (3), https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1756-2171.2011.00140.x

Beck, S. and M. Pötz (2018), *Open Innovation: from hyped phenomenon to sustainable practice.* Wirtschaftspolitische Blätter 4/2018, pp. 557-572

Bennetot Pruvot, E., T. Estermann and V. Kupriyanova (2017), *EUA Public Funding Observatory, Report 2017,* https://eua.eu/downloads/publications/eua-pfo-report-december-2017.pdf

Bennetot Pruvot, E, A.-L. Claeys-Kulik and T. Estermann (2015), *Designing strategies for efficient funding of universities in Europe*. European University Association, Brussels

Benninghoff, M. and D. Braun (2010), *Research Funding, Authority Relations, and Scientific Production in Switzerland.* In: Whitley, R., J. Gläser and L. Engwall (Eds.), Reconfiguring Knowledge Production. Changing Authority Relationships in the Sciences and their Consequences for Intellectual Innovation. Oxford University Press, Oxford-New York, pp. 81-109

Bloch, C. and J.W. Schneider (2016), *Performance-based funding models and researcher behavior: An analysis of the influence of the Norwegian Publication Indicator at the individual level.* Research Evaluation, 25(4), pp. 371-382

Bolli, T. and F. Somogyi (2011), *Do competitively acquired funds induce universities to increase productivity?* Research Policy, 40 (1), pp. 136–147

Boyle, P, L.K. Smith, N.J. Cooper, K.S. Williams and H. O'Connor (2015), *Women are funded more fairly in social science.* Nature 525, pp. 181-183

Braun, D. (1997), *Die politische Steuerung der Wissenschaft. Ein Beitrag zum "kooperativen Staat"*. Campus Verlag Frankfurt / New York

Braun, D. and D.H. Guston (2003), *Principal-agent theory and research policy: An introduction.* Research Policy, 27 (8), pp. 807-821

Broucker, B. and K. de Wit (2015), *New Public Management in Higher Education.* In: Huisman, J., H. de Boer, D.D. Dill and M. Souto-Otero (Eds.), The Palgrave International Handbook of Higher Education Policy and Governance. Palgrave-Macmillan Publishers, Basingstoke-New York, pp. 57-75

Chesborough, H.W. (2003), *Open Innovation: The new imperative for creating and profiting from technology.* Boston

Cimini, G., A. Zaccaria and A. Gabrielli (2016), *Investigating the interplay between fundamentals of national research systems: Performance, investments and international collaborations.* Journal of Infometrics 10, pp. 200-211

Claeys-Kulik, A.-L. and T. Estermann (2015), *DEFINE Thematic Report: Performance-based funding of universities in Europe*; DEFINE Project, European University Association, Brussels

Clark, B.R. (1983), *The higher education system: academic organization in cross-national perspective*. University of California Press, Berkeley

Cole, S., J.R. Cole and G.A. Simon (1981), *Chance and consensus in peer review.* Science, 2014, pp. 881-886

Cruz-Castro, L., A. Benitez-Amado and L. Sanz-Menéndez (2016), *The proof of the pudding: University responses to the European Research Council.* Research Evaluation, 25(4), pp. 358–370

Cruz-Castro, L., and L. Sanz-Menéndez (2015), *The effects of the economic crisis on public research: Spanish budgetary policies and research organizations.* Technological Forecasting & Social Change, http://dx.doi.org/10.1016/j.techfore.201508001

Dahmen, E. (1970), *Entrepreneurial activity and the development of Swedish industry, 1919-1939*. American Economic Association Translation Series. RD Irwin, New York

Daraio, C., A. Bonaccorsi, A. Geuna, Benedetto Lepori … and Stig Slipersaeter (2011), *The European university landscape: A micro characterization based on evidence from the Aquameth project.* Research Policy, 40, pp. 148-164

Daniel, H.D. (1993), *Guardians of Science. Fairness and Reliability of Peer Review.* VCH Weinheim-NewYork-Basel-Cambridge-Tokyo

Daston, L. (2014), *Wunder, Beweise und Tatsachen. Zur Geschichte der Rationalität.* 3rd Edition, S. Fischer, Frankfurt/M.

De Bellis, N. (2014), *History and Evolution of (Biblio)Metrics.* In Cronin, B. and C.R. Sugimoto (Eds.), Beyond Bibliometrics: Harnessing Multidimensional Indicators of Scholarly Impact. The MIT Press, Cambridge/MA-London, pp. 23-44

De Boer, H., J. Enders and U. Schimank (2007), *On the Way towards New Public Management? The Governance of University Systems in England, the Netherlands, Austria, and Germany.* In Jansen D. (Ed.), New Forms of Governance in Research Organizations. Springer, Dordrecht, pp. 137-152

De Boer, H., B. Jongbloed, P. Benneworth, L. Cremonini, … and H. Vossensteyn (2015): *Performance-based funding and performance agreements in fourteen higher education systems*; Report for the Dutch Ministry of Education, Culture and Science. CHEPS, Enschede, Netherlands

Deem, R. (1998), *'New managerialism' and higher education: The management of performances and cultures in universities in the United Kingdom.* International Studies in Sociology of Educatiom, 8, 47-70

Deem, R. and K. J. Brehony (2005), *Management as ideology: the case of 'new managerialism' in higher education.* Oxford Review of Education, 31(2), 217-235

Dialogic and Empirica (2014), *The Effectiveness of National Research Funding Systems.* https://www.dialogic.nl/wp-content/uploads/2016/12/2013.109-1422.pdf

Edler, J., D. Frischer, M. Glanz and M. Stampfer (2014), "Funding individuals – changing organizations: The impact of the ERC on Universities" in R. Whitley and J. Gläser (eds.), *Organizational Transformation and Scientific Change: The Impact of Institutional Restructuring on Universities and Intellectual Innovation*, Research in the Sociology of Organizations, Vol. 42, Emerald, pp. 77-110

Elg, L. and S. Hakansson (2012), *Impacts of Innovation Policy. Lessons from Vinnova's impact studies.* Vinnova Analysis VA 2012:01, Stockholm

Elken, M., N. Frolich and I. Reymert (2016), *Steering approaches in higher education. Comparing Norway, Sweden, Finland, the Netherlands and UK* (England), NIFU, Report 2016:35, Nordic Institute for Studies in Innovation, Oslo. (F)

Estermann, T. and T. Nokkala (2009), *University autonomy in Europe I*, exploratory study, European University Association, Brussels

Estermann, T., T. Nokkala and M. Steinel (2011), *University Autonomy in Europe II. The Scorecard*, European University Association, Brussels

European Commission (2009), *The Gender Challenge in Research Funding. Assessing the European National scenes.* DG Research, EUR 23721 EN, Brussels

European Commission (2019), *Policy Paper by the Commission Services. ERAC Plenary Meeting Salzburg. 5.1: Strategic debate: how to improve national Research and Innovation systems of Member States and Associated Countries.* Brussels

European Science Foundation (2015), *Career Tracking of Doctorate Holders. Pilot Project Report.* ESF, Strasbourg

Ferlie, E., C. Musselin and G. Andresani (2009), *The Governance of Higher Education Systems: A Public Management Perspective*. In C. Paradeise, E. Reale, I. Bleiklie & E. Ferlie (Eds.), University Governance. Western European Comparative Perspectives. Springer, Dordrecht, pp. 1-19

Fochler, M., U. Felt and R. Müller (2016), *Unsustainable Growth, Hyper-Competition, and Worth in Life Science Research: Narrowing Evaluative Repertoires in Doctoral and Postdoctoral Scientists' Work and Lives*. Minerva, 54(2), pp. 175-200

Fochler, M. (2016), *Variants of Epistemic Capitalism: Knowledge Production and the Accumulation of Worth in Commercial Biotechnology and the Academic Life Sciences.* Science, Technology & Human Values, pp. 1-27. (DOI: 10.1177/0162243916652224)

Fortin, J.-M. and D.J. Currie (2013), *Big science versus Little science: How scientific impact scales with funding.* In: PLoS One 8 (6), e65263 (DOI: 10.1371/journal.pone.0065263)

Fortunato, S., C.T. Bergstrom, K. Börner, J.A. Evans, D. Helbing … and A.-L. Barabasi (2018), *Science of Science.* Science, 359 (6379), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5949209/

Franzoni, C. and H. Sauermann (2014), *Crowd Science: The organization of scientific research in open collaborative projects.* Research Policy, 43 (1), pp. 1-20

Fresco, L.O., A. Martinuzzi, M. Anvret, M. Bustelo, E. Butkus … and R. Fowler Pelly (2015), *Commitment and Coherence. Essential ingredients for success in science and innovation. Ex-Post-Evaluation of the 7th EU Framework Programme (2007-2013).* Brussels https://ec.europa.eu/research/evaluations/pdf/fp7_final_evaluation_expert_group_report.pdf

Fridholm, T. and G. Melin (2012), *"Med glädje, men inte med lätthet" – om högskolans fördelning av de direkta statsanslagen för forskning* [Distribution of governmental direct appropriations to research at Swedish universities]. Technopolis, Stockholm

Fumasoli, T. and J. Huisman (2013), *Strategic Agency and System Diversity: Conceptualizing Institutional Positioning in Higher Education.* Minerva. Online Print DOI 10.1007/s11024-013-9225y

Georghiou, L., J. Howells, J. Rigby, S. Glynn, J. Butler … and N. Reeve (2000), *Impact of the Research Assessment Exercise and the future of quality assurance in the light of changes in the research landscape.* PREST report, Manchester.

Geuna, A. (2001), *The changing rationale for European university research funding: are there negative unintended consequences?* Journal of Economic Issues 35, pp. 607-632

Geuna, A. and B. Martin (2003), *University Research Evaluation and Funding: An International Comparison.* Minerva 41, pp. 277-304

Geuna, A. and F. Rossi (2015), *The University and the Economy. Pathways to Growth and Economic Development.* Edward Elgar Publishing, Cheltenham – Northampton

Geuna, A., M. Piolatto and M.S. Labini (2015), *University funding and research assessment: an* analysis of Italian and British cases. In: The University and the Economy. Pathways to Growth and Economic Development. Edward Elgar Publishing, Cheltenham – Northampton pp. 102-138

Geuna, A. and M. Piolatto (2015), *Research Assessment in the UK and Italy: Costly and difficult, but probably worth it (at least for a while).* Research Policy 45, pp. 260-271

Gläser, J., S. Lange, G. Laudel and U. Schimank (2010*). Informed authority? The limited use of research evaluation systems for managerial control in universities.* In: Whitley, R., J. Gläser and L. Engwall (Eds.), Reconfiguring Knowledge Production. Changing Authority Relationships in the Sciences and their Consequences for Intellectual Innovation. Oxford University Press, Oxford-New York, pp. 149-183

Gross, K. and C.T. Bergstrom (2019), *Contest models highlight inherent inefficiencies of scientific funding competitions.* PLoS Biol 17(1): e3000065. https//doi.org/10.1371/journal.pbio.3000065

Hage, J. and J. Mote (2010), *Transformational Organizations and a Burst of Scientific Breakthroughs. The Institut Pasteur and Biomedicine, 1889-1919.* Social Science History 34:1, pp. 13-46

Hallonsten, O. and O. Hugander (2014), *Supporting 'future research leaders' in Sweden: Institutional isomorphism and inadvertent funding agglomeration.* Research Evaluation, 23, 249-260

Harari, H., O. Kuebler and H. Markl (2006), *Recommended Steps towards the Establishment of the Institute of Science and Technology – Austria (ISTA).* Submitted to the Federation of Austrian Industry

Härlin, M. (2016), *Little for the many or much for the few?* In: Thinking Ahead. Research, Funding and the Future. RJ Yearbook 2015/2016, Makadam Publishers, Gothenburg-Stockholm, pp. 153-158

Heinze, T. (2008), *How to sponsor ground-breaking research: a comparison of funding schemes.* Science and Public Policy, 35(5), pp. 302-318

Heinze, T., P. Shapira, J.D. Rogers and J.M. Senker (2009), *Organizational and institutional influences on creativity in scientific research*. Research Policy, 38, pp. 610-623

Herbst, M., U. Hugendobler and L. Snover (2002), *MIT and ETH Zurich: Structures and Cultures juxtaposed.* CEST

Herbst, M. (2007), *Financing Public Universities.* Higher Education Dynamics, Vol. 18. Berlink Springer

Hessels, L.K., T. Franssen, W. Scholten, and S. de Rijcke (2019), *Variation in Valuation: How Research Groups Accumulate Credibility in Four Epistemic Cultures.* Minerva, published online first.

Hicks, D. (2012), *Performance-based university research funding systems*, Research Policy, Vol. 41/2, pp. 251-261. (F)

Hollingsworth, J.R. (2002), *Institutional Excellence in Biomedical Research: The Case of the Rockefeller University*, in: Creating a Tradition of Biomedical Research: The Rockefeller

University Centennial History Conference, Edition: 1: Rockefeller University Press, Editors: Darwin H. Stapleton, pp. 17-63

Hornbostel, S. and T. Möller (2015), *Die Exzellenziniative und das deutsche Wissenschaftssystem. Eine bibliometrische Wirkungsanalyse.* Wissenschaftspolitik im Dialog. Eine Schriftenreihe der Berlin-Brandenburgischen Akademie der Wissenschaften

Hughes, A., C. Lawson, A. Salter, M. Kitson, A. Bullock and R. Hughes (2016), *The Changing State of Knowledge Exchange: UK Academic Interactions with External Organizations 2005-2015.* NCUB https://researchportal.bath.ac.uk/en/publications/the-changing-state-of-knowledge-exchange-uk-academic-interactions

Ingwersen, P. and B. Larsen (2014), *Influence of a performance indicator on Danish research production and citation impact 2000-2012.* Scientometrics, 101, pp. 1325-1344

Internationale Expertenkommission Exzellenzinitiative (2016), *Evaluation der Exzellenzinitiative. Endbericht ("Imboden Bericht"),* https://www.gwk-bonn.de/fileadmin/Redaktion/Dokumente/Papers/Imboden-Bericht-2016.pdf

Janger, J. (2013), *University Governance in the Context of University Autonomy.* WIFO-Monatsberichte, 86 (2), pp. 159–171

Janger, J., and K. Nowotny (2016), *Job choice in academia*. Research Policy 45 (8), pp. 1672-1683

Janger, J., N. Schmidt and A. Strauss (2019), *International Differences in basic research grant funding – a systematic comparison. Studien zum Deutschen Innovationssystem Nr. 9-2019.* WIFO – Austrian Institute of Economic Research, Vienna. https://www.e-fi.de/fileadmin/Innovationsstudien_2019/StuDIS_09_2019.pdf

Jeschke, J.M., S. Lokatis, I. Bartram and K. Tockner (2018), *Knowledge in the Dark: Scientific Challenges and Ways Forward.* Working Paper

Jongbloed, B. and B. Lepori (2015), *The Funding of Research in Higher Education: Mixed Models and Mixed Results.* In: Huisman, J., H. de Boer, D.D. Dill and M. Souto-Otero (Eds.), The Palgrave International Handbook of Higher Education Policy and Governance. Palgrave-Macmillan Publishers, Basingstoke-New York, pp. 439-462

Jongbloed, B. (2009), *Higher education funding systems: An overview covering five European jurisdictions and the Canadian Province Ontario*. Report prepared for the Hong Kong University Grants Committee, Enschede, Netherlands

Jonkers, K. and T. Zacharewicz (2016), *Research Peformance Based Funding Systems: a Comparative Assessment.* Publications Office of the European Union, Luxembourg, doi: 10.2791/70120

Karlsson, S and O. Persson (2012), *The Swedish Production of Highly Cited Papers.* Swedish Research Council, Stockholm

Klaus, B. and D. del Alamo (2019), *Talent identification at the limits of Peer Review: an analysis of the EMBO Postdoctoral Fellowships Selection Process.* PREPRINT: http://dx.doi.org/10.1101/481655

Koier, E., B.v.d. Meulen, E. Horlings and R. Belder (2016), *Spinning plates: Funding streams and prioritisation in Dutch university research.* The Hague: Rathenau Institute

Kolarz, P., E. Arnold, K. Farla, S. Gardham … and M. Wain (2016), *Evaluation of the ESRC Transformative Research Scheme. Final Report.* Technopolis

Lam, A. (2011), *What motivates Academic Scientists to Engage in Research Commercialisation: 'Gold', 'Ribbon' or 'Puzzle'?* Research Policy 40, pp. 1354-1368

Lamont, S. (2009), *How Professors Think: Inside the Curious World of Academic Judgement.* Harvard University Press, Cambridge, MA

Langfeldt, L. (2006), *The policy challenges of peer review: managing bias, conflict of interest and interdisciplinary assessments.* Research Evaluation 15 (1), pp. 31-41

Langfeldt, L., S. Borlaug and M. Guldbrandsen (2010), *The Norwegian Centres of Excellence Scheme. Evaluation of added value and financial aspects.* NIFU STEP Report 29/2010, Oslo

Langfeldt, L., I. Ramberg, G. Sivertsen, C. Bloch and D.S. Olsen (2012), *Evaluation of the Norwegian Scheme for Independent Research Projects. FRIPRO.* NIFU STEP Report 8/2012, Oslo

Langfeldt, L., M. Benner, G. Sivertsen, E.H. Kristiansen, D. Aksnes … and A. Pelkonen (2015), *Excellence and growth dynamics: A comparative study of the Matthew effect.* Science an Public Policy 42, pp. 661-675

Langfeldt, L. and S. Kyvik (2016), *Intrinsic tensions and future challengese of peer review.* In: Thinking Ahead. Research, Funding and the Future. RJ Yearbook 2015/2016, Makadam Publishers, Gothenburg-Stockholm, pp. 137-152

Laudel, G. (2006), *The art of getting funded: how scientists adapt to their funding conditions.* Science and Public Policy, 33(7), pp. 489–504

Laudel, Grit (2013), *An In-depth Case Study of Selected WWTF Impacts.* Projektbericht. Wien. http://repository.fteval.at/id/eprint/32

Laudel, G. and E. Weyer (2014), *Where have all the Scientists Gone? Building Research Profiles at Dutch Universities and its Consequences for Research.* In R. Whitley and J. Gläser (eds.), Organizational Transformation and Scientific Change: The Impact of Institutional Restructuring on Universities and Intellectual Innovation, Research in the Sociology of Organizations, No. 42, Emerald Group Publishing, Bradford, England, pp. 111-140

Lepori, B., P van den Besselaar, Michael Dinges, Bianca Poti, … B. van der Meulen (2007a), *Comparing the evolution of national research policies: what patterns of change?* Science and Public Policy, 34/6, pp. 372-388

Lepori, B., M. Benninghoff, B. Jongbloed, C.S. Salerno and S. Slipersæter, (2007b), *Changing patterns of funding of European Higher Education institutions.* In: Bonaccorsi, A. and C. Daraio (Eds.), Universities and Strategic Knowledge Creation. Specialisation and Performance in Europe. Edward Elgar Publishing, Cheltenham, England

Leslie, L L., S. Slaughter, B.J. Taylor and L. Zhang (2012), *How do Revenue Variations Affect Expenditures Within U.S. Research Universities?* Research in Higher Education, 53 (6), pp. 614-639

Leydesdorff, L. and E. Gauthier (1996), *The Evaluation of National Performance in Selected Priority Areas Using Scientometric Methods.* Research Policy (25) 3, pp. 431-450

Li, A.Y. and Zumeta, W. (2015), *State Support for Higher Education.* In: Huisman, J., H. de Boer, D.D. Dill and M. Souto-Otero (Eds.), The Palgrave International Handbook of Higher Education Policy and Governance. Palgrave-Macmillan Publishers, Basingstoke-New York, pp. 463-482

Luukkonen, T. (2012), *Conservatism and risk-taking in peer review: Emerging ERC practices.* Research Evaluation 21 (1), pp. 48-60

Luukkonen, T. and D.A. Thomas (2016), *The 'negotiated space' of University Researchers' Pursuit of a Research Agenda.* Minerva 54 (1), pp. 99-127

Luukkonen, T., M. Stampfer and M. Strassnig (2015), *Evaluation practices in the selection of ground-breaking research proposals.* Working Paper for the ERC Scientific Council

Luukkonen, T. (2019), *Funding Transformative Research - Rationale and Impacts.* In Benner, M., S. Schwaag Serger and G. Marklund (Eds.), Smart and Learning Politics in Research and Innovation (forthcoming)

Lund Declaration (2009), *Europe Must Focus on the Grand Challenges of our Time.* Swedish EU Presidency, 8 July 2009, Lund, Sweden. Available at http://www.se2009.eu /polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_version_9_july.pdf

Lundin, P., N. Stenlas and J. Gribbe (Eds., 2010), *Science for Welfare and Warfare. Technology and State Initiative in Cold War Sweden.* Science History Publications, Sagamore Beach

König, T. (2016), *The European Research Council.* Wiley

Krull, W. et al. (2013), *Evaluation of the Danish National Research Foundation.* Ministry of Science, Innovation and Higher Education, https://ufm.dk/en/publications/2013/files-2013/evaluation_of_the_danish_national_research_foundation_web.pdf

Mattsson, P. (2011), *European knowledge transfer reflected by research collaboration and patent citations indicators.* PhD Thesis, Karolinska Institutet, Stockholm.

Martin, B. (2011), *The research excellence framework and the impact agenda: Are we creating a Frankenstein monster?,* Research Evaluation, 20/3, pp. 247-254

Martin, Br. (2000), *Research grants: problems and options.* Australian Universities' Review, 43 (2), pp. 17-22

Müller, R. and S. de Rijcke (2017), *Exploring the epistemic impacts of academic performance indicators in the life sciences.* Research Evaluation 26(3), pp. 157–168

Musselin, C. (2006), *Are Universities specific organisations?* In: Krücken, G., A. Kosmützky and M. Torka (Eds.), Towards a Multiversity? Universities between Global Trends and National Traditions, Bielefeld, Transcript Verlag, pp. 63-84

Nedeva, M., D. Braun, J. Edler, T. Luukkonen, D. Frischer, … and R. Whitley (2012), *Understanding and Assessing the Impact and Outcomes of the ERC and its Funding Schemes (EURECIA).* Final Synthesis Report. Retrieved from https://gmbh.wwtf.at /upload/eurecia_final_synthesis_report.pdf

Nedeva, M. and M. Stampfer (2012), *From "Science in Europe" to "European Science"*. Science, Vol. 336, pp. 982-983

Neufeld, J. (2015), *Determining effects of individual research grants on publication output and impact: The case of the Emmy Noether Programme (German Research Foundation).* Research Evaluation, doi: 10.1093/reseval/rvv029

Neufeld, J., N. Huber and A. Wegner (2013), *Peer review-based selection decisions in individual research funding, applicants publication strategies and performance: The case of the ERC Starting Grants.* Research Evaluation, Vol. 22, No.3, pp. 1-11

Nowotny, H., P. Scott, M. Gibbons (2003), *"Mode 2" revisited.* Minerva 41, pp. 179-194

OECD (2006), *OECD Reviews of Innovation Policy: Switzerland 2006*, OECD Publishing, Paris

OECD (2011), *OECD Reviews of Innovation Policy: Slovenia 2011*, OECD Publishing, Paris

OECD (2012), *OECD Reviews of Innovation Policy: Sweden 2012*, OECD Publishing, Paris

OECD (2014a), *Promoting Research Excellence: New Approaches to Funding*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264207462-en

OECD (2014b), *OECD Reviews of Innovation Policy: Netherlands 2014*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264213159-en

OECD (2016a), *OECD Reviews of Innovation Policy: Sweden 2016,* OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264250000-en

OECD (2016b), *OECD Reviews of Innovation Policy: Luxembourg 2016*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264232297-en

OECD (2017), *OECD Economic Survey: Norway 2017*, OECD Publishing, Paris, http://dx.doi.org/10.1787/eco_surveys-nor-2016-en

OECD (2018a), *OECD Reviews of Innovation Policy: Austria 2018*, OECD Publishing, Paris

OECD (2018b), *Effective operation of competitive research funding systems.* OECD Science, Technology and Industry Policy Papers No. 57, Paris

Öquist, G. and M. Benner (2012), *Fostering Breakthrough Research: A Comparative Study.* Academy Report, Royal Swedish Academy of Sciences

Öquist, G. and M. Benner (2014), *Room for increased ambitions? Governing breakthrough research in Norway 1990-2013*. Report to the Research Council of Norway, Oslo

Paradeise, C., E. Reale and G. Goastellec (2009), *A comparative approach to higher education reforms in Western European Countries*, in C. Paradeise et al. (eds.), University Governance: Western European Comparative Perspectives, pp. 197-226, Springer, International Publishing, Cham, Switzerland

Paradeise, C., E. Reale, I. Bleiklie and E. Ferlie (Eds.) (2009), *University Governance. Western European Comparative Perspectives.* Dordrecht: Springer

Paradeise, C. and J.C. Thoenig (2013), *Academic Institutions in Search of Quality: Local Orders and Global Standards.* Organization Studies, 34(2), 189-218

Paradeise, C., E. Reale, I. Bleiklie and E. Ferlie (Eds.) (2009), *University Governance: Western European Comparative Perspectives*, Higher Education Dynamics 25, Springer, International Publishing, Cham, Switzerland

Rafols, I., L. Leydesdorff, A. O'Hare, P. Nightingale and A. Stirling (2012), *How Journal Rankings can suppress interdisciplinary research: A comparison between Innovation Studies and Business & Management.* Research Policy 41, pp. 1262-1282

Reale, E. and E. Primeri (2015), *Introduction.* In: Primeri, E. and E. Reale (Eds.), The Transformation of University Institutional and Organizational Boundaries. Higher Education Research in the 21th Century. Sense Publishers, Rotterdam-Boston-Taipei, pp. IX-XXII

Rietschel, E., E. Arnold, A. Cenys, A. Dearing, I. Feller … and Nicoletta Stame (2009), *Evaluation of the Sixth Framework Programmes for Research and Technological Development 2002-2006.* Report of the Expert Group https://publications.europa.eu/en/publication-detail/-/publication/79d2ded6-6ba9-4a45-ad29-ad69e1ef3d4c/language-en

Salter, A.J. and B.R. Martin (2001), *The economic benefits of publicly funded basic research: a critical review*. Research Policy, 30, pp. 509–532

Sandström, U. and P. v.d. Besselaar (2018), *Funding, evaluation and the performance of national research systems.* Journal of Informetrics 12, pp. 365-384.

Sandström, U. and U. Heyman (2016), *Funding and research quality*. In: Thinking Ahead. Research, Funding and the Future. RJ Yearbook 2015/2016, Makadam Publishers, Gothenburg-Stockholm, pp. 39-60.

Sarewitz, D. (2016), *Saving Science*. The New Atlantis https://www.thenewatlantis.com/publications/saving-science

Scholten, W., L. van Drooge and P. Diederen (2018), *Excellence is extra-ordinary – Thirty years of focus on excellence in Dutch science policy.* Rathenau Institute, The Hague

Schubert, T. (2009), *Empirical observations on New Public Management to increase efficiency in public research – Boon or bane?* Research Policy 38, pp. 1225-1234

Scottish Funding Council (2018), *University Outcome Agreements. Summary of Progress and Ambitions report 2018*. Edinburgh.

Seeber, M. (2013), *Efficacy and limitations of research steering in different disciplines.* Studies in Higher Education, 38 (1), pp. 20-38

Seeber, M., B. Lepori, M. Montauti, J. Enders, H. de Boer … and E. Reale (2014), *European Universities as Complete Organizations? Understanding Identity, Hierarchy and Rationality in Public Organizations.* Public Management Review, 17 (10), pp. 1444-1474. http://dx.doi.org/10.1080/14719037.2014.943268

Sivertsen, G. and J.W. Schneider (2012), *Evaluering av den bibliometriske forskningsindikator*. Oslo: NIFU report 2012:17

Slipersaeter, S., B. Lepori and M. Dinges (2007), *Between policy and science: research councils' responsiveness in Austria, Norway and Switzerland*, in: Science and Public Policy, 34/6, pp. 401-415

SOU (2019), *En langsiktig, samordnad och dialogbaserad styrning av högskolan.* Betänkande av Styr- och resursutredningen (Strut). Statens Offentliga Utredningar 2019:6, Stockholm

Stampfer, M. (2017), *Performance agreements in Austria: A case of simultaneous under- and over-steering.* In: Austrian Council for Research and Technology Development (Ed.), Prospects and Future Tasks of Universities. Digitalization – Internationalization – Differentiation, Zürich: Lit Verlag, pp. 159-174

Stampfer, M., Pichler, R., Hofer, R. (2010): *The making of research funding in Austria: transition politics and institutional development, 1945–2005*. Science and Public Policy, 37/10, pp. 765–780

Steinthorsdottir, F.S., T.M. Heijstra, T. Einarsdottir and G.M. Petursdottir (2016), *Gender budgeting in academia. Garcia working papers 8*. University of Trento. http://garciaproject.eu/wp-content/uploads/2016/03/GARCIA_working_papers_8.pdf

Stephan, P. (2012), *How Economics Shapes Science*. Harvard University Press, Cambridge, Massachusetts

Stokes, D. (1997), *Pasteur's Quadrant. Basic Science and Technological Innovation.* The Brookings Institution, Washington

Swedish Government (2016), *Regeringens proposition 2016/17:50. Kunskap i samverkan – för samhällets utmaningar och stärkt konkurrenskraft*, Regeringen överlämnar denna proposition till riksdagen. Stockholm

Swedish Research Council (2015), *Research Quality Evaluation in Sweden – FOKUS.* Report of a government commission regarding a model for resource allocation to universities and university colleges involving peer review of the quality and relevance of research, Stockholm

Swedish Research Council, Energimyndigheten, Formas, Forte and Vinnova (2016), *Evaluation of the strategic research area initiative 2010-2014,* Stockholm

Teichler, U., A. Arimoto and W.K. Cummings (2013), *The Changing Academic Profession. Major Findings of a Comparative Survey.* The Changing Academy – The Changing Academic Profession in International Comparative Perspective 1. Springer, Dordrecht.

UKÄ (2019), *Finansieringen av svenska universitet och högskolor. De ekonomiska effekterna av statensstyrning och resurstilldelning 2007–2017*. Report, Stockholm, https://www.uka.se/download/18.a8c22c2167c579aee5e6e1/1550500187757/rapport-2019-01-31-finansieringen-av-svenska-universitet-och-hogskolor.pdf

Vaesen, K. and J. Katzav (2017), *How much would each researcher receive if competitive government research funding were distributed equally among researchers?* PLOS ONE- https://doi.org/10.1371/journal.pone.0183967

Van der Lee, R. and N. Ellemers (2015), *Gender contributes to personal research funding success in The Netherlands.* PNAS, 112 (40), pp. 12349-12353. www.pnasorg./cgi/doi/10.1073/pnas.1510159112

Van der Weijden, I., M. Verbree and P. van den Besselaar (2012), *From bench to bedside: The societal orientation of research leaders: The case of biomedical and health research in the Netherlands.* Science and Public Policy 39, pp. 285-303

Van den Besselar P. and U. Sandström (2017), *Vicious circles of gender bias, lower positions, and lower performance: Gender differences in scholarly productivity and impact.* In: PLOS One 12 (8); https://doi.org/10.1371/journal.pone.0183301

Van den Besselaar, P., U. Heyman and U. Sandström (2017), *Perverse effects of output-based research funding? Butler's Australian case revisited.* Journal of Infometrics, 11 (3), pp. 905-918

Van den Besselaar, P. and L. Leydesdorff (2009), *Past performance, peer review and project selection: a case study in the social and behavioural sciences.* Research Evaluation, 18 (4), pp. 273-288

Van Steen, J. (2012), *Modes of Public Funding of Research and Development: Towards Internationally Comparable Indicators.* OECD STI Working Group Papers, 2012/04, OECD Publishing, Paris. http://dx.doi.org/10.1787/5k98ssns1gzs-en

Volk, C. S., S. Slaughter and S.L. Thomas (2001), *Models of Institutional Resource Allocation: Mission, Market, and Gender*. The Journal of Higher Education, 72 (4), pp. 387-413

Warta, K. and T. Dudenbostel (2016a), *Radikale Innovationen – Mehr Freiraum für innovative und risikobehaftete Forschung*, Technopolis Vienna.

Warta, K., M. Stampfer, M. Strassnig, J. Gorraiz (2016b), *Evaluation des Sofia Kovalevskaja-Preisprogramms.* Endbericht für die Humboldtstiftung

Weber, M. (1917), *Wissenschaft als Beruf*. In Max Weber: Gesamtausgabe, Bd I/13. Hochschulwesen und Wissenschaftspolitik. Schriften und Reden 1895-1920. Mohr Siebeck Verlag, Tübingen

Wenneras, C. and A. Wold (1997), *Nepotism and sexism in peer-review.* Nature 387, pp. 341-343

Whitley, R. (2008), *Universities as strategic actors: Limitations and variations*. In L. Engwall and D. Weaire (Eds.), The university in the market. Portland Press Ltd, London, pp. 23-37.

Whitley, R. and J. Gläser (2014b), *The impact of institutional reforms on the nature of universities as organisations,* in R. Whitley and J. Gläser (eds.), Organizational Transformation and Scientific Change: The Impact of Institutional Restructuring on Universities and Intellectual Innovation, Research in the Sociology of Organizations, No. 42, Emerald Group Publishing, Bradford, England, pp. 19-50.

Whitley, R., J. Gläser and G. Laudel (2018), *The Impact of Changing Funding and Authority Relations on Scientific Innovations.* Minerva, https://doi.org/10.1007/s11024-018-93437

Whitley, R. and B. Martin (2010), *The UK Research Assessment Exercise. A case of Regulatory Capture?* In: Whitley, R., J. Gläser and L. Engwall (Eds.), Reconfiguring Knowledge Production. Changing Authority Relationships in the Sciences and their Consequences for Intellectual Innovation. Oxford University Press, Oxford-New York, pp. 51-80

Wouters, P. (2014), *The Citation: From Culture to Infrastructure*. In Cronin, B. and C.R. Sugimoto (Eds.), Beyond Bibliometrics: Harnessing Multidimensional Indicators of Scholarly Impact. The MIT Press, Cambridge/MA-London, pp. 47-66

Wu, L., D. Wang and J.A. Evans (2019), *Large teams develop and small teams dirupt science and technology.* Nature 556, pp. 378-382

11.2 List of abbreviations

AKA	The Academy of Finland
ANR	French National Research Agency
CNRS	French National Center for Scientific Research
CoE	Center of Excellence
CTI	Commission for Technology and Innovation
DARPA	Defense Advanced Research Projects Agency
DFG	German Research Foundation
DKK	Danish Crown (1 € = 7.43 DKK, 27 Feb 2019)
DNRF	Danish National Research Foundation
EMBO	European Molecular Biology Organisation
ERAC	European Research Area and Innovation Committee
ERC	European Research Council
EU	European Union
FDA	Food and Drug Administration
FP	Framework Programme
FFG	Austrian Research Promotion Agency
Formas	Swedish Research Council für Sustainable Development
FWF	Austrian Science Fund
GBP	British Pound (1 € = 0.86 GBP, 1 Mar 2019)
GERD	Gross Domestic Expenditure on Research and Development
GUF	General University Funds
HE / HEI	Higher Education / Higher Education Institution
HERD	Higher Education Expenditures for Research and Development
HFSP	Human Frontier Science Programme
ICREA	Catalan Institution for Research and Advanced Studies
MRC	Medical Research Council
NIH	National Institutes of Health
NOK	Norwegian Crown (1 € = 9.74 NOK, 27 Feb 2019)
NSERC	National Science and Engineering Council of Canada
NSF	National Science Foundation
NUTEK	Swedish National Board for Industrial and Technical Development
NWO	Netherlands Organisation for Scientific Research
OECD	Organisation for Economic Co-operation and Development
PA	Performance Agreement
PRFS	Performance-Based Research Funding System
PRO	Public Research Organisation
RAE	Research Assessment Exercise
RCN	The Research Council of Norway
REF	Research Evaluation Framework
RFC	Research Funding Council
SEK	Swedish Crown (1 € = 10.56 DKK, 27 Feb 2019)
SHOK	Strategic Center for Science, Technology and Innovation
SRA	Strategic Research Areas (a.k.a. SFO)
SSF	Swedish Foundation for Strategic Research
STS	Science and Technology Studies
STU	Swedish Board for Technical Development
TFR	Technical Research Council
TPF	Third Party Funding
USD	U.S. Dollar (1 € = 1,13 USD, 27 Feb 2019)
Vinnova	The Swedish Governmental Agency for Innovation Systems
VR	Swedish Research Council
VTR	Valutazione Triennale delle Ricerca
WIFO	Austrian Institute for Economic Research