An Emerging 'Arms Race' -
Resourcing the Public Communication Effort of Research Units

Bauer MW. & M. Entradas

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Abstract

In this chapter, we observe the roll-out of public communication of research institutes in the light of the medialisation hypothesis, for which we specify the arms race model (ARPC, arms race for public communication). We do this by examining relationships between the allocation of resources to public communication and the level of competition between university and between research institutes. Using data on resources allocated and indicators of competition, we examine whether the statistical findings are consistent with an arms race in public communication. We are comparing data from eight countries (Brazil, US, Japan, United Kingdom, Netherlands, Portugal, Italy, and Germany; from N=2,030 research institutes) across six areas of research (Natural Sciences, Engineering & Technology, Medicine and Health Sciences, Agriculture, Social Sciences, and Humanities). The results suggest that there is an arms race for public communication, in some fields and countries more so than in others. We end with some speculation about a dawning era of 'Baroque' science communication' in consequenes of this competition.

Competition for attention seeking and the communication function of universities

In many advanced and advancing countries the system of higher education and research-based universities has been expanding massively over the past half of a century, and this expansion has put a spotlight onto performance for purposes of accountability and reputation ranking. Some observers argue that higher education in many countries is now reaching a turning point of uncertainty for the future, after one hundred years of predicted expansion towards ever bigger and better, and ever larger participation rates among the national youth (Mandler, 2020).

Universities and other research institutions internalise this changing context in the form of public-private management [NPM] ideas, moving in the direction of running the university as if it were a utility corporation providing a service, e.g. energy or public transport, for profit, and being supervised by a regulator who maintains a market to avoid monopolistic profiteering. In this changing ecosystem,

the communication function of universities has acquired a visible and central role. In part as an effect of NPM reforms to make public organisations more business-like' with a focus on 'consumers' (e.g. Hemsley-Brown et al., 2006), communications structures are expanding and professionalised. This is visible in the proliferation of PR/communications offices and officers responsible for managing relationships between the university and society (e.g. Krücken and Meier, 2006).

National and international audit systems evaluate the performance of higher education in terms of research output and quality, in terms of teaching, and in terms of impact on economy and society. These rankings, based on a multitude of indicators, are rendering the relative positions of institutions widely visible and create a game of competition for reputation. Higher education institutions respond to this reputation challenge with the expansion of communication at the central level, at the level of research institutes where the action is (Entradas et al., 2020), and also at the level of individual scientists (Jensen and Bauer, 2011, Entradas and Bauer, 2019) who cultivate their personal profile. This expansion of the communication function is our present concern.

Two other trends are linked and parallel this proficiency of communication. Science news and science reportage have equally seen massive expansion in the public spheres of most countries. People are able to read, listen and watch to ever more science news and science programmes in diverse formats, though this might have hit a ceiling by the mid-2000s; the Covid19 years of 2020/21 most likely being above this stabilising trend (Pansegrau & Bauer, 2019).

The mass media system is rattled on the back of new social media and internet platforms. Into the 21st century, traditional media based on large scale, capital intensive central printing, radio and TV broadcasting operations, are increasingly replaced by social media platforms with global reach, that distribute information de-centrally produced on a different business model. The entry costs to media attention are very low, the costs of circulation is close to zero, and any costly gate keeping and quality control is lost or delegated to censuring systems post-hoc [i.e. AI systems which automatically recognise and edit out 'undesirable content' however defined]. This broadens the access to mass media for many more actors, and confuses the key function of a public sphere: to create a joint focus of attention out of which agenda setting and joint-intentionality for society can emerge. Thus global social media interfere with local public spheres by creating polarisation and by encouraging the celebratory expression of segmented tribal mentalities and group thinking.

Some implications of these trends also for science communication are condensed into the medialisation hypothesis. The **medialisation hypothesis** (Peters 2012; Weingart, 2012) expects a **rising presence of science in the mass media** on the one hand leading to increased public attention, and an **over-adaptation on the side of scientists and scientific institutions** to the logic of attention

seeking on the other. This requires the recognition of news values in addition to truth value that feed this rising appetite for public attention, which creates new dilemmas and tests for unintended consequences of good intentions: more science news is a good idea because it demonstrates the relevance of science to wider society; on the other hand, this search for more attention is risky for science: it changes the way science operates. Science communication does not only communicates the risks of anthropogenic climate change, genetic engineering, artificial intelligence or nuclear power; it is itself a risky activity.

Empirical research with a focus on science medialisation at universities shows an intensification of this orientation towards attention seeking in the increase of media contacts (e.g. Koso, 2021; Vogler & Schäfer, 2020), and increased use of online means (Metag & Schäfer, 2019; Fähnrich et al., 2020). However, the impacts of this growing activity in science communication is less understood. One question that remains unanswered is whether there has been a reorientation of resources from an orientation on truth values towards public attention seeking.

Several emerging trends point to such a potential pay-back risk for the conduct of science: Firstly, as hyperbole, or simply hype, becomes part of normal science operations it loses its stigma of 'sensationalism' and defines common science rhetoric. The re-orientation on news values, in addition to truth values, selects scientific careers also on public visibility rather than research reputation. We understand 'visbility-publicity-popularity' as the prestige hierarchy of the public sphere; 'reputation' as the prestige hierarchy of the scientific community of peers. Secondly, when researchers decide what to study next, they might increasingly be lured towards 'systems' that afford attractive visuals because these will attract public attention; hence butterflies rather than nematodes. Thirdly, the craving for public attention can create incentives for cutting corners and dubious research conduct including fraud. Finally, more focus on attention seeking does not come cost-free, it will shift limited resources from ground research towards communication efforts, from the primary task of research to the secondary supporting act of public communication. Note, we consider peer communication part of the primary task, the securing of truth values. It is the case that public communication enhances peer communication under conditions of extreme specialisation as demonstrated by Phillips et al. (1991) in the case of medicine, which makes the unambiguous separation between primary and secondary tasks of research more difficult. The primary task is increasingly unviable without the secondary task.

In this chapter, we will examine the latter of these trends and assemble evidence for a transfer of resources from research oriented on truth values towards attention seeking. We call it the **Arms Race for Public Communication (ARPC) hypothesis**. With increased competition among research institutes for limited funds, increasing proportions of funds and efforts are re-allocated from the

primary task of research to the secondary task of celebrating this research. The arms race metaphor suggests that this competition creates niches for hypertrophic forms of communication with functional relevance mainly for market signalling (i.e. a kind of new Baroque culture). Because these niches are costly, they could at some point tip over into dysfunctionality. Our international project tries to establish baseline data to see where this trend is at, is moving towards and its tipping point might be.

Noam (1996) predicated radical changes that would happen to higher education universities with the roll-out of networked information technology. The worldwide web and the internet lead to a fundamental redirection of the flow of information. Universities change from a place where information is centrally stored and students and researchers physically flock towards, to a place that seeks out and reaches out to people wherever they are. Research places become hubs in a global network, and they seek to attract people to operate that network via that hub wherever they are. That implies that many more locations can become hubs, seeking attention in competition with many other hubs; independently of whether these are of private or public or mixed legal status.

Real arms races are a historical reality. When military powers get locked into a race, they spend much resources on upgrading their weapons systems which become ever more destructive. To maintain a balance of potential forces, this escalation of procurement absorbs more and more state expenditures until becoming totally militarized and unsustainable.

By analogy, in biology 'arms races' are known by the **Red Queen effect** of increasing efforts only to keep pace with competitors. In Lewis Carroll's 'Through the Looking Glass', Alice complains that running in the looking-glass does not take her anywhere; the Queen replies: 'here, you see, it take all the running you can do, to keep in the same place'. Efforts increases without real progress. Another well-known example is the **Peacock effect:** developing such elaborate and beautiful feathers to impress potential mates has costs; the peacock no longer flies. The secondary functions of feathers [attention of mates] dislodges entirely the primary one [flying]. This analogy is cited by Kucharski (2020) in analysing the race for 'viral messaging' of seeking attention on social media [p175]. The viral analogy only means 'spreading fast and widely'. Any criteria for successful versus unsuccessful content features are constantly invalidated as the user interests are shifting. On any topic, machine learning will show that being more dramatic, more evocative and more surprising than anybody else requires **ever more extreme contents**, i.e. arming up for attention seeking (forget truth value, who cares?). This race shifts any focus from content creation to attention management. For this, the tricks of the trade [p176ff] are several and known as: **broadcasting** [one influencer serves many readers], **user-to-user** [many read and recommend; high reproduction rates], start with **big initial seeding** [many start-ups], honing in by **peeking method** [monitor roll-out and respond quickly], and **increase exposure through infinite scrolling** [automatic page turning, video-music continuity]. These tactics

make us, on social media, messaging ever faster, ever broader, and ever more extreme, while our concern for truth value suffers from irrelevance.

Medialisation as ARPC hypothesis

The medialisation of science has two elements: science has ever more news space available, but this deflects scientific activity from the logic of research to that of managing public attention. This over-adaptation is consequential..

We are further specifying this hypothesis with a potential for an 'arms race' for communication between institutions that conduct research: public communication [PC] needs to be intensified and professionalised without gaining any visible advantages, just to remain in the game [the potential Red Queen effect]; public engagement creates new rituals of communicationwith unclear functionality for research [the potential Peacock effect].

Box 1: a case study of academic arms race

An example of such an arms race is the annual ranking of German speaking Economists, which the Swiss Neue Zuricher Zeitung [NZZ] is organising as the 'economist impact ranking'. For several years, the newspaper publishes an annual list of economists and their affiliations audited on three weighted criteria: scientific citations (2x), media references (in previous year; 1x) and policy influence (i.e. being mentioned by parliamentarians; 1x). To enter into competition, a name must have at least five citations for the past five years; comparing across years allows to show whether entries have moved up or down, or are treading water (NZZ, 2018). To reveal the arms race, we will have to observe how the criteria audited for this ranking are accelerating on increasing thresholds to reach the same rank position. This will take a few years; it might be too early to tell, but worthwhile to keep eye on it.

What might be a benchmark for the resourcing of science communication? We might compare the resourcing of communication across to other sectors. In the pharma industry the ratio of drug R&D to drug marketing is reported to be 4 units of production on 6 units of advertising [40:60]; these figures are often highly controversial because what activities count as 'marketing' is contested (Matheson, 2008; Norris et al., 2005). In the film industry, the ratio is even more skewed towards the communication side and away from production; figures mentioned are 90:10. For every Hollywood

blockbusters, $1 dollar spent on making the movie, sees $9 for getting it into cinemas and into the daily conversation, whatever this involves.[i]

Formally, an arms race model as proposed here has five elements to consider (Dawkins & Krebs, 1979):

1. [Competition] - A competes with B, either within or between types (e.g. economists compete among themselves; but economics might compete with other social sciences across types); institutes compete with others within the university, and with others outside their host institution.
2. [Primary and secondary tasks] - This competition entails the primary task of behaving and the secondary task of support for behaving in particular manner (e.g. running and running faster); the latter requires ever larger resources; for out purposes we identify as 'research' as the primary task, and 'public communication about that research' as the secondary task.
3. [Attention seeking] - The secondary task is often evaluated on different criteria, e.g. beauty, attention or threat alarm; 'exaptation' is the name for a hypertrophic trait that shifts its function (e.g. 'walking faster' in the Red Queen effect and 'colourful, large feathers' in the Peacock effect). A bird's feathers primarily regulate temperature and allow for locomotion by flying. However, the peacocks feathers became co-opted by the mating game, they become long, heavy and beautiful, to the effect that the bird is unable to fly. In the same fashion, science communication expands beyond peer conversations, broadens its formats and takes on a different function: attention seeking.
4. [Professionalisation] - Novel structures emerge which support this secondary task; the exaptation creates related features that sustain the secondary tasks. Science communication, once the hobby of scientists, is increasingly a professional and specialised activity with an independent career structure. The wider public co-opts the communication efforts of research that affords a logic of attention seeking above and beyond truth values.
5. [Limitation] - The communication system is potentially growing to a point of exhaustion, when in an extreme scenario, there is only communication activity and very little research left. Therefore, there must be a 'natural' limit for the secondary task in order not to overwhelm the primary task. However, this limit is difficult to determine because the point of inflection might depend on context. But the intuition remains: more is not necessarily better.

Three hypothesis derived from ARPC

From the arms race for public communication, our ARPC model, we derive three initial hypotheses which we want to put to the empirical test.

H1: There is variation in institutes' resource allocation to communication across countries

For there to be a competition, there has to be some trait variation. We will compare research institutes across several countries with regards to communication activities. For this, we use several indicators of resources they absorb. We have asked institutes in eight countries (1) whether they employ communications staff, either full-time or part-time *(decentral staff),* (2) whether they have access to communication support at central level *(central staff)*, and (3) whether they maintain their own list of media contacts *(media contacts).* We also derive three indicators of resourcing of communication from the percentage of annual budget that goes on communications: (1) current funding for communications *(declared funding:* M=0.031, 0 < X < 0.13, n=1610*)* and (2) expected funding in the future *(expected funding:* M=0.051, 0 < X < 0.13, n=1614); and on the basis of staffing levels we calculate (3) communications resourcing in percentage of the institute's annual budget, considering salary levels in different countries. This yields our own estimates of resources *(actual funding:* weighted for salaries PPP: M=0.026, 0 < X < 0.84; n=1487). *Declared funding* and *expected funding* are estimates provided by the units themselves in percentage of annual budgets, i.e. actor 'subjective' estimates. *Actual funding* is calculated based on staffing numbers, i.e. observer 'objective' estimates, in percentage of annual budgets. All data are from the MORE 2018 database of research units (see Entradas et al., 2020; also see part3 of this volume). We are considering eight countries in our comparison: Brazil, USA, Japan, UK, NL, PT, IT, and DE; research institutes are representative of six OECD disciplines which are Natural Sciences, Engineering & Technology, Medicine and Health Sciences, Agriculture, Social Sciences, and Humanities (N=2,030).

H2: Resourcing the communication lines up with level of competition

In a second step we align the trait variation across research units with context information on level of competition. For this we need indicators of competitive strive, of either national or international, or within research disciplines, between research units. We are using two aggregate indicators of competition: (a) for national competition we measure the density of research population, i.e. the number of full-time researchers in higher education per country. The more researchers who work in higher education in a country, the larger is the competition for national funding sources. We call this indicator *Researchers in HE,* and it refers to the total number of full time researchers employed in higher education institutions in a country and in a discipline (OECD, UNESCO sources; scores 1137 < x < 65469). And for the international game, we consider b) the list of universities that are ranked on 2020 QS World University Ranking, and we count the number of universities listed for each country within the first 200 or 500 (https://www.topuniversities.com/qs-world-university-rankings). We call this indicator *international ranking*. The eight countries in our study receive scores 5 < x < 87.

We are testing a monotonous relationship: the higher the competition (between countries or among disciplines), the more resources are going on average into communications (in our units). We expect a consistent pattern of increasing resourcing of communication activities across levels of competitions, for different indicators, and across different disciplines.

H3: Communications staff is aware of the competitiveness among units

Finally, we ask whether communications staff in research units are aware of this competition, and whether they consider engaging this competition to be part of their task description. Conscious engagement in competition is an additional factor in this escalating cycle.

For this, we consider the question '*what are your rationales for doing PC'*; from a list of eight rationales, informants pick the two most important ones (see chapter 16 of this volume). We created an index by counting mentions, after having classified responses into either civic 'public engagement' *PE Rationales* (i.e. responding to policy, disseminate research, listen to publics), or the more corporate 'public relations' *PR Rationales* (i.e. raising profile, attracting funding, attracting support, recruiting students). 48% of institutes mention PE rationales, and 52% mention PR rationales for their activities. By relating one to the other, we create a ratio score of PE rationales over PR rational (PR/PE = 1 means 'balanced'; < 1 means 'PE dominates'; > 1 means 'PR dominates').

Evidence of alignment of communication effort and level of competition

H1: There is variation in institutes' resource allocation to communication across countries

We can clearly identify variation in average resource allocation per research units across eight countries as shown in figure panel 1. Staffing levels vary: 32% of research units in Germany report employing specialist PC staff in their units; 40% of units report part-time PE staff, some of them in addition to full-time. Overall with 50% of units with PC competences, Germany and Portugal are the countries with most PC staffing; at the other end is Japan with 10% of units with full-time PE staff. All in all about 50% of all units in Germany and PT report access of own PE staff, while 26% of UK units have the same. Many universities also offer support for communication at the central level; this is reported by most units in the UK, Netherlands and Italy, all with above 60% of units accessing central support. This is less the case in Portugal. Not all research units are equally media savvy to the extent that they keep their own media contact lists. We find that 44% of Portuguese units report such lists, but only 20% of UK and Japanese units keep them.

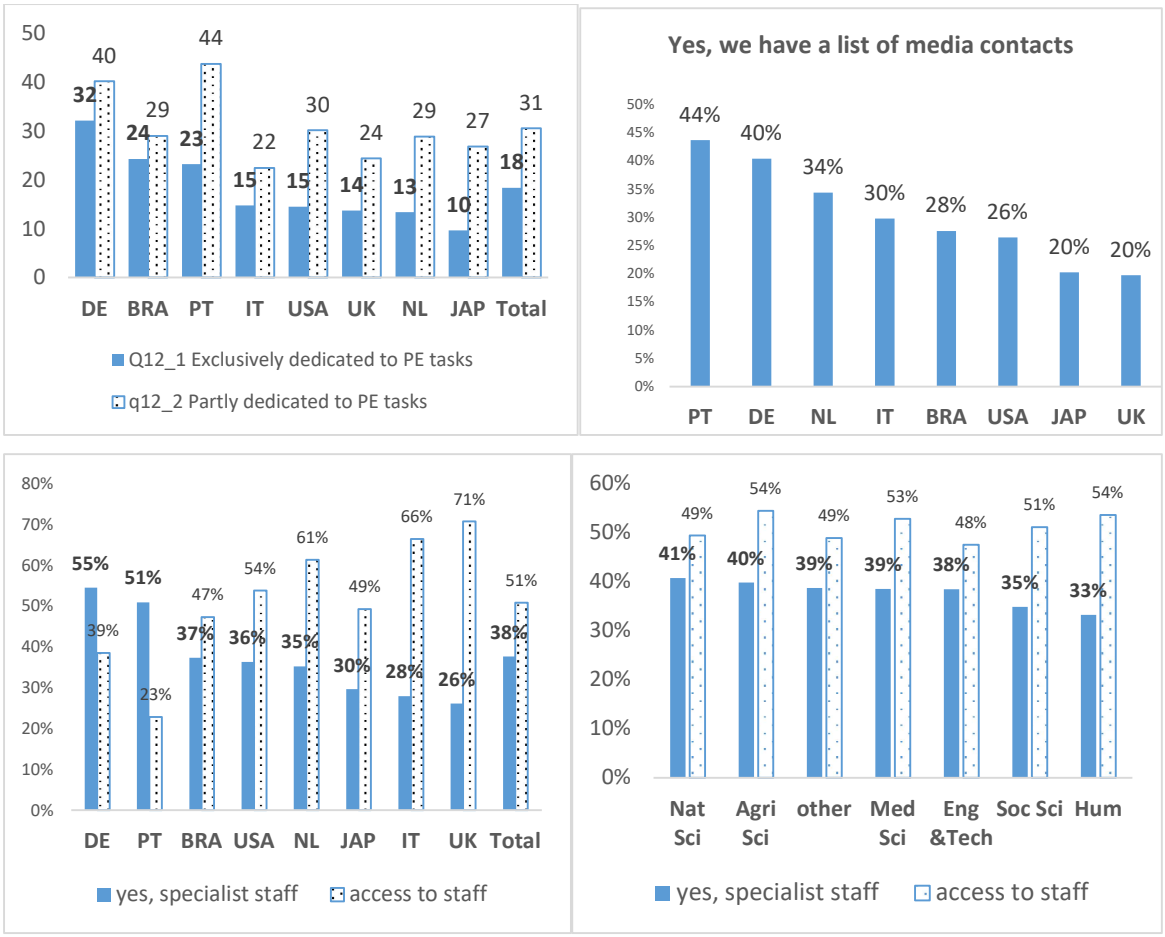


Figure 1: shows the % of research units that a) report their own full-time or part-time communication staff, b) maintain a media contacts list locally, and c) employ decentral specialist staff or have access to specialists at the central level, and for different countries and disciplines.

Staffing is among other things a cost factor. We estimate how much of the annual research budgets go into communications staffing at each unit, as shown in Figure 1. Our estimates show that this 'declared funding' varies between 2-5% on average, be that across nations or across disciplines. We also observe that most units expect this commitment to rise in the next years. *Expected funding* is generally higher and varies between 4-7%. The social sciences and humanities invest more on communication than the others. Across countries we find a clear ordering of average expenditure; however, there is some discrepancy between declared-subjective and actual-objective estimates of that commitment (see Figure 2).

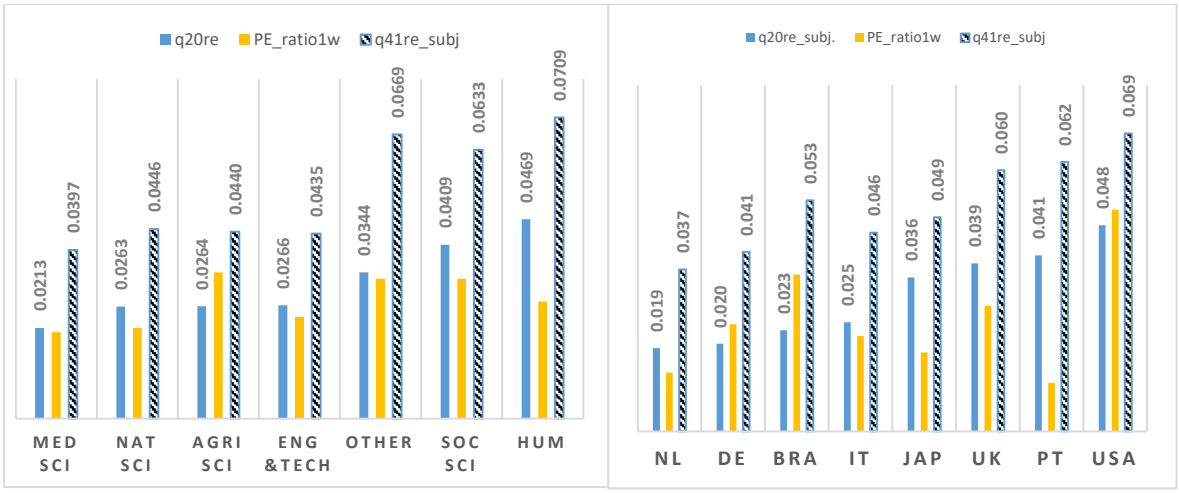


Figure 2: shows three estimates of annual resources allocated to PC activities in % of annual unit budget. Declared funding is the subjective estimates of current expenditure; actual funding is a calculation of PC expenditure including staff salaries in comparable currency; and expected funding is a subjective estimate of future communication expenditure.

The richer a unit is in terms of annual overall budget, the smaller is their declared 'subjective' commitment to public communication. However, if we consider the 'objective' actual funding, the relationship is direct: the richer a the unit, the larger is their PC expenditure. It thus would appear that richer units tend to underestimate their PC effort, while poorer ones overestimate it.

H2: Resourcing the communication lines up with level of competition

Secondly, having examined the variation in PC commitment across countries and disciplines, we ask the second question: how this variation is lining up, if we consider indicators of competition – both national and international? We do this in three steps: (i) first we compare different indicators of resource allocation and different indicators of competition, (ii) then we compare resource allocation for different disciplines again competition, and (iii) finally, we summarize these relationships which gives a clearer notion of a potential arms race over public communication among research institutes.

i) Resource allocation and competition. The results for three different indicators are shown in Figure 3. We are lining up actual, declared and future funding with the density of the researcher population and with the number of universities in the top-500 list (both on log scales). Curve fitting shows that, for all countries, all relationships are linear with correlations between r=0.90 [R-square = 0.81] and r=0.56 [R-square = 0.31]. This means, the stiffer the competition between research institutes, the

larger the percentage of PE expenditure. This alignment is strongest on both indicators of competition when we consider the actual funding of the communication effort.

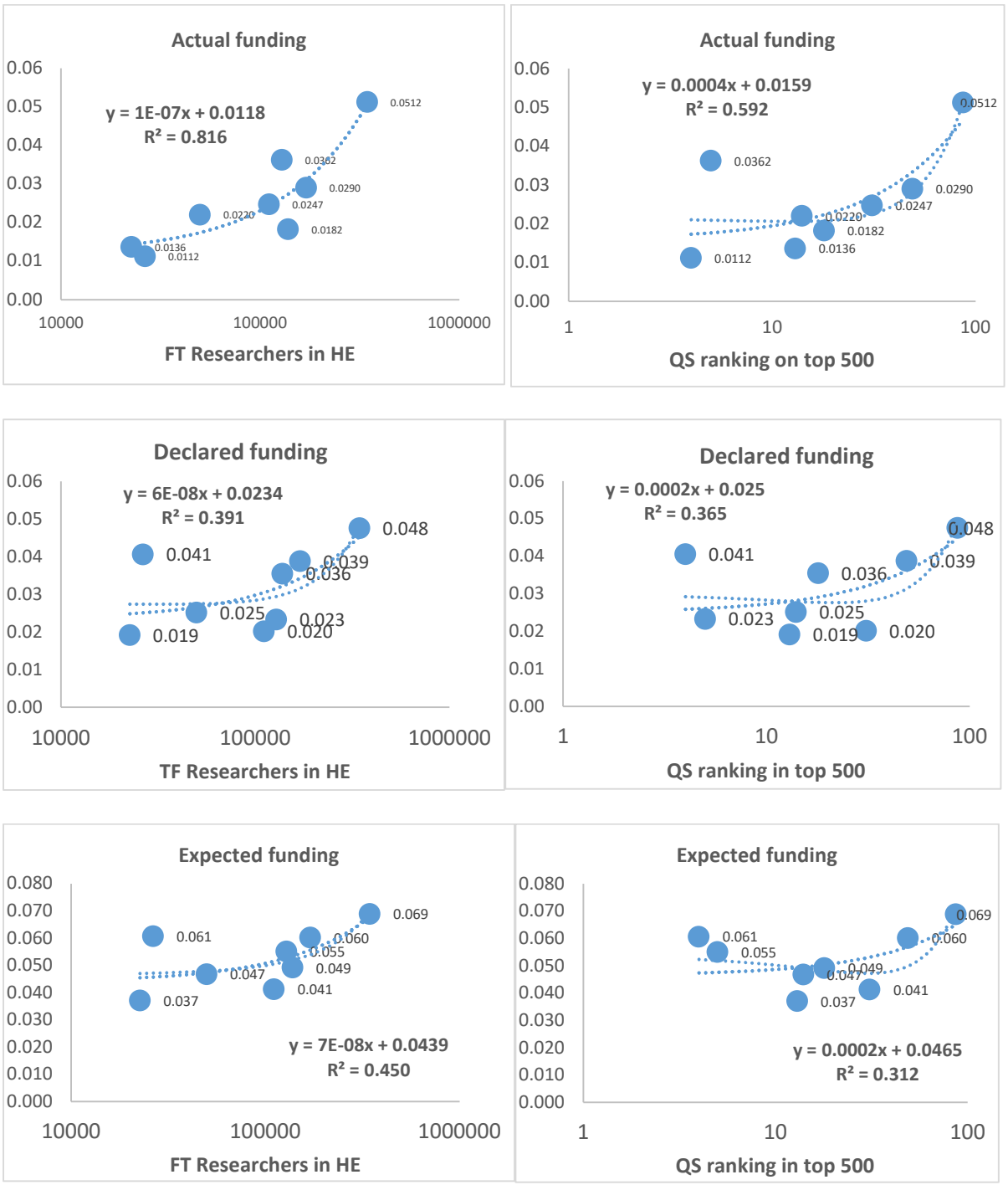


Figure 3: the graphics show the correlation our three resource indicators (declared, future and actual funding) with two competition indicators for different countries: a) on the left, FT researchers in HE stands for the national population density chasing grants, and b) on the right, QS ranking stands for international competition. The dots represent the different countries.

ii) *Effects of competition on resource allocation in different disciplines.*

If we consider the effect of competition on the different OECD disciplines, we find that these are not equally affected by this intensifying pressure. We are using international competition - number of universities in top 500 - as the predictors and the 'declared' communications funding estimates as criterion. The linear curve fit is best for Engineering (r= 0.91), and the Natural Sciences (r=0.70), less for the others, and least for the Social Sciences (r=0.26) and Agriculture (r=0.23). Overall, the direction of fit is consistently linear: the stronger the international competition among universities, the larger is the declared PC expenditures; this trend is in evidence across all disciplines, but less so for social science and for agricultural research institutes.

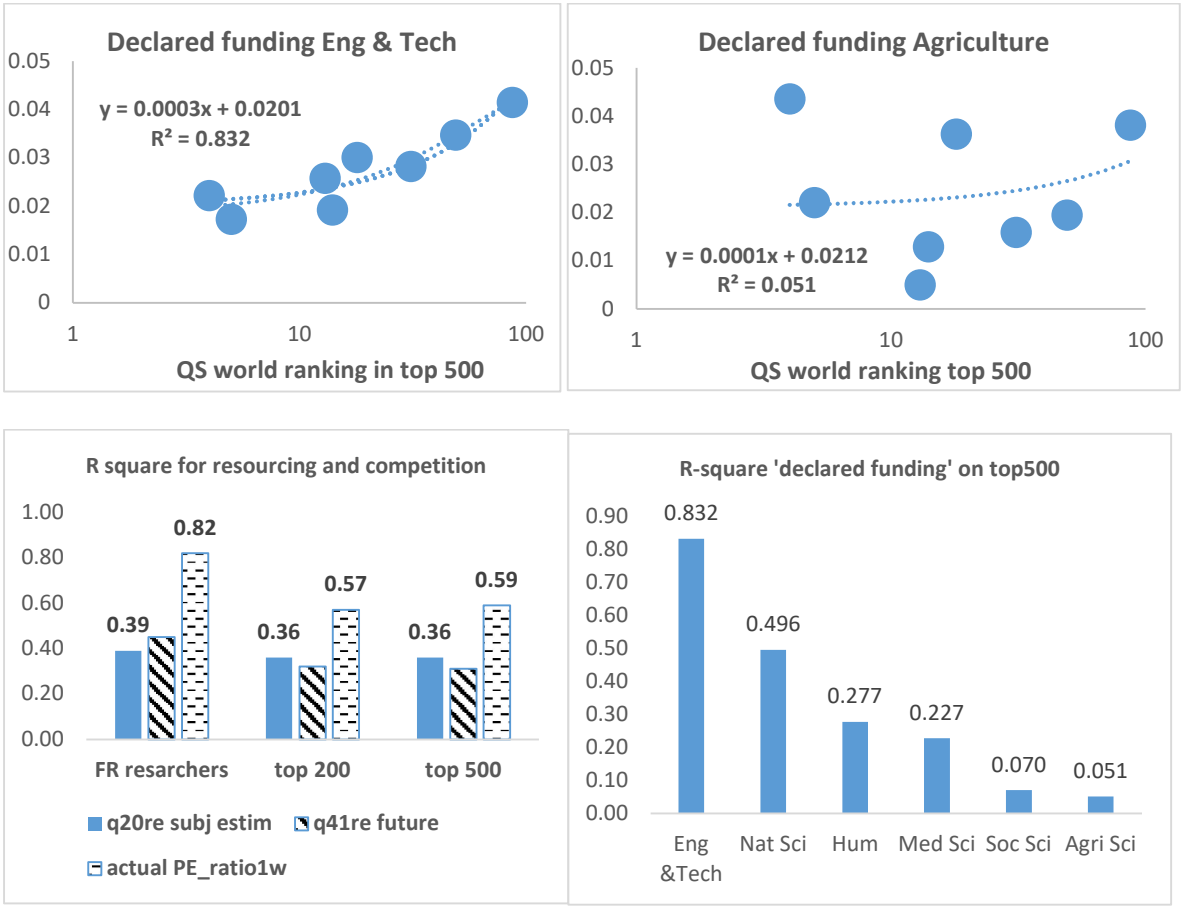


Figure 4: the top two graphics show the line-up of resources across countries for the disciplines at the extremes of the scale: the correlation between declared expenditure for 'engineering' and 'agriculture'. The bottom graphs provides a summary overview of these alignments. We considered three indicators of resourcing (actual, declared and future). Their alignment is strongest with density of the research population across the eight countries. The alignment is less strong when competition is indicated by university rankings. For the actual expenditure this alignment is strongest across all competition indicators.

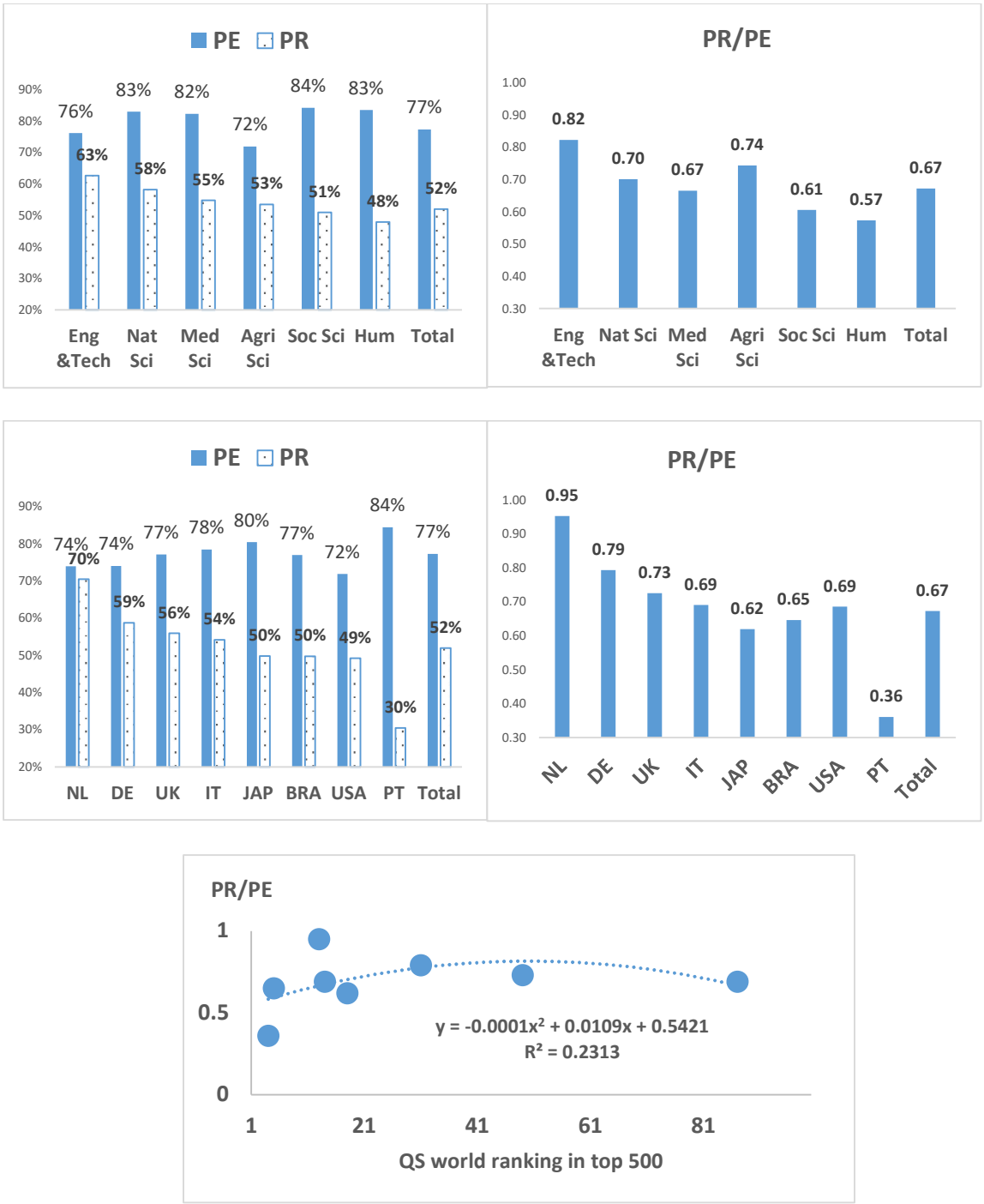
Across disciplines the alignment - best fitting with 'declared funding' - of communication effort and level of competition varies considerably. The curve fit best for Engineering with 83% variance explained, to lesser extent for Agricultural Sciences with only 5%. Let us also recall the above observation: expenditure for communication is overestimated among poorer units and underestimated among richer institutes.

H3: Communications staff is aware of the competitiveness among research institutes

Thirdly, we consider the awareness of competition. We did not directly ask officers/managers of research institutes whether they were in a competitive arms race. For this purpose, we need indirect evidence of entanglement. We asked to identify the two most important rationales for engaging in public communication, which we grouped as PE Rationales and PR rationales, and from which we defined the PR/PE ratio index, for each country and each discipline.

Overall, 77% of research units report PE motives, and 52% also report PR motives as most important. This suggests a PR/PE ratio of 0,62, meaning that in 2018 PE motives remain more important than PR motives. In terms of avowed motives, competitiveness remains in the background and not fore ground of communication managers' rationales.

Figure 5 below point to these rationales in aggregate across countries and disciplines. There is little variation for PE motives, but more variation for espoused PR motives. 74% of Dutch research institutes report PE rationales and 70% report PR rationales; the Dutch PR/PE index is therefore the highest at 0.95; PE and PR motives are more balanced, but PE still trumps PR. The countries order on a sliding scale, with Portugal being the leader in PE motives (84%), and a bare 30% PR motives; the PT competitiveness index is therefore the lowest with 0.36. A similarly sliding scale we find for disciplines: awareness of competitiveness is higher among the Engineers, and lower among the Social Sciences and Humanities (index 82 vs. 61 or 57), the other disciplines are mid-range. It seem that for these two contexts, country and disciplines, PE remains dominant and PR does not trump PE rationales.



Figures 5: The awareness of competition in research units expressed by the rationale for communication (PR rationales (funding, support, attention, recruitment) in relation to PE rationales (policy compliance, dissemination, involvement). The PR/PE index indicates the balance between these two: R > 1 means 'PR dominates'; R < 1 means 'PE dominates' the communication activities of units. Note, percentages add to more than 100% because of multiple mentioning.

Looking at a possible alignment between actual competition and perceived competitiveness across countries, we find a potentially non-linear relation: the fitted curve is slightly inverted u-shaped (R-square = 0.23). This suggests that countries at the lower end of international competition are also less aware of this competitive context and remain focused on the PE efforts, the same seems true of countries at the higher end of competition. It seem that the middle ground shows a more acute sense of competitiveness between 'blessed ignorance' on the one hand and 'smug oblivion' on the other. This could be another hypothesis that deserves further examination.

A potential arms race for public communication of science

In this chapter, we provided evidence of an arms race; the data is indeed consistent with such the hypothetical prediction. Research institutes are entangled in national and international competition for public reputation, and this affords increasing re-allocation of funding for public communication activities. This trend is demonstrated cross-sectionally in the linear alignment of average resources and levels of competition, across countries and across six different scientific disciplines. This alignment is strongest for Engineering and the Natural Sciences, and less so for the Social Sciences or Agriculture.

We demonstrate this alignment for different indicators of 'expenditure': actual, declared and future funding of public communication efforts. Future expenditure is expected to increase for all contexts, which indicates further expansion is likely in the coming years. We also observed, when comparing declared and actual expenditure, that smaller research units overestimate and larger units underestimate their actual communication commitments.

Finally, we observe that communication staff is aware of this competitive context. But the logic of public engagement [PE] still dominates over that of public relation [PR], when we consider the espoused rationales for public communication.

Our data lines up different research institutes in cross-sectional comparison and provides compelling benchmark data for the alignment of public communication and competition. However, this is does not yet suffice to make the full case for the ARPC hypothesis. For that we will need longitudinal data to verify, in each unit, the escalation of PC expenditure in the coming years, and this escalation needs to be aligned with level of competition. Observation of this arms race should also distinguish more carefully between different races: e.g. between central and decentral communication within the university, between research units in any one country, and between research institutes and universities in the global market place for ideas, impact and staff. What is the relative contribution of any of these

types of competition to the expanding secondary task, the professional field of public communication of science?

An arms race for public communication will create parties who are interested in maintaining, expanding and supporting this secondary task, which is consistent with developing a professionalism that is full of good intentions to do a 'better job'. The boom in science communication in recent years, as observed by the 'medialisation hypothesis', is already consistent with this professionalization of the field. An increased focus on attention seeking away from truth orientation, which is often deplored in polemics about 'declining quality' of science communication or increasing mis- and disinformation about science, is a likely consequence of this development.

Our present diagnosis of an arms race thus specifies another risk to be included in the medialisation hypothesis: the reallocation of resources to 'non-essential' activities potentially 'starves' the core activity of research, leading to a Red Queen effect of intensifying efforts without progress; and in extremis, ending in a Peacock Effect, offering marvellous public communication but little substance of research. Let us end with a wild speculation in order to further elaborate such potential trends.

A concluding speculation: the dawning 'Baroque of science communication'

A brief glance into the history art might allow us to appreciate what is happening with slightly different eyes and ears. A more positive note on the arms race arises from an historical analogy with an earlier arms race which created the 'Baroque style' of artistic expression. In other words, good things might arise from an arms race in communicating for 'better science', in the same way as the Baroque style emerged from the competition over the 'true religion' in the 17th century.

For modernist, ornament is a crime

The history of art recognises the 'Modernist Movement' at the turn of the 19th into the 20th century – with Vienna as one of its centres - for which 'ornamental art' is a 'crime against humanity', because it wastes effort and strains limited human resources and thus endangers health. This stripped-down aesthetics is morally loaded with the cultivation of the ascetic virtues of simplicity, precision and clarity, leading to the avoidance or an outright ban of everything unnecessary or unessential, i.e. all ornamentation or embellishment of artefacts. This moral norm eschews the tastes of the wider public as Barbarity and proceeds unashamedly on the elitist path: only the selected few can fully achieve and appreciates this ascetic art form. This attitude was consequential for music [12-tone music], literature [Ulysses], design [art nouveau] and philosophy [Neo-Positivism], culminating in polemics against ornament and the misuse of language in 'nonsensical metaphysics' (Pfafigan, 1985), and contempt for

the masses (Sammut & Bauer, 202; Sloterdijk, 2000). We can recognise a similar attitude also among scientists or scientific institutions for whom any public communication of science is a step too far into the barbarism of the masses; though this attitude has become rare and less pronounced over the past 30 years.

An opposite attitude to art is the earlier Baroque lifestyle which exalted ornamentations in an expansive festival of celebrations. Until the early 20th century, 'baroque' was a term of insult; its meaning pejorative and referring to artistic work that was supposed to be confused, weird, unnatural, dissonant, forced, unnecessarily difficult, grotesque, corrupt, and overloaded with pomp and splendour, and only an inferior manifestation of art. Only, the 20th century brought the re-appreciation of Baroque as a style sui generis that combines general artistic features in a recurrent manner which we must appreciate as a 'way of being and seeing' rather than as an aberration of taste from an arbitrary standard (Woelfflin, 1915). In this new light, 'baroque' came to be defined by recurrent features, which we can even recognise in 20th century Jazz, such as the baseline over a progression of cords [basso continuo], the big band [concerto grosso], and above all the cultivation of free improvisation over a given theme and a base line [basso continuo], and the Musical genre such as 'West Side Story' or 'Hair' as a large theatrical event involving music and acting [opera].

Recognising the creative achievement of Baroque ornamental art.

The origin of Baroque is commonly dated in the period of 1600 to 1750. This is also the period of competition between the religious 'Reform' and 'Counter-Reform' in Europe and on the Global Stage for maritime expansion (Vaubel, 2005). In this context, artefacts were designed that exalted multi-sensory experiences involving large-scale visual, sound and movement events. It extended to architecture, painting, sculpture, literature and music, and brought about new formats, including large installations [e.g. large paintings, churches, opera, and concerto]. Many new developments emerged for example in music: the combination of polyphony with harmony [counter-point, basso continuo], a rhetoric of codified thematic expressions [the Suite], and a catalogue of ornamentations. This historical arms race pitched musical composers of the Catholic European South like Monteverdi and Vivaldi against the Reformed North of Bach, Schuetz or Buxtehude.

Baroque ecstatic exuberance cultivated creative communication of seemingly exaggerated and functionless manifestations [similar to biological exaptation as in the Peacock's feathers]; it brought flourishing artistic creativity to places where there was hitherto little [e.g. New World Baroque]; created a new tonal order, the well-tempered system of 12 minor and major scales, which is considered an early example of cultural rationalization. Some recurrent features of Baroque chime with current concerns of science and science communication. One could start with Law's (2011) recognitions of baroque features in the 'performative turn' of science. He calls for science studies to

recover the 'rationality in flesh and body' [i.e. embodiment of cognition and emotions] including the features of theatricality, undoing of boundaries, heterogeneity, folding many in one, movement and self-consciousness, and apprehending otherness also in modern science.

In other words, the lesson of the historic Baroque might be the following: the ecstatic exuberance of Baroque expression is a creative achievement arising from a competitive arms race [of religion and theology]. This race brought forth new formats of communication [Baroque art], a way of seeing the world with an aura of celebration and festivity, and all this in the service of a higher power [represented by the Church or the 'absolutist' King]. This is far from misplaced investment and wasteful effort, because 'Baroque' is the innovation. This might find an analogy in performative science and the current flourishment of science communication and its buzzling proliferation of formats and events of different size and shape. Once more, some of this event making might be considered superfluous and wasteful investment by some. However, positive consequences might arise when access to science is broadened by these formats; yet, there are risks along the way.

Baroque concerns about the misuse of creative communication

Even on these risks, there might be a useful analogy in the discussions of Baroque music at the time. Similar to present day discussions about science communication, we find voiced concerns about the misuse of the art and the appeal to authorities to prevent such aberrations.

Three types of misuses were identified in the critical commentary on Baroque music at the time: the overuse of dissonances [against the natural order of proportions], music playing in inappropriate situations [against beer happiness of music; 'devilish noise …..for pleasure rather than edification'], and poor-quality performances (Eggebrecht, 1991, 261ff). For all three, the authorities are called upon to police the performances and to censor improper conduct. Similar appeals can be heard about present-day science communication, when misinformation, poor quality, sensationalism and polarisation, particularly in new media and social media networks, are invoked. We are witnessing at the same time calls for policing these abuses on the basis of what seem arbitrary norms [fact checking, closure of websites]. Maybe also the concern of the 17th century that '*music should praise the greater glory of God'*, echoes in current mantras that *'science must contribute to economic growth'*. However, to expect that censorship and regulation might put this right is most probably as misplaced in the 21st century as it was in the 17th century. More likely, it is the underlying arms race that drives the escalating performances. The final lesson of this analogy might be: If we want to stop the misuse of communication and the proliferation of 'wasteful Baroque science communication', we'd better focus on de-escalating this arms race.

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[i] Personal communication in 2018 with a neighbour of the first author, who works as a film producer in the British film industry.