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Original Article

Competition in Science: Links Between Publication Pressure, Grant Pressure and the Academic Job Market

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In the current discussions concerning the pressure for publication and to obtain grants, the questions about what publication and grant pressure actually involve and how they are linked to the academic job market, are often neglected. In this study, we show that publication and grand pressure are not just external forces but internal ones as scientists apply pressure to themselves in the process of competition. Through two surveys, one of 1,133 recent PhDs at five Dutch universities and one of 225 postdoctoral researchers at two Dutch universities, we found that publication and grant pressure have to be considered in relation with competition for academic jobs. While publication and grant pressure are perceived to be too high by a majority of these early career researchers, the effects of publication and grant pressure by themselves are limited.
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Introduction[1]

Academia is often described as a "hyper-competitive" environment (Fang and Casadevall, 2011; Alberts *et al.*, 2014). In this environment, the pressure to publish scientific articles is high (Miller *et al.*, 2011; van Dalen and Henkens, 2012; Tijdink *et al.*, 2013, 2014). Miller *et al.*'s study (2011) showed that almost all faculty members in management science at research-oriented business schools in the USA experience publication pressure. In a worldwide survey of demography researchers, van Dalen and Henkens (2012) revealed that 50–75% believe publication pressure in their organization to be high, but perceptions differ per country. Tijdink *et al.* (2013) confirm that half of medical professors in the Netherlands believe publication pressure is "excessive." Similarly, 72% of young biomedical scientists in Flanders find publication pressure "too high" (Tijdink *et al.*, 2014).

Parallel to publication pressure, the need for obtaining competitive project-based funding is increasing but success rates have declined since the early 2000s. In the USA, the percentage of successful grant applications to the National Institutes of Health has fallen from around 30% to little over 10% (Alberts *et al.*, 2014). In the Netherlands, success rates of the NWO Innovational Research Incentives Scheme, which is the main research grant scheme in the country, decreased to a similar extent since their introduction (Gerritsen *et al.*, 2013). As early career researchers in the Netherlands are often employed on temporary contracts, their need for obtaining competitive project-based funding is especially great (van der Weijden *et al.*, 2016).

In this study, we analyzed publication pressure and pressure to obtain research grants (grant pressure) in the context of competition in science. We hypothesized that due to the links between competition with respect to publishing, funding and academic jobs, publication and grant pressure are tightly linked to securing positions on the academic labor market. Therefore, our research questions were:

1. How do early career researchers in the Netherlands perceive publication and grant pressure?
2. Which links exist between publication pressure, grant pressure and competition on the academic labor market according to early career researchers?
3. To which extent do publication and grant pressure influence job satisfaction and job choice of early career researchers?

These questions were assessed using a mix of quantitative and qualitative data from two surveys, one among 1,133 PhD graduates, and the other among 225 postdoctoral researchers.

Literature Background

Competition in science

Competition is the contest between two or more individuals or groups for scarce goods. Such goods can be both material, e.g., financial resources, and immaterial, such as recognition or status. Competition for material and immaterial goods also takes place in science (Stephan, 2012, 29–31). For example, one may strive to be the first to discover the genetic mutation underlying a certain disease. Or multiple researchers may attempt to obtain financial resources from a charity, such as the British Heart Foundation. As the BHF's resources are finite, researchers have to compete for these funds. In this paper, we focus on competition in three aspects of the scientific system: publishing, funding and the labor market.

Competition in publishing occurs when scientists strive to be the first to make a new discovery and publish it (Merton, 1957). Or, in the words of Merton, "to claim

priority." Such priority claims yield recognition by peers, which is in itself also a scarce good in science and subject to competition (Merton, 1968).

Competition also occurs in the distribution of financial resources, or funding, among scientists. Over the past decades, the distribution of funding has undergone several changes. An important change in the public funding of research which occurred since the 1970s has been the shift from block funding to project-based funding, also called competitive funding (Lepori *et al.*, 2007).

There is also competition with regard to academic jobs. In most research fields, opportunities in the academic job market are scarce. The academic career system is highly pyramidal in shape, with few positions at the top and many at the bottom (Waaijer, 2015). In addition, more early career researchers aspire to a top position than there are places available (Stephan, 2012, 170). Furthermore, competition for academic jobs has intensified (Teichler *et al.*, 2013). The academic profession has also undergone changes in other aspects, such as an increased one-dimensionality and uniformity in the career development of academics (Ates and Brechelmacher, 2013; Kwiek and Antonowicz, 2015). For each step in the academic career, certain formal output criteria have been formulated, and these criteria are increasingly similar across several countries. At the same time, coincidence plays a major factor in career progress (van Balen, 2010; van Arensbergen *et al.*, 2013), e.g., obtaining external financial means is crucial but acquiring such funding is often based on random factors. The length of time during which junior academics are employed on temporary contracts, is increasing as well (Goastellec *et al.*, 2013).

The three types of competition are mutually connected. In his work, Merton (e.g., 1957, 1968) shows how intricately linked competition between material and immaterial goods in science are. Generally, in order to obtain competitive funding for research, a publication record with a large number of publications, in prestigious journals, is necessary (van Arensbergen *et al.*, 2014). The connection also goes into the other direction, as funding for research may lead to more publications.

In the scarce academic job market, the recognition obtained by publishing academic work and securing funding is crucial in obtaining a (permanent) job. For example, the more publications as first or last authors Argentinean life scientists have, the greater the chance of tenure (Jonkers, 2011). Spanish scientists who published before they obtained their PhD have a shorter time to tenure than scientists who did not (Sanz-Menéndez *et al.*, 2013) and German sociologists increase their chance of tenure by 10–15% with every peer-reviewed journal article or monograph (Lutter and Schröder, 2014).

The competition for research funding is linked to the competition for jobs through the fact that securing funding creates jobs for researchers. In addition, it can yield recognition for a researcher: securing a research grant can function as a "stamp of approval" that the research funding agency gives scientists by awarding them a grant (van Arensbergen *et al.*, 2013), thereby increasing their chances on the academic labor market.

External pressures or self-induced forces?

In science, competition can lead to pressure to publish articles and obtain grants. As shown above, publication pressure is not just the result of competition in publishing but also of competition for funding and for academic jobs. In physics, pressure is a "force exerted against an opposing body" (Webster Dictionary). In contrast to this definition from physics, we propose that scientists themselves play a crucial role in reinforcing and extending publication pressure. Scientists are not opposing bodies on which an external force (in this case to publish) is exerted. Rather, scientists themselves are the force that increases publication pressure, like a propulsive force.

In the competitive contest of science, scientists will attempt to surpass their peers. In the competition for publications, this means that they will try to publish more papers than their competitors. In addition, they will try to publish papers of a higher quality than their competitors (or at least publish in journals with a higher impact factor). Scientists will try to publish as many papers and of such high quality as is expected of them, or even exceed the expectations. A key notion is that quality and quantity criteria are applied as *relative* measures. In competition, one does not have to meet a specific goal, but one has to be better than others. Thus, one has to reach the goal one *predicts* will surpass the competitors. According to classical economic theory, this will lead to a spur in efficiency: scientists will produce better output (and/or more of it) for the same input. Indeed, an empirical study on the number of publications per person over the course over the 20th century found that this number has increased tremendously in all fields except the arts and humanities (Fanelli and Larivière, 2016). This implies that the publication bar that has to be reached to gain recognition, but also to obtain funding, has been set higher over time. This level of publications needed is thus subject to a propulsive force induced by scientists themselves, a notion also hinted at by Abma (2013, 34, 111–123) but not made explicit.

We propose that the level of required publications is also subject to influences from the academic labor market. If career prospects are good (i.e., a small number of qualified candidates being available for a large number of jobs), the need for publications to showcase academic talent is smaller than in a tighter labor market. We suggest that the pressure on scientists to secure research funding is highly dependent on the competition for academic jobs. In a tight labor market, securing a research grant independently can be the only option for scientists to secure a tenured profession. In addition, competition and expectations play a role. For example, the goal of the Dutch Innovational Research Incentives Scheme (*Vernieuwingsimpuls,* NWO, 2016) is to provide talented, creative researchers to pursue their own line of research. However, as explained earlier, securing a personal research grant from schemes such as these has increasingly become a prerequisite for a career in Dutch academia as it also serves as a quality stamp or threshold. As such, empirical research shows that this funding

scheme does not offer *a* way to do research but, due to the recognition that it provides, becomes *the* way in the competition for academic jobs (van Arensbergen *et al.*, 2013).

Overview of the academic system in the Netherlands

As this study was conducted in the Netherlands, we will also provide a short overview of its university system. The Netherlands has fourteen universities, which have the exclusive right to confer doctorate degrees. Funding of universities is often divided into three types: direct government funding via a lump sum (which must also be used for teaching), indirect government funding through competitive grants and funding from other public and private sources. In the past decades, the share of indirect government and other funding sources has increased, while the share of direct government has decreased (Association of Dutch Universities, 2016). In terms of performance, the Dutch academic landscape is often described as a high plateau with a few peaks (Adviesraad voor Wetenschaps- en Technologiebeleid, 2014). Although far from a perfect measure of quality, this is corroborated by the position of Dutch universities on several university rankings: a large majority of Dutch universities consistently ranks among the top 200, but their performance is quite far behind world-class universities in the USA and the United Kingdom (Association of Dutch Universities, 2017).

As in other countries, competition for academic jobs in the Netherlands has intensified. The number of PhD graduations in the Dutch higher education system has increased in past decades, while opportunities for academic employment have not kept pace with this increase (Waaijer, 2017). The standard upward career trajectory in Dutch academia depends on both the individual merits and the positions available in the science system. Recently, it was estimated that annually 750 assistant professorships are available each year, covering only about 20% of the postdoc population in the Netherlands (de Goede *et al.*, 2013). Full and associate professors and the majority of assistant professors are usually employed on a permanent contract (Association of Dutch Universities, 2015); however, over the last few years, we see that assistant professors are increasingly employed on a temporary contract.

Data and Methods

Survey sample and distribution

The results from this paper are based on two web-based surveys among early career researchers in the Netherlands. Both were designed with a focus on the career experiences of early career researchers – how do they see their career prospects, which factors influence their career choice and how satisfied are they with their

jobs? Both also included questions on other aspects of academic life, two of which were publication and grant pressure. The first is a survey among 1,133 recent PhD graduates, and the second a survey among 225 postdoctoral researchers. Below, we give a summary of the methodology and measured variables of both surveys. More elaborate descriptions of the survey questionnaires, survey methodologies and variables are given in earlier papers (Waaijer *et al.*, 2015 for the PhD survey; van der Weijden *et al.*, 2016 for the postdoc survey).

The PhD survey was sent to 2,193 persons who obtained a PhD from Delft University of Technology, Erasmus University Rotterdam, Utrecht University, or Wageningen University between April 2008 and March 2009, and to persons who obtained a PhD from Leiden University between January 2008 and April 2012. A survey invitation was distributed through email or LinkedIn, and up to three reminders were sent if respondents had not completed the survey. The survey was open from October 23, 2013, until January 21, 2014. Of the 2,193 PhD graduates in the survey sample, 1,133 started the survey (52%) and 960 progressed to the final question (44%). Analyses were performed using the data as were available – we did not require respondents to fill in answers, except for when a response was required for routing. We chose not to require an answer to every question because the survey was quite long, and we preferred respondents to fill in a "don't know" option or not fill in an answer at all and progress to the next question, rather than quit the survey completely. Non-response analysis of the 1,133 respondents showed that regarding gender, age, year of PhD and city of PhD, respondents formed a good representation, but Dutch nationals were overrepresented among the respondents compared to the country of birth of the entire sample (Waaijer *et al.*, 2015).

The postdoctoral survey was sent to 571 postdoctoral researchers (postdocs) from two universities in the Netherlands, one university of technology and a large one with a broad research subject profile. Postdocs were defined as newly qualified researchers with a PhD and/or MD backgrounds who work autonomously in research at universities or related institutions but without a permanent contract. Their names and email addresses were obtained from the Human Resource Departments of the two universities. A total of 225 postdocs completed the questionnaire (39% response rate). We do not have information about the age, discipline, gender or nationality of our non-response group. Gender and nationality data are available on a national level, however. A comparison of the gender of the respondents (40% female) and the gender of the total population of postdocs in the Netherlands (44% female according to de Goede *et al.*, 2013) shows that our sample is quite representative in terms of gender. A comparison of the nationality of the respondents (65% non-Dutch) and the total population (49% non-Dutch according to de Goede *et al.*, 2013) suggests that there is an overrepresentation of non-Dutch nationals compared to Dutch nationals among the respondents.

Variables

In the PhD graduate survey, perception of publication pressure and grant pressure in academia were measured on a five-point Likert scale: "far too low" – "too low" – "about right" – "too high" – "far too high." Respondents were also asked to which extent these pressures in academia made them hesitant to choose a career in academia, also on a five-point scale (ranging from "not at all" to "very much"). The perception of career prospects was determined by asking respondents how they would rate "long-term career perspectives" in academia on a five-point Likert scale ranging from "very bad" to "very good." The survey also contained an open question that asked the respondents to indicate which "long-term career aspects" had been most decisive in choosing their career, which resulted in 754 responses. Answers were coded in an iterative manner, with new code names inserted as additional themes arose. A second individual coded a random 10% sample of filled-in answers with the codebook developed by the first coder to assess inter-observer reliability. Inter-coder agreement was 100% for the mention of pressure due to competition, obtaining grants and publishing, 82% for long-term career prospects and 89% for job (in)security. In addition, we measured sector of employment (academia, non-academic research or outside research). PhDs were classified as working in academia if they performed basic research, applied research and/or experimental development in their main job [following OECD definitions (OECD, 2002, 77–82)] and worked at a university, university of applied sciences or college, academic hospital or research institute. PhDs were classified as working in non-academic research if they performed research and/or development and worked elsewhere. If PhDs were not involved in research or development, they were classified as working outside research.

In the postdoc survey, satisfaction with publication pressure was measured on a seven-point Likert scale ranging from "very dissatisfied" to "very satisfied." Satisfaction with publication pressure was one of nine items that respondents were asked to rate their satisfaction with. Other items included contact with colleagues, employment conditions and career perspectives. Respondents were asked in an open question to further explain their answers. The respondents' elaborations on publication pressure thus often showed how publication pressure is linked with other aspects, resulting in 50 responses. Answers were coded independently by two of the authors. In the case of disagreement, the coding was discussed until agreement was reached.

Results

Perception of publication and grant pressure

First, we assessed the perception of publication and grant pressure in academia by early career researchers. We found that six in ten PhDs described the pressure to

Table 1 Perception of publication and grant pressure in academia among PhD graduates

	Pressure to publish	*Pressure to obtain grants*
	n valid responses (%)	
Far too high	142 (16)	204 (23)
Too high	404 (45)	429 (49)
Neutral	342 (38)	218 (25)
Too low	10 (1)	15 (2)
Far too low	4 (0)	3 (0)

N.B. Percentages may not add up to 100 due to rounding.

publish in academia as "too high" or "far too high" (Table 1). The PhDs' feeling on grant pressure is even stronger: seven in ten found this pressure too or far too high.

Links between publication and grant pressure and competition for jobs

We also examined the links between publication and grant pressure, and the competition for jobs, by looking at both quantitative and qualitative data from our surveys. To start, we looked at the correlation between how the PhDs perceive publication pressure, grant pressure, long-term career perspectives in academia and availability of permanent positions in academia. We found that the perceptions of publication and grant pressure are highly correlated (Pearson's correlation: 0.537; Table 2). Correlations of publication and grant pressure with the perception of career prospects and availability of permanent positions were smaller, but still statistically significant. The higher PhDs rated publication and grant pressure, the more negatively they rated career prospects.

In addition, we examined the strength of this link through a quite quantitative analysis of text data. The PhD survey contained an open question on which long-term career aspects had been most decisive in their career choice. This was the final question in a section that also contained questions on which job attributes played a role in job choice, to which extent long-term career prospects played a role, and to which extent publication and grant pressure played a role. Through the structure of the questionnaire, respondents were primed to think of the aforementioned factors when answering the open question concerning the factors that had been most influential in their career choices. We determined how often publication pressure, grant pressure and factors relating to the labor market were mentioned in the same answer.

A quarter of PhDs mentioned career prospects as a decisive factor, and 20% job security (Table 3). However, not many PhDs mentioned competition, publication pressure or grant pressure: only 5%. At the same time, of the 5% that did, many mentioned career prospects (34%) and job security as well (40%), which indicates a strong link between publication and grant pressure, and competition on the academic labor market. It is especially the combination of high work pressure and the lack of job security that PhDs found very stressful, especially if this uncertainty

Table 2 Pearson's correlation (*n*; *p* value) between PhDs' perception of publication pressure, grant pressure, long-term career perspectives and availability of permanent positions in academia

	Publication pressure	*Grant pressure*	*Long-term career perspectives*	*Availability of permanent positions*
Publication pressure	1 (900; N/A)	0.537 (864; <0.001)	−0.096 (827; 0.006)	−0.086 (836; 0.013)
Grant pressure	0.537 (864; <0.001)	1 (867; N/A)	−0.187 (799; <0.001)	−0.182 (810; <0.001)
Long-term career perspectives	−0.096 (827; 0.006)	−0.187 (799; <0.001)	1 (859; N/A)	0.669 (829; <0.001)
Availability of permanent positions	−0.086 (836; 0.013)	−0.182 (810; <0.001)	0.669 (829; <0.001)	1 (864; N/A)

Table 3 Relative importance of and connections between academic career prospects, job (in)security, and publication and grant pressure according to early career researchers

Factor	*Postdocs*[a] *n = 50*	*PhD graduates*[b] *n = 754*
Career prospects (except job security)	29 (58%)	192 (25%)
Job (in)security	16 (32%)	154 (20%)
Competition, publication pressure and grant pressure	12 (24%)	35 (5%)
Mentioned in connection with		
Career prospects (except job security)	6 (50%)	12 (34%)
Job (in)security	4 (33%)	14 (40%)

[a] Postdoc survey: mention of factor in answer to open question to elaborate on satisfaction with several aspects.

[b] PhD graduate survey: mention of factor in answer to open question on which long-term career aspects had been most important in career choice.

lasted for a longer period of time. The high work pressure stems from demands to publish (mentioned six times) and even more from the continual requirement to obtain research grants. However, since prospects of job security increase but are not secured with an extensive publication list and external funding, these two pressures were considered mutually interactive.

In the postdoc survey, the respondents were asked to rate their satisfaction with nine items, of which one was publication pressure. Other items included the current employment conditions and career perspectives. Respondents were invited to elaborate on their answers. As such, if postdocs mentioned publication pressure (or competition in general) in their answers, it indicates they most likely find it to be an important issue. Twelve postdocs (24% of all postdocs who provided an answer to the open question; Table 2) mentioned publication and grant pressure. In comparison, more postdocs mentioned career prospects in general and job (in)security specifically (i.e., temporary vs. permanent positions): 29 (58%) mentioned career prospects in general, and 16 (32%) job security. Half of the postdocs mentioning publication and grant pressure also referred to career prospects and a third mentioned job security.

Similar to the PhDs, the postdocs indicated they felt a certain level of publication pressure ("I feel a bit pressured to publish as much as possible" [male postdoc, humanities]; "Publication pressure is not as high as I feared" [female postdoc, natural sciences]), but not as explicitly as the PhD group. The pressure to write and obtain grants is felt much stronger (in particular the small chance of succeeding), and grant pressure is quite overwhelmingly related to the lack of career prospects within the university.

Influence of publication and grant pressure

Furthermore, we looked at the influence of publication and grant pressure. In our postdoc survey, respondents were asked how satisfied they were with publication

Table 4 Influence of pressure to publish and to obtain grants on career choice of PhDs

	Pressure to publish	*Pressure to obtain grants*
	n valid responses (%)	
Very much	111 (12)	183 (19)
Much	172 (18)	234 (24)
Moderately	231 (24)	188 (20)
A little	140 (15)	132 (14)
Not at all	296 (31)	214 (22)

Question: "To what extent have the pressure to publish/to obtain grants made you hesitate to choose a job in academic R&D?" N.B. Percentages may not add up to 100 due to rounding.

pressure. They indicated they were quite satisfied with the publication pressure they experienced, with over half of them being "very satisfied" to "somewhat satisfied," and only 18% being "somewhat dissatisfied" to "very dissatisfied." At first glance, these findings might look contradictory. However, two separate (but related) variables were measured: among PhDs the perception of publication and grant pressure *in general* was measured, whereas among postdocs the *influence* of publication pressure on the satisfaction of the individual postdoc was measured.

In the PhD survey, respondents were asked about the influence of publication and grant pressure on career decisions. They were asked to what extent publication and grant pressure made them hesitant to pursue an academic career. According to 30% of the respondents, publication pressure had "much" or "very much," and another 24% reported "moderate" hesitation (Table 4). The influence of grant pressure is even stronger: over 40% say grant pressure has made them hesitate much or very much to continue their career in academia.

The results mentioned above indicate that a majority of doctoral holders was hesitant about choosing an academic career due to the publication and grant pressure. Next, we investigated whether these opinions depend on the sector PhDs work in. We hypothesized that those working outside of academia classify the

Table 5 Influence of publication pressure on PhDs, by sector of employment

	Academia	*Non-academic research*	*Non-research*
		n valid responses (%)	
Very much	68 (12)	33 (12)	10 (9)
Much	90 (16)	63 (24)	16 (15)
Moderately	141 (25)	61 (23)	22 (21)
A little	86 (15)	33 (12)	17 (16)
Not at all	173 (31)	77 (29)	42 (39)
p value		*0.154*	

N.B. Percentages may not add up to 100 due to rounding; *p* values from Pearson's Chi-squared test of independence between sector of employment and influence of publication pressure on job choice.

Table 6 Influence of pressure to obtain grants on PhDs, by sector of employment

	Academia	*Non-academic research*	*Non-research*
		n valid responses (%)	
Very much	106 (19)	55 (21)	21 (20)
Much	123 (22)	76 (28)	28 (26)
Moderately	140 (25)	37 (14)	8 (7)
A little	88 (16)	28 (10)	12 (11)
Not at all	102 (18)	71 (27)	38 (36)
p value		*<0.001*	

N.B. Percentages may not add up to 100 due to rounding; *p* values from Pearson's Chi-squared test of independence between sector of employment and influence of publication pressure on job choice.

publication and grant pressure as (far) too high more often than those working in academia and that it has made them hesitate to pursue an academic career to a greater extent. Contrary to our hypothesis, PhDs working outside academia were almost as likely to find publication and grant pressure (far) too high as those in academia. In addition, PhDs working outside academia stated publication pressure had made them hesitant as often as PhDs in academia (Table 4). The influence of grant pressure did differ by sector: PhDs working outside academia indicated they were heavily influenced slightly more often than those in academia, but also more often said they were not influenced at all (Table 5). In comparison, the distribution of responses over the categories was more even for PhDs in academia (Table 6).

Our results show that despite the fact that many PhDs stated that publication and grant pressure had made them hesitant to choose a career in academia, it has not been a decisive factor in their *actual* job choices. Only for grant pressure, we found a small correlation between the hesitations it has caused according to the respondents and their actual sector of employment. However, it is important to keep in mind that we asked the respondents to rate publication and grant pressure *in general*, not which degree of publication and grant pressure they experienced themselves, which may limit the relationship between the perception of publication and grant pressure and their effect on respondents.

Despite the fact that we did not observe large effects of publication and grant pressure on actual job choice among the entire PhD population in our study, for some individual PhDs competition, publication pressure and grant pressure have been decisive factors in career choice. Again, we often found connections between these factors and career prospects.

Many PhDs who mentioned competition in science, publication pressure or grant pressure as a decisive factor in job choice, explained that they would leave academia at some point. Sixteen out of the 42 respondents mentioned explicitly that they intended to leave academic research and find another job. In the following two examples from PhDs, we see that these combined pressures from publication and grants resulted in considering or choosing a career outside academia:

> Career prospects within science are not very bright. Most people have fixed-term contracts with little hopes of attaining tenure. There also is very stiff competition when it comes to obtaining grants and these also involve a decent amount of luck. The fact that only publications contribute to a successful career in science, leads to a rather one-dimensional view on researchers. For me, the unhealthy focus on publications and the high amount of uncertainty with regards to employment contracts may be reasons to leave science. (Male PhD, social sciences)

> Basically, after my PhD research and another two years of postdoc research, I realized that I did not want to be under the constant pressure of having to obtain grants, without any certainty that I would get a position at the university. Above that, competition for funding is really fierce (I see that on a daily basis in my current job) and I did not feel competent enough to be able to compete successfully. The uncertainty was definitely the most important aspect, and therefore I decided to quit academia. (Female PhD, natural sciences)

Quite a number of the PhDs wanted to do more practically oriented research for example in the industry, particularly since they disliked the one-dimensionality of an academic career. Three of these sixteen PhDs saw a supportive role for themselves within academia (e.g., policy-oriented), for example:

> I chose a supporting role instead of an academic role, because there were far more long-term job security and development opportunities than in an academic capacity. The project-based and grant-reliant aspect of an academic job have completely put me off it. (Male PhD, medical and health sciences)

Just three PhD-respondents felt that given the current competitive situation, they would like to stay in academia, and only one of them was confident that she would:

> The most important was whether I thought I would enjoy the future job on the long term. My personality does not allow me to do things less that 120% and it is only worth it as long as I enjoy it. I have always told myself that as soon as my curiosity/enthusiasm is gone (for more than 1/2 a year) I will stop. But given that I still really like research, I looked at the availability of a permanent job in academia after my post-doc. I am aware of the high competition for permanent jobs in academia and I know your chances in industry decrease if you stay in academia too long. So I assessed my chances to get a job after my post-doc, before I decided to stay in academia. But given that I got my PhD cum laude, that I already got asked to apply for jobs after I would return to the Netherlands […] and I am doing my post-doc research in a very good group at a famous university, I thought it would be ok. (Female PhD, natural sciences)

The postdocs would also like to stay in academia, but they considered it unlikely that they would, as they did not see not clear prospects for a permanent contract (mentioned 22 times). If there were any open permanent positions, they were filled in an accidental manner: *"it will come down to sheer luck"* (postdoc 34). Two female postdocs complained that when a permanent position appeared it was given to a younger male (Dutch) colleague.

Moreover, both the PhDs and the postdocs said that the mobility expected from them does not fit with their personal interests, particularly if it concerned a partner and children:

> I just wanted to settle down in one place without having to move every couple of years. Plus, in academic environment there is too much competition, which I cannot stand on the long run. (Male PhD, natural sciences)

Finally, quite substantial numbers of the PhDs who mentioned competition in science as a decisive factor in job choice (ten out of the 43) feared that the current competitiveness in science would have an impact which goes beyond their own career prospects – they thought this competitiveness will lead to deterioration of science. The PhDs felt pressured to publish unfinished work, or saw falsification or omission of data as a way to tenure. Several considered their work in science a very disappointing experience, a rat race, where intellectual curiosity is exchanged for political correctness:

> [The most important aspect in my career choice was] curiosity to learn. Unfortunately my curiosity has not been fulfilled: it's all about numbers and figures and almost never about intellectual stimulation, challenges and curiosity. The academic world has been a very disappointing experience for me, actually. Not at all what I expected. It's a rat race that does not reward intellectual curiosity but the politically correct attitude (nowadays 'creativity', 3–5 years ago 'social relevance'). […]. (Female PhD, humanities)

> I chose this job because I have a passion for teaching the next generation of scientists and for providing service to my profession and public health. The increasing emphasis on research money over quality of research, with almost no importance attributed to teaching, makes me think this profession is moving the wrong direction. (Female PhD, medical and health sciences)

Discussion and Conclusions

Science is characterized by competition at several levels, e.g., being the first to make a discovery and publish it, getting recognition from peers, obtaining research

funding and securing a faculty position (Stephan, 2012, 16–34). Publication and grant pressure are the results of competition at several levels. In this study, we showed how publication and grant pressure are perceived by early career researchers, how they are connected to a competition for jobs and which influences they have on early career researchers.

Our results show that an overwhelming majority of recent PhDs see the pressure to publish in academia as (far) too high. Even more PhDs perceived the pressure to obtain research grants as (far) too high. The finding that so many researchers perceived publication pressure as too high is highly similar to other studies on the topic (e.g., Miller *et al.*, 2011; van Dalen and Henkens, 2012; Tijdink *et al.,* 2013, 2014).

In addition, we showed that publication pressure, grant pressure and the academic labor market are tightly connected, a notion also mentioned but not elaborated upon by Anderson *et al.* (2007, 443–6) and Tijdink *et al.* (2015, 9–10). This conclusion is supported by several of our findings. First of all, in their responses to our open questions, early career researchers who see publication or grant pressure as a problem often also make notion of (a lack of) career prospects. And most respondents perceive a connection between achieving publications, obtaining grants and job opportunities: if researchers do not publish scientific output of sufficient quality or in sufficient quantity, they are not able to secure a consecutive academic position. Second, there is a correlation between the perception of publication pressure, grant pressure and career prospects.

At the same time, the influence of publication and grant pressure on early career researchers is actually quite small. Postdoctoral researchers are not dissatisfied with publication pressure by itself, as shown by their rating of satisfaction with publication pressure. In addition, there is no relation between the perception of publication and grant pressure and actual sector of employment, i.e., publication and grant pressure did not seem to have driven many PhDs out of academia. Thus, early career researchers seemed to have accepted publication pressure as a "fact of life." Since these pressures are at least partly self-enforced, we believe that this makes them easier to accept for the academics. Being able to cope with such forces enhances their sense of autonomy and independence (e.g., Teelken, 2015). In contrast, a lack of career prospects did drive some PhDs away from academia (as shown by our qualitative analysis, but also shown quantitatively in Waaijer, 2017).

In conclusion, we showed that competition in academia and its resulting publication and grant pressure are perceived as too high by early career researchers. At the same time, we demonstrated that the consequences of these perceptions by themselves are rather limited. These pressures should not be viewed separately from another competitive process in science, that of the academic labor market. It is through their connection to academic career prospects (or lack thereof) that publication and grant pressure exert their main influence.

Policy Implications

Our study shows that junior academics perceive competition in academic, driven by a scarcity of resources, as too high. Naturally, increased availability of funding for research would alleviate this problem of competition to some extent. But, as the amount of available funding will still be finite, an increase in funding will not solve the problem of heavy competition. The manner in which funding is distributed could alleviate the problem to a larger extent. Funding distributed on a long-term basis could enable more permanent contracts and thus improve the career prospects of junior academics more substantially.

In addition, in the current academic environment, evaluation is mainly based on scholarly indicators such as publications, citations and grants (van den Brink and Benschop, 2012, and also mentioned some of the early career researchers in our study). This type of evaluation has consequences for how scholars can practice their profession (Smeenk *et al.*, 2008; Teelken, 2015). However, evaluation based on these indicators fails to grasp the entirety of scientists' impact. An instrument that could be used is the ACUMEN portfolio (2014), particularly for researchers in academia. It has an explicit focus on demonstrating specific types of achievements and skills rather than listing all achievements and activities. This makes it easier for evaluators to compare people based upon their portfolios and to identify specific kinds of skills or expertise needed. In addition, the ACUMEN portfolio incorporates an age factor to allow for a fairer comparison of academics at different stages of their career and to compensate for inequalities due to gender or disability that may otherwise be hidden.

Ideally, PhD scholars and postdocs should be informed of the lack of employment opportunities within academia in an early stage, and encouraged to prepare for work in other sectors as part of their professional development. But more profoundly, a combination of more stable funding and more multi-dimensional evaluation will improve the work environment of junior academics.

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