SN Social Sciences (2024) 4:105
https://doi.org/10.1007/s43545-024-00895-9

ORIGINAL PAPER

Explaining research performance: investigating the importance of motivation

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Received: 14 December 2023 / Accepted: 15 April 2024

Abstract
In this article, we study the motivation and performance of researchers. More specifically, we investigate what motivates researchers across different research fields and countries and how this motivation influences their research performance. The basis for our study is a large-N survey of economists, cardiologists, and physicists in Denmark, Norway, Sweden, the Netherlands, and the UK. The analysis shows that researchers are primarily motivated by scientific curiosity and practical application and less so by career considerations. There are limited differences across fields and countries, suggesting that the mix of motivational aspects has a common academic core less influenced by disciplinary standards or different national environments. Linking motivational factors to research performance, through bibliometric data on publication productivity and citation impact, our data show that those driven by practical application aspects of motivation have a higher probability for high productivity. Being driven by career considerations also increases productivity but only to a certain extent before it starts having a detrimental effect.

Keywords Research · Performance · Productivity · Motivation

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Published online: 23 May 2024

Introduction

Motivation and abilities are known to be as important factors in explaining employees' job performance of employees (Van Iddekinge et al. 2018), and in the vast scientific literature on motivation, it is common to differentiate between intrinsic and extrinsic motivation factors (Ryan and Deci 2000). In this context, path-breaking individuals are said to often be intrinsically motivated (Jindal-Snape and Snape 2006; Thomas and Nedeva 2012; Vallerand et al. 1992), and it has been found that the importance of these of types of motivations differs across occupations and career stages (Duarte and Lopes 2018).

In this article, we address the issue of motivation for one specific occupation, namely: researchers working at universities. Specifically, we investigate what motivates researchers across fields and countries (RQ1) and how this motivation is linked to their research performance (RQ2). The question of why people are motivated to do their jobs is interesting to address in an academic context, where work is usually harder to control, and individuals tend to have a lot of much freedom in structuring their work. Moreover, there have been indications that academics possess an especially high level of motivation for their tasks that is not driven by a search for external rewards but by an intrinsic satisfaction from academic work (Evans and Meyer 2003; Leslie 2002). At the same time, elements of researchers' performance are measurable through indicators of their publication activity: their productivity through the number of outputs they produce and the impact of their research through the number of citations their publications receive (Aksnes and Sivertsen 2019; Wilsdon et al. 2015).

Elevating research performance is high on the agenda of many research organisations (Hazelkorn 2015). How such performance may be linked to individuals' motivational aspects has received little attention. Thus, a better understanding of this interrelation may be relevant for developing institutional strategies to foster environments that promote high-quality research and research productivity.

Previous qualitative research has shown that scientists are mainly intrinsically motivated (Jindal-Snape and Snape 2006). Other survey-based contributions suggest that there can be differences in motivations across disciplines (Atta-Owusu and Fitjar 2021; Lam 2011). Furthermore, the performance of individual scientists has been shown to be highly skewed in terms of publication productivity and citation rates (Larivière et al. 2010; Ruiz-Castillo and Costas 2014). There is a large body of literature explaining these differences. Some focus on national and institutional funding schemes (Hammarfelt and de Rijcke 2015; Melguizo and Strober 2007) and others on the research environment, such as the presence of research groups and international collaboration (Jeong et al. 2014), while many studies address the role of academic rank, age, and gender (see e.g. Baccini et al. 2014; Rørstad and Aksnes 2015). Until recently, less emphasis has been placed on the impact of researchers' motivation. Some studies have found that different types of motivations drive high levels of research performance (see e.g. Horodnic and Zaiţ 2015; Ryan and Berbegal-Mirabent 2016). However, researchers are only starting to understand how this internal drive relates to research performance.

While some of the prior research on the impact of motivation depends on self-reported research performance evaluations (Ryan 2014), the present article combines survey responses with actual bibliometric data. To investigate variation in research motivation across scientific fields and countries, we draw on a large-N survey of economists, cardiologists, and physicists in Denmark, Norway, Sweden, the Netherlands, and the UK. To investigate how this motivation is linked to their research performance, we map the survey respondents' publication and citation data from the Web of Science (WoS).

This article is organised as follows. First, we present relevant literature on research performance and motivation. Next, the scientific fields and countries are then presented before elaborating on our methodology. In the empirical analysis, we investigate variations in motivation across fields, gender, age, and academic position and then relate motivation to publications and citations as our two measures of research performance. In the concluding section, we discuss our findings and implications for national decision-makers and individual researchers.

Motivation and research performance

As noted above, the concepts of intrinsic and extrinsic motivation play an important role in the literature on motivation and performance. Here, intrinsic motivation refers to doing something for its inherent satisfaction rather than for some separable consequence. Extrinsic motivation refers to doing something because it leads to a separable outcome (Ryan and Deci 2000).

Some studies have found that scientists are mainly intrinsically motivated (Jindal-Snape and Snape 2006; Lounsbury et al. 2012). Research interests, curiosity, and a desire to contribute to new knowledge are examples of such motivational factors. Intrinsic motives have also been shown to be crucial when people select research as a career choice (Roach and Sauermann 2010). Nevertheless, scientists are also motivated by extrinsic factors. Several European countries have adopted performance-based research funding systems (Zacharewicz et al. 2019). In these systems, researchers do not receive direct financial bonuses when they publish, although such practices may occur at local levels (Stephan et al. 2017). Therefore, extrinsic motivation for such researchers may include salary increases, peer recognitions, promotion, or expanded access to research resources (Lam 2011). According to Tien and Blackburn (1996), both types of motivations operate simultaneously, and their importance vary and may depend on the individual's circumstances, personal situation, and values.

The extent to which different kinds of motivations play a role in scientists' performance has been investigated in several studies. In these studies, bibliometric indicators based on the number of publications are typically used as outcome measures. Such indicators play a critical role in various contexts in the research system (Wilsdon et al. 2015), although it has also been pointed out that individuals can have different motivations to publish (Hangel and Schmidt-Pfister 2017).

Based on a survey of Romanian economics and business administration academics combined with bibliometric data, Horodnic and Zait (2015) found that intrinsic motivation was positively correlated with research productivity, while extrinsic motivation was negatively correlated. Their interpretations of the results are that researchers motivated by scientific interest are more productive, while researchers motivated by extrinsic forces will shift their focus to more financially profitable activities. Similarly, based on the observation that professors continue to publish even after they have been promoted to full professor, Finkelstein (1984) concluded that intrinsic rather than extrinsic motivational factors have a decisive role regarding the productivity of academics.

Drawing on a survey of 405 research scientists working in biological, chemical, and biomedical research departments in UK universities, Ryan (2014) found that (self-reported) variations in research performance can be explained by instrumental motivation based on financial incentives and internal motivation based on the individual's view of themselves (traits, competencies, and values). In the study, instrumental motivation was found to have a negative impact on research performance: As the desire for financial rewards increase, the level of research performance decreases. In other words, researchers mainly motivated by money will be less productive and effective in their research. Contrarily, internal motivation was found to have a positive impact on research performance. This was explained by highlighting that researchers motivated by their self-concept set internal standards that become a reference point that reinforces perceptions of competency in their environments.

Nevertheless, it has also been argued that intrinsic and extrinsic motivations for publishing are intertwined (Ma 2019). According to Tien and Blackburn (1996), research productivity is neither purely intrinsically nor purely extrinsically motivated. Publication activity is often a result of research, which may be intrinsically motivated or motivated by extrinsic factors such as a wish for promotion, where the number of publications is often a part of the assessment (Cruz-Castro and Sanz-Menendez 2021; Tien 2000, 2008).

The negative relationship between external/instrumental motivation and performance and the positive relationship between internal/self-concept motivation and performance are underlined by Ryan and Berbegal-Mirabent (2016). Drawing on a fuzzy set qualitative comparative analysis of a random sampling of 300 of the original respondents from Ryan (2014), they find that scientists working towards the standards and values they identify with, combined with a lack of concern for instrumental rewards, contribute to higher levels of research performance.

Based on the above, this article will address two research questions concerning different forms of motivation and the relationship between motivation and research performance.

RQ1 How does the motivation of researchers vary across fields and countries?

RQ2 How do different types of motivations affect research performance?

In this study, the roles of three different motivational factors are analysed. These are scientific curiosity, practical and societal applications, and career progress. The study aims to assess the role of these specific motivational factors and not the intrinsic-extrinsic distinction more generally. Of the three factors, scientific curiosity most strongly relates to intrinsic motivation; practical and societal applications also entail strong intrinsic aspects. On the other hand, career progress is linked to extrinsic motivation.

In addition to variation in researchers' motivations by field and country, we consider differences in relation to age, position and gender. Additionally, when investigating how motivation relates to scientific performance we control for the influence of age, gender, country and funding. These are dimensions where differences might be found in motivational factors given that scientific performance, particularly publication productivity, has been shown to differ along these dimensions (Rørstad and Aksnes 2015).

Research context: three fields, five countries

To address the research question about potential differences across fields and countries, the study is based on a sample consisting of researchers in three different fields (cardiology, economics, and physics) and five countries (Denmark, Norway, Sweden, the Netherlands, and the UK). Below, we describe this research context in greater detail.

The fields represent three different domains of science: medicine, social sciences, and the natural sciences, where different motivational factors may be at play. This means that the fields cover three main areas of scientific investigations: the understanding of the world, the functioning of the human body, and societies and their functions. The societal role and mission of the fields also differ. While a primary aim of cardiology research and practice is to reduce the burden of cardiovascular disease, physics research may drive technology advancements, which impacts society. Economics research may contribute to more effective use of limited resources and the management of people, businesses, markets, and governments. In addition, the fields also differ in publication patterns (Piro et al. 2013). The average number of publications per researcher is generally higher in cardiology and physics than in economics (Piro et al. 2013). Moreover, cardiologists and physicists mainly publish in international scientific journals (Moed 2005; Van Leeuwen 2013). In economics, researchers also tend to publish books, chapters, and articles in national languages, in addition to international journal articles (Aksnes and Sivertsen 2019; van Leeuwen et al. 2016).

We sampled the countries with a twofold aim. On the one hand, we wanted to have countries that are comparable so that differences in the development of the science systems, working conditions, or funding availability would not be too large. On the other hand, we also wanted to assure variation among the countries regarding these relevant framework conditions to ensure that our findings are not driven by a specific contextual condition.

The five countries in the study are all located in the northwestern part of Europe, with science systems that are foremost funded by block grant funding from the national governments (unlike, for example, the US, where research grants by national funding agencies are the most important funding mechanism) (Lepori et al. 2023).

In all five countries, the missions of the universities are composed of a blend of education, research, and outreach. Furthermore, the science systems in Norway, Denmark, Sweden, and the Netherlands have a relatively strong orientation towards the

Anglo-Saxon world in the sense that publishing in the national language still exists, but publishing in English in internationally oriented journals in which English is the language of publications is the norm (Kulczycki et al. 2018). These framework conditions ensure that those working in the five countries have somewhat similar missions to fulfil in their professions while also belonging to a common mainly Anglophone science system.

However, in Norway, Denmark, Sweden, and the Netherlands, research findings in some social sciences, law, and the humanities are still oriented on publishing in various languages. Hence, we avoided selecting the humanities field for this study due to a potential issue with cross-country comparability (Sivertsen 2019; Sivertsen and Van Leeuwen 2014; Van Leeuwen 2013).

Finally, the chosen countries vary regarding their level of university autonomy. When combining the scores for organisational, financial, staffing, and academic autonomy presented in the latest University Autonomy in Europe Scorecard presented by the European University Association (EUA), the UK, the Netherlands, and Denmark have higher levels of autonomy compared to Norway and Sweden, with Swedish universities having less autonomy than their Norwegian counterparts (Pruvot et al. 2023). This variation is relevant for our study, as it ensures that our findings are not driven by response from a higher education system with especially high or low autonomy, which can influence the motivation and satisfaction of academics working in it (Daumiller et al. 2020).

Data and methods

The survey

The data used in this article are a combination of survey data and bibliometric data retrieved from the WoS. The WoS database was chosen for this study due to its comprehensive coverage of research literature across all disciplines, encompassing the three specific research areas under analysis. Additionally, the WoS database is well-suited for bibliometric analyses, offering citation counts essential for this study.

Two approaches were used to identify the sample for the survey. Initially, a bibliometric analysis of the WoS using journal categories ('Cardiac & cardiovascular systems', 'Economics', and 'Physics') enabled the identification of key institutions with a minimum number of publications within these journal categories. Following this, relevant organisational units and researchers within these units were identified through available information on the units' webpages. Included were employees in relevant academic positions (tenured academic personnel, post-docs, and researchers, but not PhD students, adjunct positions, guest researchers, or administrative and technical personnel).

Second, based on the WoS data, people were added to this initial sample if they had a minimum number of publications within the field and belonged to any of the selected institutions, regardless of unit affiliation. For economics, the minimum was five publications within the selected period (2011–2016). For cardiology and physics, where the individual publication productivity is higher, the minimum was 10 publica-

Table 1 Response rate by country

Country	Response rate (Percentage)
Denmark	31.7
Norway	47.0
Sweden	35.6
The Netherlands	17.6
The United Kingdom	12.0

Table 2 Response rate by field

Field	Response rate (Percentage)
Cardiology	26.0
Economics	27.0
Physics	30.3

tions within the same period. The selection of the minimum publication criteria was based on an analysis of publication outputs in these fields between 2011 and 2016. The thresholds were applied to include individuals who are more actively engaged in research while excluding those with more peripheral involvement. The higher thresholds for cardiology and physics reflect the greater frequency of publications (and co-authorship) observed in these fields.

The benefit of this dual-approach strategy to sampling is that we obtain a more comprehensive sample: the full scope of researchers within a unit and the full scope of researchers that publish within the relevant fields. Overall, 59% of the sample were identified through staff lists and 41% through the second step involving WoS data.

The survey data were collected through an online questionnaire first sent out in October 2017 and closed in December 2018. In this period, several reminders were sent to increase the response rate. Overall, the survey had a response rate of 26.1% (N=2,587 replies). There were only minor variations in response rates between scientific fields; the variations were larger between countries. Tables 1 and 2 provide an overview of the response rate by country and field.

Operationalisation of motivation

Motivation was measured by a question in the survey asking respondents what motivates or inspires them to conduct research, of which three dimensions are analysed in the present paper. The two first answer categories were related to intrinsic motivation ('Curiosity/scientific discovery/understanding the world' and 'Application/practical aims/creating a better society'). The third answer category was more related to extrinsic motivation ('Progress in my career [e.g. tenure/permanent position, higher salary, more interesting/independent work]'). Appendix Table A1 displays the distribution of respondents and the mean value and standard deviation for each item.

These three different aspects of motivation do not measure the same phenomenon but seem to capture different aspects of motivation (see Pearson's correlation coefficients in Appendix Table A2). There is no correlation between curiosity/scientific discovery, career progress, and practical application. However, there is a weak but significant positive correlation between career progress and practical application. These findings indicate that those motivated by career considerations to some degrees also are motivated by practical application.

In addition to investigating how researchers' motivation varies by field and country, we consider the differences in relation to age, position and gender as well. Field of science differentiates between economics, cardiology, physics, and other fields. The country variables differentiate between the five countries. Age is a nine-category variable. The position variable differentiates between full professors, associate professors, and assistant professors. The gender variable has two categories (male or female). For descriptive statistics on these additional variables, see Appendix Table A3.

Publication productivity and citation impact

To analyse the respondents' bibliometric performance, the Centre for Science and Technology Studies (CWTS) in-house WoS database was used. We identified the publication output of each respondent during 2011–2017 (limited to regular articles, reviews, and letters). For 16% of the respondents, no publications were identified in the database. These individuals had apparently not published in international journals covered by the database. However, in some cases, the lack of publications may be due to identification problems (e.g. change of names). Therefore, we decided not to include the latter respondents in the analysis.

Two main performance measures were calculated: publication productivity and citation impact. As an indicator of productivity, we counted the number of publications for each individual (as author or co-author) during the period. To analyse the citation impact, a composite measure using three different indicators was used: total number of citations (total citations counts for all articles they have contributed to during the period, counting citations up to and including 2017), normalised citation score (MNCS), and proportion of publications among the 10% most cited articles in their fields (Waltman and Schreiber 2013). Here, the MNCS is an indicator for which the citation count of each article is normalised by subject, article type, and year, where 1.00 corresponds to the world average (Waltman et al. 2011). Based on these data, averages for the total publication output of each respondent were calculated. By using three different indicators, we can avoid biases or limitations attached to each of them. For example, using the MNCS, a respondent with only one publication would appear as a high impact researcher if this article was highly cited. However, when considering the additional indicator, total citation counts, this individual would usually perform less well.

The bibliometric scores were skewedly distributed among the respondents. Rather than using the absolute numbers, in this paper, we have classified the respondents into three groups according to their scores on the indicators. Here, we have used percentile rank classes (tertiles). Percentile statistics are increasingly applied in bibliometrics (Bornmann et al. 2013; Waltman and Schreiber 2013) due to the presence of outliers and long tails, which characterise both productivity and citation distributions.

As the fields analysed have different publication patterns, the respondents within each field were ranked according to their scores on the indicators, and their percentile rank was determined. For the productivity measure, this means that there are three groups that are equal in terms of number of individuals included: 1: *Low productivity* (the group with the lowest publication numbers, 0–33 percentile), 2: *Medium productivity* (33–67 percentile), and 3: *High productivity* (67–100 percentile). For the citation impact measure, we conducted a similar percentile analysis for each of the three composite indicators. Then everyone was assigned to one of the three percentile groups based on their average score: 1: *Low citation impact* (the group with lowest citation impact, 0–33 percentile), 2: *Medium citation impact* (33–67 percentile), and 3: *High citation impact* (67–100 percentile), cf. Table 3. Although it might be argued that the application of tertile groups rather than absolute numbers leads to a loss of information, the advantage is that the results are not influenced by extreme values and may be easier to interpret.

Via this approach, we can analyse the two important dimensions of the respondents' performance. However, it should be noted that the WoS database does not cover the publication output of the fields equally. Generally, physics and cardiology are very well covered, while the coverage of economics is somewhat lower due to different publication practices (Aksnes and Sivertsen 2019). This problem is accounted for in our study by ranking the respondents in each field separately, as described above. In addition, not all respondents may have been active researchers during the entire 2011–2017 period, which we have not adjusted for. Despite these limitations, the analysis provides interesting information on the bibliometric performance of the respondents at an aggregated level.

Regression analysis

To analyse the relationship between motivation and performance, we apply multinomial logistic regression rather then ordered logistic regression because we assume that the odds for respondents belonging in each category of the dependent variables are not equal (Hilbe 2017). The implication of this choice of model is that the model tests the probability of respondents being in one category compared to another (Hilbe 2017). This means that a reference or baseline category must be selected for each of the dependent variables (productivity and citation impact). Furthermore, the coefficient estimates show how the probability of being in one of the other categories decreases or increases compared to being in the reference category.

For this analysis, we selected the medium performers as the reference or baseline category for both our dependent variables. This enables us to evaluate how the inde-

Table 3 Citation impact groups and productivity percentile groups

	Frequency–number of individuals	Percentage of total number of individuals
Citation impact group		
1 (low citation impact)	703	33.3
2 (medium citation impact)	705	33.3
3 (high citation impact)	706	33.3
Productivity percentile group		
1 (low productivity)	703	33.3
2 (medium productivity)	704	33.3
3 (high productivity)	707	33.3

pendent variables affect the probability of being in the low performers group compared to the medium performers and the high performers compared to the medium performers.

To evaluate model fit, we started with a baseline model where only types of motivations were included as independent variables. Subsequently, the additional variables were introduced into the model, and based on measures for model fit (Pseudo R^2, -2LL, and Akaike Information Criterion (AIC)), we concluded that the model with all additional variables included provides the best fit to the data for both the dependent variables (see Appendix Tables A5 and A6). Additional control variables include age, gender, country, and funding. We include these variables as controls to obtain robust effects of motivation and not effects driven by other underlying factors. The type of funding was measured by variables where the respondent answered the following question: ‘How has your research been funded the last five years?’ The funding variable initially consisted of four categories: ‘No source’, ‘Minor source’, ‘Moderate source’, and ‘Major source’. In this analysis, we have combined ‘No source’ and ‘Minor source’ into one category (0) and ‘Moderate source’ and ‘Major source’ into another category (1). Descriptive statistics for the funding variables are available in Appendix Table A4. We do not control for the influence of field due to how the scientific performance variables are operationalised, the field normalisation implies that there are no variations across fields. We also do not control for position, as this variable is highly correlated with age, and we are therefore unable to include these two variables in the same model.

Results

The motivation of researchers

In the empirical analysis, we first investigate variation in motivation and then relate it to publications and citations as our two measures of research performance.

As Fig. 1 shows, the respondents are mainly driven by curiosity and the wish to make scientific discoveries. This is by far the most important motivation. Practical application is also an important source of motivation, while making career progress is not identified as being very important.

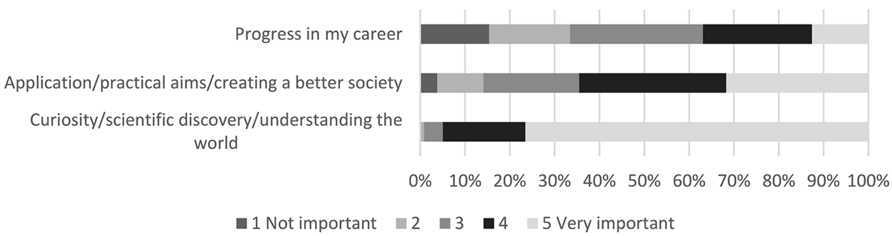

Fig. 1 Motivation of researchers– percentage

Table 4 Mean value of motivation items by field of science

	Cardiology		Economics		Physics		Other	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Curiosity/scientific discovery/understanding the world	4.68	0.62	4.72	0.59	4.71	0.61	4.71	0.55
Application/practical aims/creating a better society	3.94	0.95	4.00	1.00	3.57	1.18	3.94	1.07
Progress in my career	2.89	1.26	3.26	1.23	3.01	1.22	2.81	1.23

Table 5 Mean value of motivation items by country

	Denmark		Norway		Sweden		The Netherlands		The United Kingdom	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Curiosity/scientific discovery/understanding the world	4.77	0.51	4.65	0.63	4.73	0.56	4.67	0.65	4.76	0.56
Application/practical aims/creating a better society	3.68	1.18	3.87	1.06	3.76	1.13	3.77	1.10	3.74	1.14
Progress in my career	3.20	1.18	3.00	1.24	3.03	1.24	2.88	1.23	3.05	1.30

Table 6 Mean value of motivation items by gender

	Female		Male	
	Mean	SD	Mean	SD
Curiosity/scientific discovery/understanding the world	4.69	0.59	4.72	0.57
Application/practical aims/creating a better society	3.99	1.04	3.73	1.12
Progress in my career	3.20	1.21	2.95	1.24

Table 7 Correlations between motivation items, age and position. according to Pearson's correlation coefficient

	Age	Position
Curiosity/scientific discovery/understanding the world	0.04	0.10*
Application/practical aims/creating a better society	-0.04	0.02
Progress in my career	-0.48*	-0.27*

As Table 4 shows, at the level of fields, there are no large differences, and the motivational profiles are relatively similar. However, physicists tend to view practical application as somewhat less important than cardiologists and economists. Moreover, career progress is emphasised most by economists. Furthermore, as table 5 shows, there are some differences in motivation between countries. For curiosity/scientific discovery and practical application, the variations across countries are minor, but researchers in Denmark tend to view career progress as somewhat more important than researchers in the other countries.

Furthermore, as table 6 shows, women seem to view practical application and career progress as a more important motivation than men; these differences are also significant. Similar gender disparities have also been reported in a previous study (Zhang et al. 2021).

There are also some differences in motivation across the additional variables worth mentioning, as Table 7 shows. Unsurprisingly, perhaps, there is a significant moderate negative correlation between age, position, and career progress. This means that the importance of career progress as a motivation seems to decrease with increased age or a move up the position hierarchy.

Motivation and research performance

In the second part of the analysis, we relate motivation to research performance. We first investigate publications and productivity using the percentile groups. Here, we present the results we use using predicted probabilities because they are more easily interpretable than coefficient estimates. For the model with productivity percentile groups as the dependent variable, the estimates for career progress were negative when comparing the medium productivity group to the high productivity group and the medium productivity group to the low productivity group. This result indicates that the probability of being in the high and low productivity groups decreases compared to the medium productivity group as the value of career progress increases, which may point towards a curvilinear relationship between the variables. A similar pattern was also found in the model with the citation impact group as the dependent variable, although it was not as apparent.

As a result of this apparent curvilinear relationship, we included quadric terms for career progress in both models, and these were significant. Likelihood ratio tests also show that the models with quadric terms included have a significant better fit to the data. Furthermore, the AIC was also lower for these models compared to the initial models where quadric terms were not included (see Appendix Tables A5–A7). Consequently, we base our results on these models, which can be found in Appendix Table A7. Due to a low number of respondents in the low categories of the scientific curiosity/discovery variable, we also combined the first three values into one to include it as a variable in the regression analysis, which results in a reduced three-value variable for scientific curiosity/discovery.

Results– productivity percentile group

Using the productivity percentile group as the dependent variable, we find that the motivational aspects of practical application and career progress have a significant effect on the probability of being in the low, medium, or high productivity group but not curiosity/scientific discovery. In Figs. 2 and 3, each line represents the probability of being in each group across the scale of each motivational aspect.

Figure 2 shows that at low values of application, there are no significant differences between the probability of being in either of the groups. However, from around value 3 of application, the differences between the probability of being in each group increases, and these are also significant. As a result, we concluded that high scores on practical application is related to increased probability of being in the high productivity group.

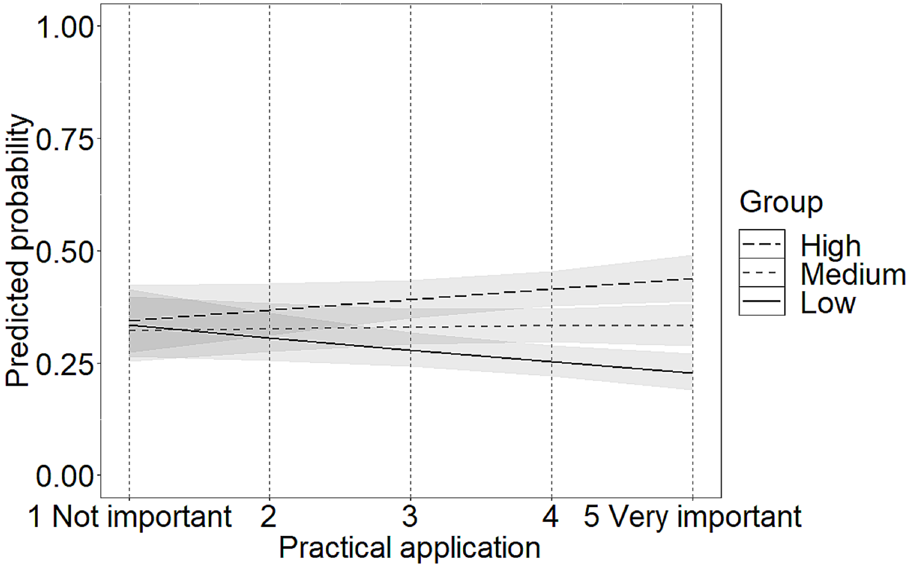

Fig. 2 Predicted probability for being in each of the productivity groups according to the value on the 'practical application' variable

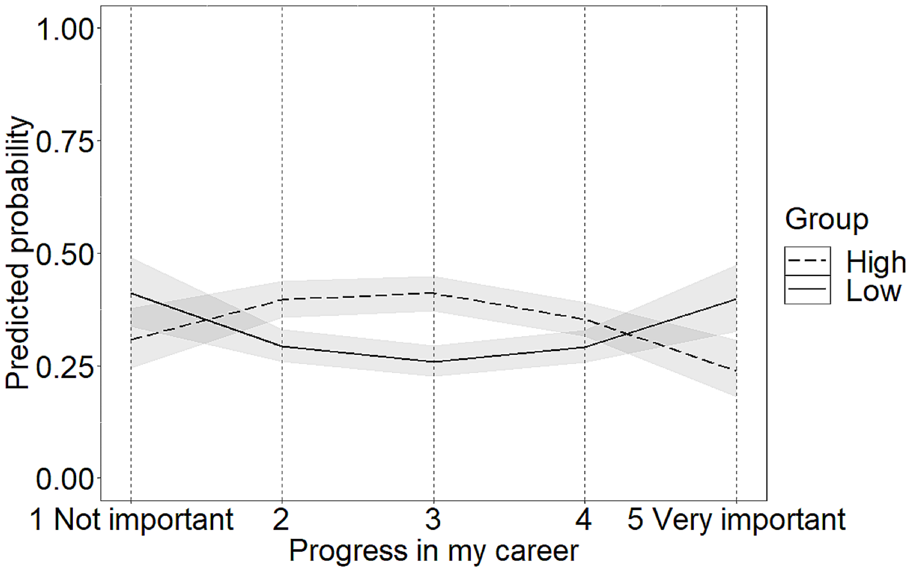

Fig. 3 Predicted probability of being in the low and high productivity groups according to the value on the 'progress in my career' variable

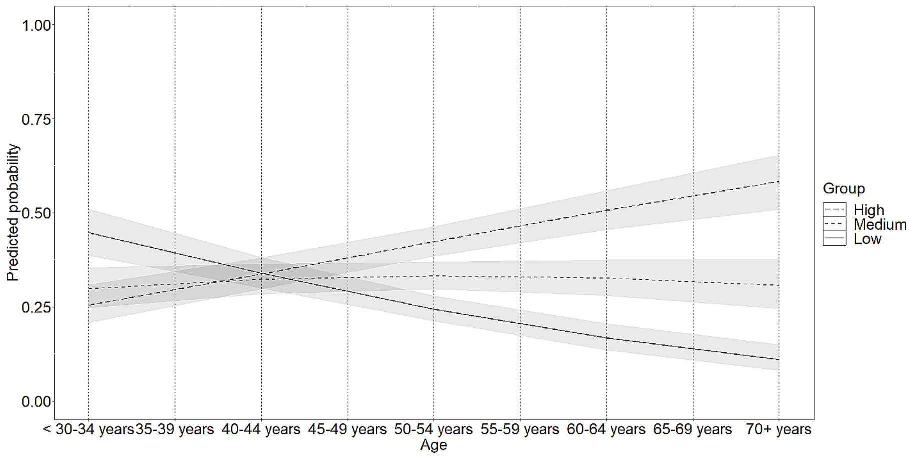

Fig. 4 Predicted probability of being in each of the productivity groups according to age

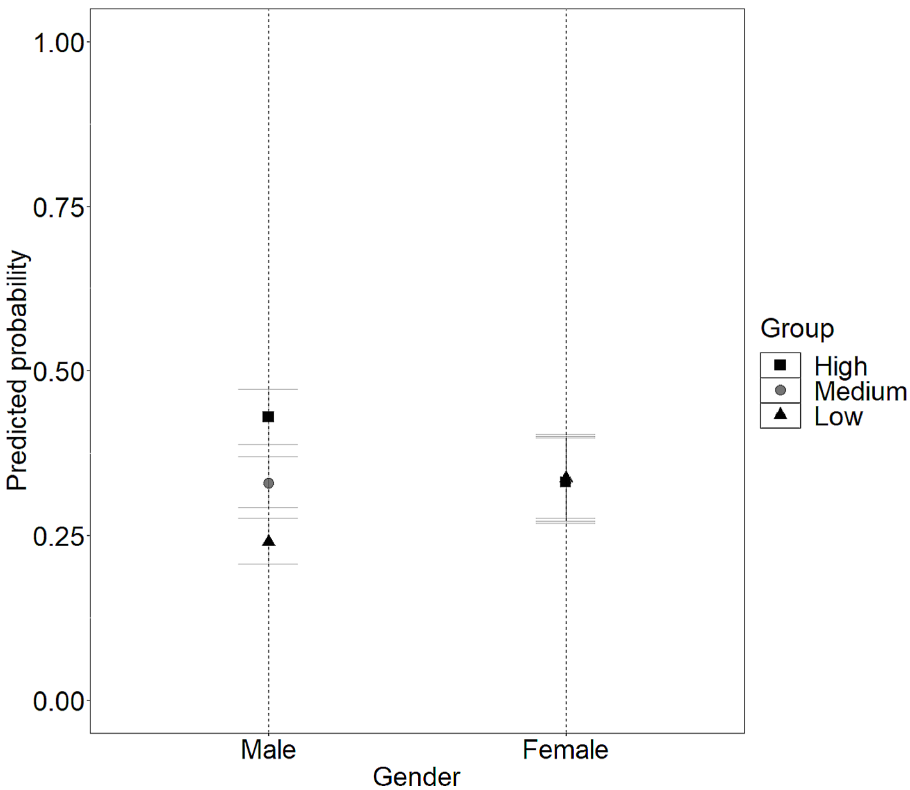

Fig. 5 Predicted probability for being in each of the productivity groups according to the value on the 'practical application' variable

In Fig. 3, we excluded the medium productivity group from the figure because there are no significant differences between this group and the high and low productivity group. Nevertheless, we found significant differences between the low productivity and the high productivity group. Since we added a quadric term for career progress, the two lines in Fig. 3 have a curvilinear shape. Figure 3 shows that there are only significant differences between the probability of being in the low or high productivity group at mid and high values of career progress. In addition, the probability of being in the high productivity group is at its highest value at mid values of career progress. This indicates that being motivated by career progress increases the probability of being in the high productivity group but only up to a certain point before it begins to have a negative effect on the probability of being in this group.

We also included age and gender as variables in the model, and Figs. 4 and 5 show the results. Figure 4 shows that age especially impacts the probability of being in the high productivity and low productivity groups. The lowest age category (<30–34 years) has the highest probability for being in the low productivity group, while from the mid age category (50 years and above), the probability is highest for being in the high productivity group. This means that increased age is related to an increased probability of high productivity. The variable controlling for the effect of funding also showed some significant results (see Appendix Table A7). The most relevant finding is that receiving competitive grants from external public sources had a very strong and significant positive effect on being in the high productivity group and a medium-sized significant negative effect on being in the low productivity group. This shows that receiving external funding in the form of competitive grants has a strong effect on productivity.

Figure 5 shows that there is a difference between male and female respondents. For females, there are no differences in the probability of being in either of the groups, while males have a higher probability of being in the high productivity group compared to the medium and low productivity groups.

Results– citation impact group

For the citation impact group as the dependent variable, we found that career progress has a significant effect on the probability of being in the low citation impact group or the high citation group but not curiosity/scientific discovery or practical application. Figure 6 shows how the probability of being in the high citation impact group increases as the value on career progress increases and is higher than that of being in the low citation impact group, but only up to a certain point. This indicates that career progress increases the probability of being in the high citation impact group to some degree but that too high values are not beneficial for high citation impact. However, it should also be noted that the effect of career progress is weak and that it is difficult to conclude on how very low or very high values of career progress affect the probability of being in the two groups.

We also included age and gender as variables in the model, and we found a similar pattern as in the model with productivity percentile group as the dependent variable. However, the relationship between the variables is weaker in this model with the citation impact group as the dependent variable. Figure 7 shows that the probability of

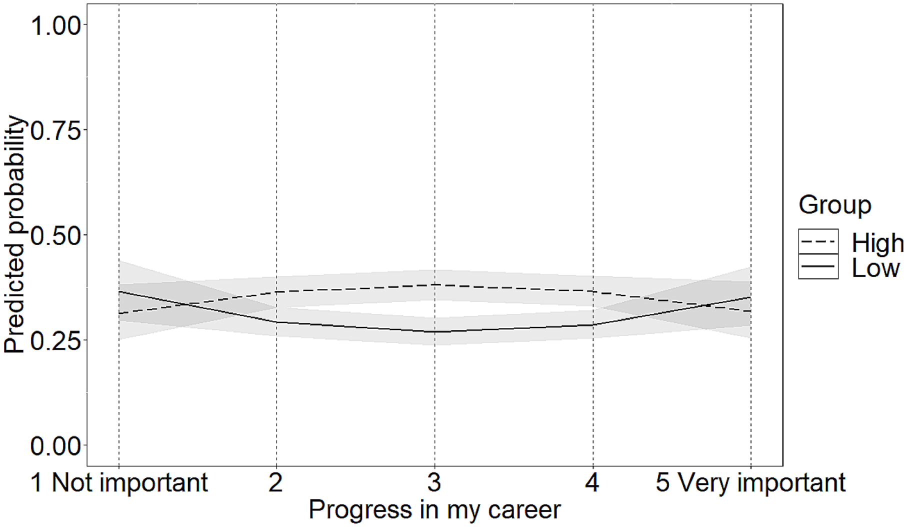

Fig. 6 Predicted probability for being in each of the citation impact groups according to the value on the 'progress in my career' variable

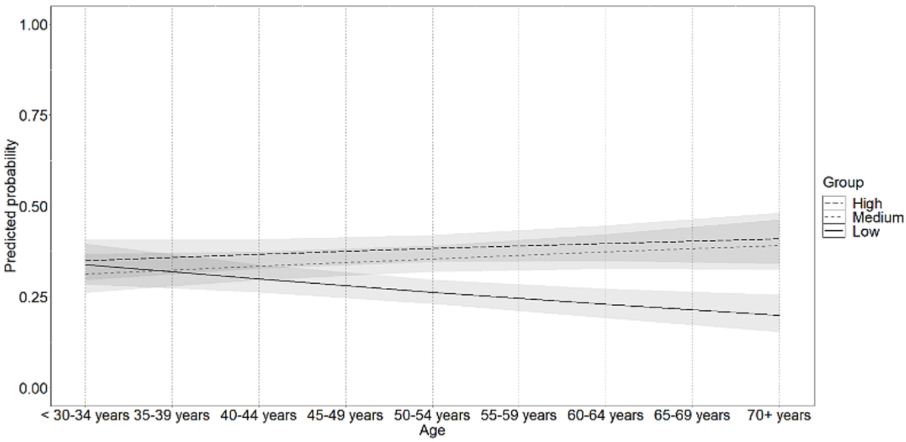

Fig. 7 Predicted probability of being in each of the citation impact groups according to age

being in the high citation impact group increases with age, but there is no significant difference between the probability of being in the high citation impact group and the medium citation impact group. We only see significant differences when each of these groups is compared to the low citation impact group. In addition, the increase in probability is more moderate in this model.

Figure 8 shows that there are differences between male and female respondents. Male respondents have a significant higher probability of being in the medium or high citation impact group compared to the low citation impact group, but there is no significant difference in the probability between the high and medium citation impact

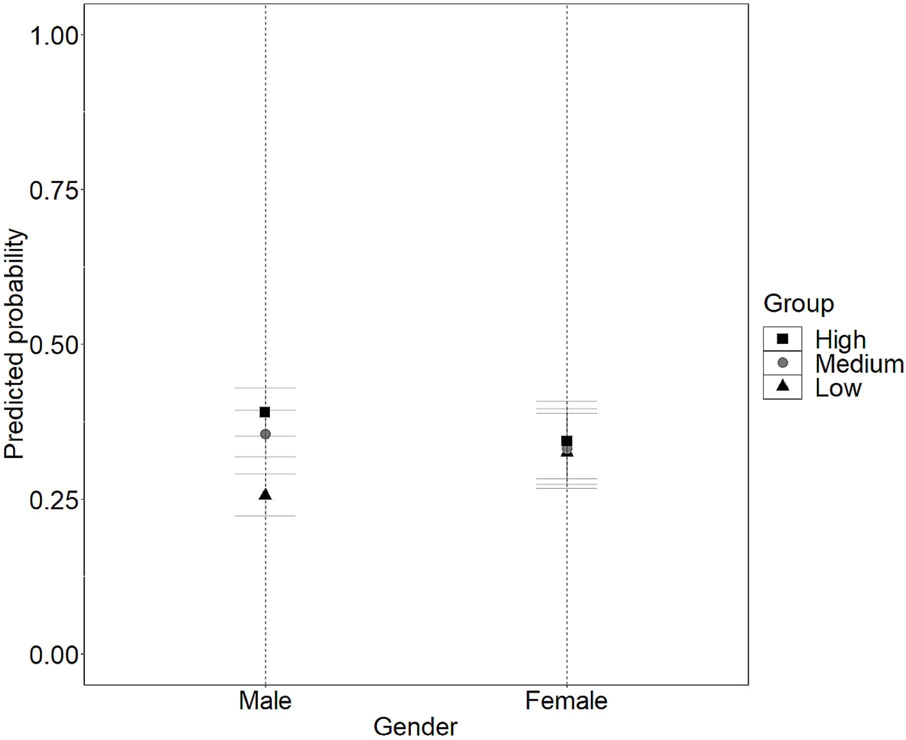

Fig. 8 Predicted probability for being in each of the citation impact groups according to gender

groups. For female respondents, there are no significant differences. Similarly, for age, the effect also seems to be more moderate in this model compared to the model with productivity percentile groups as the dependent variable. In addition, the effect of funding sources is more moderate on citation impact compared to productivity (see Appendix Table A7). Competitive grants from external public sources still have the most relevant effect, but the effect size and level of significance is lower than for the model where productivity groups are the dependent variable. Respondents who received a large amount of external funding through competitive grants are more likely to be highly cited, but the effect size is much smaller, and the result is only significant at $p<0.1$. Those who do not receive much funding from this source are more likely to be in the low impact group. Here, the effect size is large, and the coefficient is highly significant.

Concluding discussion

This article aimed to explore researchers' motivations and investigate the impact of motivation on research performance. By addressing these issues across several fields and countries, we provided new evidence on the motivation and performance of researchers.

Most researchers in our large-N survey found curiosity/scientific discovery to be a crucial motivational factor, with practical application being the second most supported aspect. Only a smaller number of respondents saw career progress as an important inspiration to conduct their research. This supports the notion that researchers are mainly motivated by core aspects of academic work such as curiosity, discoveries, and practical application of their knowledge and less so by personal gains (see Evans and Meyer 2003). Therefore, our results align with earlier research on motivation. In their interview study of scientists working at a government research institute in the UK, Jindal-Snape and Snape (2006) found that the scientists were typically motivated by the ability to conduct high quality, curiosity-driven research and de-motivated by the lack of feedback from management, difficulty in collaborating with colleagues, and constant review and change. Salaries, incentive schemes, and prospects for promotion were not considered a motivator for most scientists. Kivistö and colleagues (2017) also observed similar patterns in more recent survey data from Finnish academics.

As noted in the introduction, the issue of motivation has often been analysed in the literature using the intrinsic-extrinsic distinction. In our study, we have not applied these concepts directly. However, it is clear that the curiosity/scientific discovery item should be considered a type of intrinsic motivation, as it involves performing the activity for its inherent satisfaction. Moreover, the practical application item should probably be considered mainly intrinsic, as it involves creating a better society (for others) without primarily focusing on gains for oneself. The career progress item explicitly mentions personal gains such as position and higher salary and is, therefore, a type of extrinsic motivation. This means that our results support the notion that there are very strong elements of intrinsic motivation among researchers (Jindal-Snape and Snape 2006).

When analysing the three aspects of motivation, we found some differences. Physicists tend to view practical application as less important than researchers in the two other fields, while career progress was most emphasised by economists. Regarding country differences, our data suggest that career progress is most important for researchers in Denmark. Nevertheless, given the limited effect sizes, the overall picture is that motivational factors seem to be relatively similar regarding disciplinary and country dimensions.

Regarding gender aspects of motivation, our data show that women seem to view practical application and career progress as more important than men. One explanation for this could be the continued gender differences in academic careers, which tend to disadvantage women, thus creating a greater incentive for female scholars to focus on and be motivated by career progress aspects (Huang et al. 2020; Lerchenmueller and Sorenson 2018). Unsurprisingly, respondents' age and academic position influenced the importance of different aspects of motivation, especially regarding career progress. Here, increased age and moving up the positional hierarchy are linked to a decrease in importance. This highlights that older academics and those in more senior positions drew more motivation from other sources that are not directly linked to their personal career gains. This can probably be explained by the academic career ladder plateauing at a certain point in time, as there are often no additional titles and very limited recognition beyond becoming a full professor. Finally, the type of funding that scholars received also had an influence on their productivity and, to a certain extent, citation impact.

Overall, there is little support that researchers across various fields and countries are very different when it comes to their motivation for conducting research. Rather, there seems to be a strong common core of academic motivation that varies mainly by gender and age/position. Rather than talking about researchers' motivation per se, our study, therefore, suggests that one should talk about motivation across gender, at different stages of the career, and, to a certain degree, in different fields. Thus, motivation seems to be a multi-faceted construct, and the importance of different aspects of motivation vary between different groups.

In the second step of our analysis, we linked motivation to performance. Here, we focused on both scientific productivity and citation impact. Regarding the former, our data show that both practical application and career progress have a significant effect on productivity. The relationship between practical application aspects and productivity is linear, meaning that those who indicate that this aspect of motivation is very important to them have a higher probability of being in the high productivity group. The relationship between career aspects of motivation and productivity is curve linear, and we found only significant differences between the high and low productivity groups at mid and high values of the motivation scale. This indicates that being more motivated by career progress increases productivity but only to a certain extent before it starts having a detrimental effect. A common assumption has been that intrinsic motivation has a positive and instrumental effect and extrinsic motivation has a negative effect on the performance of scientists (Peng and Gao 2019; Ryan and Berbegal-Mirabent 2016). Our results do not generally support this, as motives related to career progress are positively linked with productivity only to a certain point. Possibly, this can be explained by the fact that the number of publications is often especially important in the context of recruitment and promotion (Langfeldt et al. 2021; Reymert et al. 2021). Thus, it will be beneficial from a scientific career perspective to have many publications when trying to get hired or promoted.

Regarding citation impact, our analysis highlights that only the career aspects of motivation have a significant effect. Similar to the results regarding productivity, being more motivated by career progress increases the probability of being in the high citation impact group, but only to a certain value when the difference stops being significant. It needs to be pointed out that the effect strength is weaker than in the analysis that focused on productivity. Thus, these results should be treated with greater caution.

Overall, our results shed light on some important aspects regarding the motivation of academics and how this translates into research performance. Regarding our first research question, it seems to be the case that there is not one type of motivation but rather different contextual mixes of motivational aspects that are strongly driven by gender and the academic position/age. We found only limited effects of research fields and even less pronounced country effects, suggesting that while situational, the mix of motivational aspects also has a common academic core that is less influenced by different national environments or disciplinary standards. Regarding our second research question, our results challenge the common assumption that intrinsic motivation has a positive effect and extrinsic motivation has a negative effect on the performance of scientists. Instead, we show that motives related to career are positively linked to productivity at least to a certain point. Our analysis regarding citation patterns achieved similar results. Combined with the finding regarding the importance of current academic position and age for specific patterns of motivation, it could be argued that the fact that the number of publications is often used as a measurement in recruitment and promotion makes academics that are more driven by career aspects publish more, as this is perceived as a necessary condition for success.

Our study has a clear focus on the research side of academic work. However, most academics do both teaching and research, which raises the question of how far our results can also inform our knowledge regarding the motivation for teaching. On the one hand, previous studies have highlighted that intrinsic motivation is also of high importance for the quality of teaching (see e.g. Wilkesmann and Lauer 2020), which fits well with our findings. At the same time, the literature also highlights persistent goal conflicts of academics (see e.g. Daumiller et al. 2020), given that extra time devoted to teaching often comes at the costs of publications and research. Given that other findings in the literature show that research performance continues to be of higher importance than teaching in academic hiring processes (Reymert et al. 2021), the interplay between research performance, teaching performance, and different types of motivation is most likely more complicated and demands further investigation.

While offering several relevant insights, our study still comes with certain limitations that must be considered. First, motivation is a complex construct. Thus, there are many ways one could operationalise it, and not one specific understanding so far seems to have emerged as best practice. Therefore, our approach to operationalisation and measurement should be seen as an addition to this broader field of measurement approaches, and we do not claim that this is the only sensible way of doing it. Second, we rely on self-reported survey data to measure the different aspects of motivation in our study. This means that aspects such as social desirability could influence how far academics claim to be motivated by certain aspects. For example, claiming to be mainly motivated by personal career gains may be considered a dubious motive among academics.

With respect to the bibliometric analyses, it is important to realise that we have lumped researchers into categories, thereby 'smoothening' the individual performances into group performances under the various variables. This has an effect that some extraordinary scores might have become invisible in our study, which might have been interesting to analyse separately, throwing light on the relationships we studied. However, breaking the material down to the lower level of analysis of individual researchers also comes with a limitation, namely that at the level of the individual academic, bibliometrics tend to become quite sensitive for the underlying numbers, which in itself is then hampered by the coverage of the database used, the publishing cultures in various countries and fields, and the age and position of the individuals. Therefore, the level of the individual academic has not been analysed in our study, how interesting and promising outcomes might have been. even though we acknowledge that such a study could yield interesting results.

Finally, our sample is drawn from northwestern European countries and a limited set of disciplines. We would argue that we have sufficient variation in countries and disciplines to make the results relevant for a broader audience context. While our results show rather small country or discipline differences, we are aware that there might be country- or discipline-specific effects that we cannot capture due to the sampling approach we used. Moreover, as we had to balance sufficient variation in framework conditions with the comparability of cases, the geographical generalisation of our results has limitations.

Conclusion

This article investigated what motivates researchers across different research fields and countries and how this motivation influences their research performance. The analysis showed that the researchers are mainly motivated by scientific curiosity and practical application and less so by career considerations. Furthermore, the analysis shows that researchers driven by practical application aspects of motivation have a higher probability of high productivity. Being driven by career considerations also increases productivity but only to a certain extent before it starts having a detrimental effect.

The article is based on a large-N survey of economists, cardiologists, and physicists in Denmark, Norway, Sweden, the Netherlands, and the UK. Building on this study, future research should expand the scope and study the relationship between motivation and productivity as well as citation impact in a broader disciplinary and geographical context. In addition, we encourage studies that develop and validate our measurement and operationalisation of aspects of researchers' motivation.

Finally, a long-term panel study design that follows respondents throughout their academic careers and investigates how far their motivational patterns shift over time would allow for more fine-grained analysis and thereby a richer understanding of the important relationship between motivation and performance in academia.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s43545-024-00895-9.

Acknowledgements We are thankful to the R-QUEST team for input and comments to the paper.

Author contributions All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Silje Marie Svartefoss, Jens Jungblut, Dag W. Aksnes, Kristoffer Kolltveit, and Thed van Leeuwen. The first draft of the manuscript was written by all authors in collaboration, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Funding The authors disclosed the receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Research Council Norway (RCN) [grant number 256223] (R-QUEST).
Open access funding provided by University of Oslo (incl Oslo University Hospital)

Data availability The data set for this study is available from the corresponding author upon reasonable request.

Declarations

Competing interests The authors have no competing interests to declare that are relevant to the content of this article.

Informed consent was retrieved from the participants in this study.

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