**Exploring the determinants of scientific productivity: A proposed typology of researchers**

**José Luis Ballesteros-Rodríguez**
Departamento Economía y Dirección de Empresas
Universidad de Las Palmas de Gran Canaria, Las Palmas, Spain
https://orcid.org/0000-0002-3934-2679
email: joseluis.ballesteros@ulpgc.es

**Petra De Saá-Pérez**
Departamento Economía y Dirección de Empresas
Universidad de Las Palmas de Gran Canaria, Las Palmas, Spain
https://orcid.org/0000-0002-3945-5454
email: petra.desaaperez@ulpgc.es

**Natalia García-Carbonell**
Departamento de Organización de Empresas
Universidad de Cádiz, Cádiz, Spain
https://orcid.org/0000-0003-0065-3100
email: natalia.carbonell@uca.es

**Fernando Martín-Alcázar**
Departamento de Organización de Empresas
Universidad de Cádiz, Cádiz, Spain
https://orcid.org/0000-0002-9768-4618
email: fernando.martin@uca.es

**Gonzalo Sánchez-Gardey**
Departamento de Organización de Empresas
Universidad de Cádiz, Cádiz, Spain
https://orcid.org/0000-0003-2523-5407
email: gonzalo.sanchez@uca.es

**Abstract**

**Purpose:** Although several previous studies were focused on examining the determinants of research productivity, the knowledge of the competences and motives that lead researchers to achieve relevant scientific performance remains unclear. This paper is aimed at contributing to this gap in the research by proposing a typology to understand academic researchers' traits and extending the traditional "more is better" approach, which assumes that higher levels of competence and motivation are always preferable

**Design and methodology:** Cluster analysis was applied to a sample of 471 Spanish academics to examine diverse combinations of human capital attributes—knowledge, skills, and abilities—and two sources of motivation — intrinsic and extrinsic.

**Findings:** Four researcher profiles were identified: 1) high vocational academics; 2) motivated academics; 3) self-starter academics; and 4) reactive academics. Based on these preliminary findings, we present conclusions about the functioning and productivity of academic researchers.

**Originality and value:** This paper contributes a novel typology of researchers to the extant literature based on the variables of academic human capital and motivation. The findings indicate that a required and specific combination of attributes better fits the reality of research activities.

**Keywords:** human capital, motivation, academic researchers, typology, scientific productivity

## Introduction

Reduced government research funding, international and national research evaluations, and even pressure from current world university rankings have forced universities to improve their performance indicators. Hence, more than ever before, the expression "publish or perish" (Nygaard, 2017, p. 519) reflects the reality of many academic researchers. Higher-quality research and increased quantities of publications are demanded, which requires the increased activity of research groups and academics.

Several previous studies have focused on clarifying researchers' productivity, which has been an ongoing debate in the current academic literature (Brew et al., 2016). Diverse perspectives supported these studies, regarding factors such as the academic environment, institutional support, reward systems, patterns of collaboration, and, in particular, individual researcher's characteristics and motives. From a micro-perspective, the analysis of individual traits—either single or a set —has mainly followed the traditional "more is better" approach, which assumes that higher levels of competences are always better (Ployhart et al., 2014). Although it has been widely accepted, this approach fails to offer conclusive explanations of the extent to which individual research attributes determine scientific results. Previous findings showed that having many competences did not always imply an increase in performance (Wright & McMahan, 2011; Tan, 2014). We question whether the "more is better" approach really fits the academic reality and propose a "profile" view to present a complementary combination of research attributes. Additionally, in order to provide a complete profile of academics and preliminary research results, we introduce the factor of academics' research motivation, assuming that competences are a necessary but insufficient condition for performance (Harris & Kaine, 1994; Ryan, 2014).

Therefore, this paper fills an important gap in the literature by focusing on the individual characteristics and motives required in research processes (Corley et al., 2019; Munshaw et al., 2019). To address the gap, our proposal integrates two main bodies of literature in the scientific productivity research: a) intellectual capital arguments to use *human capital* as a main dimension to explain differences in research productivity; b) *motivation theory* to introduce the traditional "intrinsic" and "extrinsic" dimensions of academics' motivation. In doing so, this paper contributes to the current literature by proposing a preliminary academic typology based on an integrated profile of individual characteristics and by extending the analysis of academics' traits.

This paper is structured as follows: 1) we review the existing literature on human capital and motivation in academia and how both attributes influence scientific productivity; 2) we conduct an exploratory K-means cluster analysis to describe researcher typology in a sample of 471 Spanish academics; 3) we discuss the findings and implications of the study, and we propose future directions of research.

## Configuring academic profiles: an integrative view of human capital and motivation

### *Academic human capital and scientific performance*

Previous studies in the organizational literature recognized the importance of intellectual capital in generating value (Dzenopoljac et al., 2017; Ferreira & Franco, 2017; Mehralian et al., 2018). In the last decade, these arguments have also been applied to universities and public and non-profit organizations (Sangiorgi & Siboni, 2017). Despite the importance of every intellectual capital dimension— human, social, and organizational—in explaining the functioning of universities, human capital is considered a crucial intangible resource that affects scientific productivity (Bozeman et al., 2001; Lin & Bozeman, 2006; Ponomariov & Boardman, 2010; Karlsson & Wigren, 2012; Thienput et al., 2015; Corley et al., 2019; Munshaw et al., 2019).

In particular, the extant literature presents several different perspectives that explain the link between human capital and performance in the academic context, which has led to a lack of consensus about the specific traits that affect research results. Hence, in our literature review, we organize this previous work into three main lines of research: 1) studies that examine the effects of single and/or disconnected academic attributes, mainly demographic, on research performance; 2) studies that focus on analyzing sets of unobservable individual characteristics; 3) the stream of literature that is based on traditional human capital theory (Becker, 1962). In the latter, academic attributes are describes as "knowledge, skills and other specific abilities" (KSA). Most works in this group used Bozeman et al.'s (2001) "scientific and technical human capital (STHC)" model to expand the original notion of KSA. Specifically, the STHC model is defined as "the sum of an individual researcher's professional network ties, technical knowledge and skills, and resources broadly defined'' (Bozeman et al., 2001, p. 636). This view implies a more integrative view of academic human capital than previous works.

Regarding the first group of studies, Mayrath (2008) identified different attributes: collaboration (mentoring, cooperation with colleagues, or giving feedback); passion, curiosity, and research skills (focused research, knowledge of the literature, and writing skills); research management (scheduled time to write, minimizing distraction, and social deadlines). These attributes are related to high levels of publications in top educational psychology journals. Other studies in this group focused on the analysis of demographic variables. In this vein, Bentley (2012) described different factors that affect publication productivity and observed gender differences. The author found that academic rank, doctorate qualifications, research time, and international research collaboration positively affected publication productivity; however, higher levels were shown in the male researchers. With a similar focus, Piro, Aksnes, and Rørstad (2013) find a curvilinear relationship between age and research productivity (González-Brambila & Veloso, 2007), which increased with age and then peaked before it declined. They also found relevant differences between scientific domains. Specifically, researchers in the humanities and social sciences tended to be productive for longer periods. Several investigations paid special attention to the link between rank and scientific productivity, finding that individual publication productivity tended to increase as researchers moved up the hierarchy of academic positions (Aksnes et al., 2011; Piro et al., 2013)

We also find works as Quimbo and Sulabo's (2014) research in which the authors confirmed that educational attainment and teaching load significantly affected research self-efficacy. They explained, "this implies that those with higher educational attainment have greater confidence that they can conduct research more efficiently than those who have lower educational attainment" (p. 1693).

This first group of works offered a limited approach to understanding how individual research attributes influence scientific performance. They presented analyses of several individual observable variables, and they applied diverse methods to measure research productivity, which led to partial conclusions.

A different line of research provided the literature with a broader perspective on this topic. An increasing number of systematic studies have examined individual variables, thus contributing to the literature by examining deeper, unobservable characteristics, such as determinants of scientific performance. For example, Prpić (1996) proposed that academic professional and social characteristics shaped the human capital of eminent researchers who had a higher number of publications. Recently, Ulrich and Dash (2013) grouped 20 different academic attributes into three main categories: 1) scientific competences, such as the ability to learn, adapt, and formulate research questions; 2) project and management skills, such as communication; 3) personal aptitudes, such as creativity and motivation. Similarly, McNie et al. (2016) described "soft" and "hard" skills as required to perform research adequately. The former relates to interpersonal skills, such as communication and leadership, and the latter relate to specific research skills, such as hypothesis formulation and research protocol.

Because of the lack of consensus regarding the abilities and skills required to be prolific in the academic context, another set of works was based on traditional human capital theory. The scientific and technical human capital (STHC) model emerged as an alternative means of studying research capacity (Bozeman et al., 2001). According to the model, human capital is defined based on the KSA notion, and STHC is understood as "the sum of an individual researcher's professional network ties, technical knowledge and skills, and resources broadly defined" (p. 636). The STHC model introduces social capital to complete the traditional human capital concept. It is widely used in the academic literature in systematic studies that explain academics' capacity and career development (Bozeman & Corley, 2004; Lin & Bozeman, 2006; Jonkers & Tijssen, 2008; Gaughan & Corley, 2010; Niu, 2014; Corley et al., 2019). For example, the STHC model was applied to analyze scientists' collaboration strategies and their effects on research productivity (Bozeman & Corley, 2004; Jonkers & Tijssen, 2008; Niu, 2014). It was also very useful in determining scientific productivity in the context of university–industry collaboration and transfer (Dietz & Bozeman, 2005; Lin & Bozeman, 2006; Gaughan & Corley, 2010). Recently, the model was updated and completed to incorporate a cultural dimension (Corley et al., 2019). As these authors explained, the cultural dimension provides "an explicit focus on how interacting with people from different cultural backgrounds (including gender, race, SES, nationality and discipline) can increase STHC and S&T performance" (p. 695) (Table 1).

Based on the foregoing review of the previous work on academic human capital, to shape the academic profiles proposed in the present study, we apply the traditional "knowledge, skills and abilities (KSA)" framework (Becker, 1962) to examine human capital at the individual level (Munshaw et al., 2019). Instead of offering the expanded version of KSA arguments, in contrast to the STHC model, our study is based on only the intrinsic characteristics that affect research results.

Hence, to introduce the dimension of knowledge in the academic profile, we used the traditional distinction between tacit knowledge (i.e., knowing that), which refers to the theories, arguments, and assumptions in academic disciplines, and explicit knowledge (i.e., knowing how), which is understood as the knowledge of methodology and research techniques (Bozeman et al., 2001).

Several definitions of the concepts of skill and ability are offered in the literature. However, in considering these dimensions of human capital in the proposed academic profiles, we followed Van der Heijde and Van der Heijden's (2006) definition of skills as individual and general attributes, such as dynamism, motivation, communicative skills, and teamwork, which are usually acquired through formal education. Abilities are considered attributes that enable individuals to perform well in a specific job and a job environment. In researchers, they include topic identification, writing ability, and language domains. According to these definitions, skills are general characteristics, and abilities pertain to performance in a workplace.

| Perspectives and Theories | Focus and Methods | Results | Authors |
|---|---|---|---|
| **ACADEMIC HUMAN CAPITAL** | | | |
| Sociological view | - Quantitative study<br>- Chi-square analysis<br>- Survey of eminent scientists listed in the bibliographical directory *Who is Who in Croatia*. | - Important differences between the observed groups were found in terms of socio-professional profile, in the average scientific productivity and its subtypes, as well as in the determinants of scientific productivity. | Prpić (1996) |
| Human capital | - Theoretical paper (model proposal) | - S&T human capital was defined as a concept, encompassing not only the individual human capital endowments but also researchers' tacit knowledge, craft knowledge, and expertise.<br>- S&T human capital included social capital. | Bozeman et al. (2001) |
| Human capital | - Quantitative study<br>- OLS regression analysis<br>Survey of Careers of Scientists and Engineers (conducted between October 2001 to March 2002) | - Female scientists showed a higher percentage (%) of female collaborators, than males did (24%).<br>- The results showed great differences in rank: non-tenure track females had 84% of their collaborations with females.<br>- Regarding collaboration cosmopolitanism, researchers tended to work with people in their own work group. | Bozeman and Corley (2004) |
| Human capital (STHC model) | - Quantitative study<br>- Regression models (Tobit model)<br>- Curriculum vitae of 1200 research scientists and engineers were collected and coded.<br>- Patent data were collected from the U.S. Patent and Trademark Office. | - Physical and mathematical scientists and engineers were shown to have higher productivity rates than researchers in other fields.<br>- The most important differences in publication rates and patent productivity involved job- and grant-related variables. | Dietz and Bozeman (2005) |
| Human capital (STHC model) | - Quantitative study<br>- OLS regression analysis<br>- The RVM Survey of Careers of Scientists and Engineers (conducted between October 2001 and March 2002). | - The results suggested that previous industry experience increased the annual publication productivity of junior faculty members and women researchers. | Lin and Bozeman (2006) |
| Scholarship productivity-gender, age differences, country of PhD, and cohort | - Quantitative study<br>- Regressions<br>- 4.328 researchers, in all fields of knowledge, who have been part of the Mexican National System of Researchers (SNI) | - The findings showed a quadratic relationship are no age and the number of published papers (it peaks around 53 years old, 5 or 10 years later than what prior studies have shown).<br>- Age did not have important influence on research output and impact.<br>- Reputation influenced the number of citations but not publications.<br>- Gender: The results suggested that there were no important differences in scientific output. | González-Bambrila and Veloso (2007) |

| | | | |
|---|---|---|---|
| Scholarship productivity, mobility, and international collaboration (STHC model) | - Quantitative analysis<br>- Correlation analysis<br>- Sample of Chinese researchers at the senior level of professor/principal investigator (PI) | - Host countries lost relevant human capital when Chinese researchers returned home–*return brain drain*. | Jonkers and Tijssen (2008) |
| Scholarship productivity | - Qualitative study<br>-Survey of top educational psychology authors | - Four categories of authors' attributions for productivity were identified: collaboration, passion/curiosity, research skills, and time management. | Mayrath (2008) |
| Human capital (STHC model) | - Quantitative analysis<br>- Regressions (nested models)<br>- 151 research extensive universities (Carnegie, 2000) | - The results showed that center affiliated researchers tend to be more involved in a range of industry-related activities relative to their exclusively department-based colleagues.<br>- Center affiliated men are particularly advantaged in the development of industrial interactions. | Gaughan and Corley (2010) |
| Scholarship productivity-gender differences | - Large-scale study (bibliographic database developed)<br>-*National citation report* (NCR) database (covering the period 1981–2009)<br>-*Norwegian Research Personnel Register* (information on individual characteristics: gender, age, and position) | - Publications by female researchers showed lower citation rates than men–although the differences were not large.<br>- These differences in citation rates can be attributed to differences in productivity. There is a cumulative advantage effect of increasing publication output on citation rates. | Aksnes et al. (2011) |
| Scholarship productivity-gender differences | - Quantitative study<br>- Regression analyses<br>- Survey of the Academic Profession conducted by the Carnegie Foundation for the Advancement of Teaching and the 2007 Changing Nature of the Academic Profession (CAP) survey | - Academic rank, doctorate qualifications, research of time, and international research collaboration showed the strongest positive association with publication productivity.<br>- Women reported significantly lower levels on each of these factors. | Bentley (2012) |
| Scholarship productivity-scientific field differences in terms of academic positions, age, and gender. | - Quantitative study<br>- Descriptive and explorative analysis<br>- Data from the national Norwegian database, FRIDA | - Researchers in medicine, natural sciences, and technology were the most productive when whole counts of publications are used.<br>- Researchers in the humanities and social sciences were the most productive when article counts are fractionalized according to the total number of authors. | Piro et al. (2013) |
| Viewpoints and discussion article | - Revision and discussion of the report, *Skills and competencies needed in the research field: Objectives 2020* (APEC & Deloitte, 2010) | - Personal: The report provided a set of relevant competences and attributes:<br>*scientific competences<br>*project and management skills<br>personal aptitudes | Ulrich and Dash (2013) |

| | | | |
|---|---|---|---|
| Human capital (STHC model) | - Bibliometric analysis and interviews | - The results showed that increasing the information base with qualitative data, a deeper understanding of science, technology, and innovation (ST&I) dynamics is possible. | Niu (2014) |
| Scholarship productivity research culture, individual attributes, institutional factors | - Quantitative study<br>- Path analysis (survey-correlational research design) | - Self-efficacy was found to be a significant determinant of productivity. | Quimbo and Sulabo (2014) |
| Science policy | - Theoretical paper (typology proposal) | - The proposed multidimensional research typology divided research into three general activities: knowledge production, learning and engagement, and organizational and institutional processes.<br>- Human capital was defined as the set of soft and hard skills and the set of research skills required to perform adequately. | McNie et al. (2016) |
| Human capital (STHC model) | - Theoretical paper (model proposal) | - A revised STHC model was proposed in which the authors included a cultural dimension, complementing the human and social capital components of the original model. | Corley et al. (2019) |
| **Perspectives/Theories** | **Focus/Methods** | **Results** | **Authors** |
| **WORK MOTIVATION** | | | |
| Intrinsic/extrinsic motivation | *-Over justification paradigm* | - Proposal of a working model of creativity in research and development.<br>- Individual work motivation survey, proving that intrinsic motivation was a determinant of creativity and scientific output. | Amabile (1994) |
| Maslow's hierarchy of needs | - Qualitative study<br>- Delphi study | - The findings showed that if researchers did not satisfy their basic needs, they were not able to focus on the achievement of higher-order needs, such as relevant scientific goals. | Kamalanabhan et al. (1999) |
| Intrinsic/extrinsic motivation | - Theoretical paper | - The paper identified different sources of motivation aligned to traditional university remuneration, promotion, and performance schemes. | Dunkin (2003) |

| | | | |
|---|---|---|---|
| Intrinsic/extrinsic motivation | - Quantitative study<br>- Exploratory factor analysis | - The paper used Cassidy and Lynn's seven measures to demonstrate that it can be clustered around intrinsic and extrinsic motivation. | Story et al. (2008) |
| Intrinsic/extrinsic motivation (validation scale) | - Quantitative study<br>- Confirmatory factor analysis (robust maximum likelihood estimation method) | - The paper proposed the Motivation at Work Scale (MAWS), which presented good levels of fit. | Gagné et al. (2010) |
| Intrinsic/extrinsic motivation | - Quantitative study<br>- Regression analyses<br>- Empirical analysis based on restricted-use data from two waves (2001 and 2003) of the Survey of Doctorate Recipients (SDR), administered by the National Science Foundation. | - The results suggested that intrinsic motivation is usually linked more to innovative performance than to extrinsic motives | Sauermann and Cohen (2010). |
| Intrinsic/extrinsic motivation | - Quantitative study<br>- Exploratory factor analysis<br>- Independent sample t-tests<br>- 208 Italian faculty members, inventors of university-owned patents | - The results showed that major motivations to patent were prestige, reputation, and knowledge exchange. | Baldini (2011) |
| Intrinsic/extrinsic motivation | - Qualitative study<br>- 64 in-depth interviews with technical visionaries, their direct technical managers (TM) and their human resource managers (HRM) | - The results suggested that technical managers share the perspectives of technical visionaries—core employees, drivers of radical innovation, and normally intrinsically motivated employees—on motivation and demotivation. In contrast, the HRMs were not in alignment with the perspectives of technical visionaries. | Hebda et al. (2012) |
| Intrinsic/extrinsic motivation | - Quantitative<br>- Regression models (Probit model)<br>- National Science Foundation's Scientists and Engineers Statistical Data System database | - The results suggested that there is a higher taste for nonmonetary returns in academia than in industry. | Agarwal and Ohyama (2013) |
| Intrinsic/extrinsic motivation | - Quantitative study<br>- Questionnaire-based survey (230 academics in 11 UK universities) | - The results showed that academics had positive attitudes toward knowledge sharing as a way to improve and increase their relationships with colleagues and offer opportunities for internal promotion and external positions.<br>- Respondents were relatively neutral in terms of the academic leadership they perceived and the role of organizational structure and information technology in knowledge sharing.<br>- The findings also suggested that academics present a relatively low level of affiliation to their university, perceptions of a high level of autonomy, and a high level of affiliation to their discipline. | Fullwood et al. (2013) |

| | | | |
|---|---|---|---|
| Intrinsic/extrinsic motivation | - Quantitative study<br>- Confirmatory factor analysis of the measurement model of motivation using LISREL<br>- Analysis of variance (ANOVA)<br>- Online survey sent to United Kingdom-based research scientists (N = 405) from chemical, biological and biomedical fields | - The motivational sources found: internal self-concept motivation (the strongest) and instrumental motivation (the weakest), respectively for research scientists. | Ryan (2014) |
| Intrinsic/extrinsic motivation | - Quantitative study<br>- Regression models (Tobit model)<br>- Questionnaire survey (Romanian academics of economics and business administration) and official university records of professorial research output | - The empirical evidence confirmed that intrinsic motivation was positively correlated with research productivity, whereas extrinsic motivation was negatively correlated. | Horodnic and Zaiţ (2015) |
| Intrinsic/extrinsic motivation | - Quantitative<br>- Standard OLS regression<br>- Belgian edition of the Careers of Doctorate Holders (CDH) survey (7.160 responses) and information on scientists' and researchers' earnings | -The results showed that the counterfactual wage faced by an academic scientist increases with time spent on development and decreases with time spent on research, challenging the traditional arguments for the "high taste for science" expression.<br>- The results also showed that the preference for science increased the relationship between research orientation and wages. | Balsmeier and Pellens (2016) |
| Intrinsic/extrinsic motivation | - Quantitative<br>- Hierarchical regression<br>- Sample of 170 employees in a knowledge-intensive firm | - The results suggested that the social climate for cooperation better predicts knowledge sharing when employees show low levels of intrinsic motivation and have high levels of job autonomy. | Llopis and Fons (2016) |
| Intrinsic/extrinsic motivation (validation scale) | - Quantitative study<br>- Exploratory and confirmatory factor analysis<br>- SEM | - The findings confirmed that the proposed scale has a good fit. | Olaya-Escobar et al. (2017) |
| Intrinsic/extrinsic motivation | - Qualitative study<br>Grounded theory(GT) as an inductive methodology used to collect, analyze, and interpret data from multiple case - studies. | - The findings showed that the motivation for knowledge sharing is related to individuals' awareness of the need to share knowledge both inside and outside their organizations. | Chen et al. (2018) |

***Work motivation in research scientists***

As highlighted in the literature, the analysis of academic human capital does not always lead to understanding the differences in scientific productivity between academics and universities (Goudard & Lubrano, 2012). Human capital is configured as a necessary but insufficient condition to obtain relevant research results. Hence, we base our arguments on several well-established theories, such as expectancy theory (Vroom, 1964) and goal-setting theory (Locke & Latham, 1990) to defend our argument that the interaction between motivation and academic human capital may lead to better performance (Ryan, 2017; Van Iddekinge et al., 2018). Generally, the arguments in previous works posit that when individuals show low levels of or lack motivation, they also tend to demonstrate similarly low levels of performance regardless of their ability level. In contrast, if individuals are motivated and interested in their tasks, the differences in ability become more important, and the link between abilities and performance may be positive, showing higher levels of performance in high-ability individuals.

Regarding the link between abilities and motivation, motivation can be defined from different perspectives, which has led to a lack of consensus in the literature (Kleinginna & Kleinginna, 1981). However, it generally involves a variety of processes, such as attention, the development of plans, and even the urge to act (Harmon-Jones et al., 2013), thus working as the "linchpin between the person and the situation in the prediction of behavior" (Schultheiss et al., 2009, p. 268).

Although work motivation has been considered one of the major topics of organizational studies, there is a lack of studies on the research environment (Ryan, 2014). Prior works have stressed the importance of motivation in scientific performance (Amabile, 1994; Karle, 1997; Kamalanabhan et al., 1999; Sauermann & Cohen, 2010; Hebda et al., 2012; Olaya-Escobar et al., 2017). Among the most influential works, Amabile (1994) was one of the first to conduct individual work motivation survey, showing that intrinsic motivation was a determinant of scientific output. Kamalanabhan et al. (1999), applying the Maslow's hierarchy of needs, found that if researchers did not satisfy their basic needs, they would not be able to focus on the achievement of higher-order needs, such as relevant scientific goals. Recent studies, such as by Sauermann and Cohen (2010), reinforced the general conclusion that intrinsic motivation is usually linked more to innovative performance than to extrinsic motives. From a qualitative perspective, Hebda et al. (2012) examined differences in perceptions between technical visionaries (TV), such as core employees who are drivers of radical innovation, and normally intrinsically motivated, technical and HR managers of TV motivation and demotivation, finding that discrepancies appeared between technical managers and HR managers. Other studies were focused on providing new and more complete measurement tools to assess different dimensions of motivation. For example, Gagné et al. (2010) and Olaya-Escobar et al. (2017) developed and validated two motivation scales that identified diverse dimensions of motivation. The former study identified four dimensions of motivation: intrinsic motivation, identified regulation, introjected regulation, and external regulation. The latter study measured intrinsic motivation, extrinsic motivation, and university support and services. Both scales showed acceptable levels of fit in configuring alternative scales for assessing motivation.

In brief, the foregoing studies characterize the state of the motivational literature in the research context. They revealed the following: a) the multidimensional nature of the construct in which intrinsic and extrinsic dimensions have been widely used, b) the need for more development in measurement scales, c) and the preponderance of intrinsic motivation as a determinant of scientific productivity (Ryan, 2014).

Therefore, to complete the proposed academic profile of attributes, we follow the logic of the self-determination theory (SDT) (Deci & Ryan, 2000) and the traditional distinction between extrinsic and intrinsic motivation. This distinction provides us with consistent and deeply developed arguments to precisely define the proposed typology of academics. Moreover, considering the objective of the study, this distinction better fits the research environment, which has been demonstrated in recent works (Horodnic & Zaiţ, 2015; Llopis & Fons, 2016; Olaya-Escobar et al., 2017; Chen et al., 2018).

In general, intrinsic motivation is related to the enjoyment or pleasure of the activity itself (Dunkin, 2003). Personal satisfaction and self-esteem are crucial elements of intrinsic motivation (Fullwood et al., 2013). Some intrinsic factors that affect the motivation to conduct research are personal pleasure, intellectual challenges, and scientific and social contributions (Manley, 1998). These nonmonetary factors, as Olaya-Escobar et al. (2017) mentioned, are commonly recognized in the literature as indicating "a high taste for science" (Agarwal & Ohyama, 2013; Balsmeier & Pellens, 2016).

Extrinsically motivated individuals pursue a specific aim or goal external to the activity itself (Story et al., 2008). Remuneration, working conditions, and career promotion are traditional extrinsic factors that motivate academics to undertake research (Horodnic & Zaiţ, 2015). The recent literature includes other aspects, such as the access to new infrastructures (e.g., having laboratory equipment, research assistants, etc.) to facilitate and develop research activities (Baldini, 2011). Therefore, the combination of both attributes and their dimensions could be used to configure specific academic profiles, providing a comprehensive view of academics' characteristics (Table 1).

## Empirical analysis

### *Expert panel, survey design, data collection, and sample*

Because of the complexity of the topic and the lack of specific measures in the academic context, comprehensive empirical work is required, including different stages. The survey was designed as part of a broad research project (ECO2014- 56580-R) that was developed between 2014 and 2018 to examine relevant aspects of intellectual capital and its management in public universities. An expert panel of 62 leading scholars from the Andalusian Research Plan designed the survey and its measures. the panel used the Delphi technique to reach consensus among specialists in human capital and motivation descriptions (Landeta, 2006). In the initial stage, the panel members were asked seven open questions about intellectual capital and the ability–motivation–opportunity theory in universities. Their responses were meticulously analyzed, and 175 factors were extracted, 40 of which related specifically to researchers' human capital and motivation. The preliminary set of factors was examined twice by the experts to confirm their opinions about the proposed factors.

Consensus on the different topics was reached after three rounds of discussion. Prior to the survey, a pretest was conducted to ensure the clarity of the questions and to minimize the likelihood of problems encountered by the respondents. The obtained items were integrated into a five-point Likert scale survey (1 = completely disagree, 5 = completely agree). The following are examples of these items: "I have the necessary theoretical training to conduct research within my scientific field"; "I know the most relevant publication within my scientific field"; "I research for promotion"; and "I research for my own personal satisfaction.".

When the Delphi technique and the survey design were completed, the data collection process started, including the following:

- *Population and sample:* Because the survey design included questions related not only to human capital and motivation but also to many other different aspects of intellectual capital, we decided to address the survey to different ranks of academics (i.e., full professor, professor, associate professor, assistant professor, lecturer, postdoctoral PhD, and PhD student) and to different scientific fields of research (arts and humanities, sciences, health sciences, social and legal sciences, and engineering and architecture) in Spanish public universities
- *Spanish research system*: The Spanish research system is currently in a stage of development. Spain is ranked 11th in the world in research productivity (Cotec Report, 2018), and it has increased the production of scientific publications. The proportion of these articles published in first-quartile journals increased to 13% between 2007 and 2016 (CRUE Report, 2017). We found the analysis of the human capital used to achieve these results especially interesting.
- *Mailing process*:
    - In February 2017, the vice-rectorate for research at our university emailed vice-rectorates for research at other Spanish public universities to explain our research and to request the collaboration of their academics in responding to our survey.
    - An email that included an information letter about the research and the link to the online survey was then sent to the vice-rectorates for research at the universities, who then forwarded the email to their academics and encouraged them to participate and complete the survey (February 2017). This email generated 1,176 valid responses. Subsequently, in May 2017, a reminder note was sent, which prompted 114 additional responses and a response rate of 10.2%.

The final sample of 1,290 included responses from all academic ranks (i.e., full professor, professor, associate professor, assistant professor, lecturer, postdoctoral PhD, and PhD student). From this sample, we extracted academics with a permanent job position to provide the sample used in this study (i.e., 471 researchers). This decision was based on the logic that to ensure that the respondents included in the final sample used to configure the typology had extensive research experiences that lead them to deeply develop research competences and motives. The final sample comprised academics in different scientific fields in the following proportions: arts and humanities (15.1%), sciences (37.7%), health sciences (8.1%), social and legal sciences (23%), and engineering and architecture (16.2%). In the sample, the gender distribution was 65% men and 35% women (Table 2). The academic ranks in the sample were in the following proportions: full professors (31.8%), professors (50.5%), and associate professors (17.6%).

**Table 2:** Description of the Sample (N = 471)

| Variable | Descriptive Statistics |
|---|---|
| **Gender** | Male: 65%<br>Female: 35% |
| **Academic ranks** | Full Professors: 31.8%<br>Professors: 50.5%<br>Associate Professors: 17.6% |
| **Scientific field** | Art and Humanities: 15.1%<br>Sciences: 37.7%<br>Health Sciences: 8.1%<br>Social and Legal Sciences: 23%<br>Engineering and Architecture: 16.2% |

## Methodology and measures

***Previous data analyses***

Before conducting the cluster analysis, we first examined the descriptive statistics and described the sample characteristics to determine whether the data followed a normal distribution. In this case, the data followed a non-normal distribution. We also tested for possible nonresponse bias and concluded that it was not a serious concern in the study (($\chi^2$ university = 54.344, Sig. = 0.381; ($\chi^2$ scientific field of research = 133.657 Sig. = 0.997; ($\chi^2$ age = 30.749, Sig. = 0.968).

Additionally, preliminary analyses were conducted to examine the associations between other variables in the sample (Table 3 and Table 4). Specifically, we tested for possible relationships between scientific field, gender, h-index, and different clusters. We used the h-index to measure the researchers' productivity. Among its main advantages, Hirsch (2005) highlighted that in contrast to other measurements of productivity in academia, the h-index considers the quantity and impact of publications, and it is simple to compute and interpret (Alonso et al., 2009). Additionally, it can be obtained by any researcher through Thomson ISI Web of Science (Hirsch, 2005). Moreover, as Costas and Bordons (2007, p. 194) observed, because of its objectivity, the h-index is also useful in comparative descriptions of scientific topics (Banks, 2006), journal assessment (Braun, et al., 2006), and awarding scientific prizes (Hirsch, 2005). In another vein, authors such as Vanclay (2007) stressed the importance of the h-index in terms of its robustness, which avoids the effect of rarely cited papers.

We found significant differences derived in the tests (Table 3 and Table 4): a) the gender and h-index showed slight differences between men and women; b) the scientific fields and h-index indicated that sciences and health sciences perform better than other fields; c) the scientific fields and clusters confirmed the predominance of a certain scientific field in each cluster; d) the scientific field and gender showed that except social and legal sciences, which had equal numbers of men and women, the remaining fields showed a higher proportion of men; f) the h-index and clusters showed interesting differences between groups of academics (Table 3).

**Table 3:** ANOVA and Crosstabs

| ANOVA (human capital and motivation) | | |
|---|---|---|
| *Human capital and motivation dimensions* | F | Sig. |
| Research abilities | 67.454 | .000 |
| Scientific knowledge | 128.258 | .000 |
| Proactiveness | 20.806 | .000 |
| Accuracy | 1.724 | .161 |
| Reflexivity | 9.849 | .000 |
| Extrinsic motivation | 193.656 | .000 |
| Intrinsic motivation | 188.430 | .000 |

| ANOVA (Gender-H-index) | | | | |
|---|---|---|---|---|
| Gender | N | Mean (SD) | F | Sig. |
| Female | 134 | 9.16 (8.786) | 7.046 | .008 |
| Male | 270 | 11.84 (9.934) | | |

| ANOVA (Scientific field-H-index) | | | | |
|---|---|---|---|---|
| S. field | N | Mean (SD) | F | Sig. |
| Art & Hum | 46 | 1.59 (1.962) | 76.555 | .000 |
| Sciences | 164 | 17.74 (9.202) | | |
| Health S. | 35 | 13.80 (8.152) | | |
| Soc & Leg | 91 | 4.51 (4.067) | | |
| Eng & Arch | 69 | 8.12 (7.136) | | |

| Chi-square test (Scientific field clusters) | | | |
|---|---|---|---|
| | Value | df | Asymp. sig. (2-sided) |
| Pearson chi-square | 24.672 | 12 | .016 |
| Likelihood ratio | 25.063 | 12 | .015 |
| N of valid cases | 465 | | |

| Chi-square test (Gender-clusters) | | | |
|---|---|---|---|
| | Value | df | Asymp. sig. (2-sided) |
| Pearson chi-square | 7.278 | 3 | .064 |
| Likelihood ratio | 7.248 | 3 | .064 |
| N of valid cases | 464 | | |

| Chi-square test (Gender-scientific fields) | | | |
|---|---|---|---|
| | Value | df | Asymp. sig. (2-sided) |
| Pearson chi-square | 19,997 | 4 | ,001 |
| Likelihood ratio | 20,537 | 4 | ,000 |
| N of valid cases | 467 | | |

**Table 4:** ANOVA Research Productivity

| ANOVA (H-index-clusters) | | |
|---|---|---|
| | F | Sig. |
| H-index | 6.460 | .000 |

| | N | Mean | SD | Std. error | 95% Conf. Interval | | Min. | Max. |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lower bound | Upper bound | | |
| 1 | 105 | 13.16 | 10.485 | 1.023 | 11.13 | 15.19 | 0 | 36 |
| 2 | 160 | 11.52 | 9.216 | .729 | 10.08 | 12.96 | 0 | 37 |
| 3 | 83 | 9.93 | 9.666 | 1.061 | 7.82 | 12.04 | 0 | 36 |
| 4 | 56 | 6.57 | 7.407 | .990 | 4.59 | 8.56 | 0 | 37 |
| **Total** | 404 | 10.93 | 9.626 | .479 | 9.99 | 11.87 | 0 | 37 |

Finally, an exploratory factor analysis (EFA) was conducted to determine the underlying structure of the collected data (Table 5 and Table 6). We checked for the reliability of the measures, which is discussed in the following paragraphs. The results of the EFA yielded five human capital dimensions, which confirmed arguments based on the KSA framework (Becker, 1962). As explained in the literature review, a set of works that examined and measured academic attributes was based on traditional human capital theory, in which researcher human capital was defined according to the KSA framework. Hence, items 8–11 were labelled *scientific knowledge* (knowledge); items 12–16 were labelled *proactiveness* (skills); items 17–19 were labelled *accuracy* (skills); items 20–22 were labelled *reflexivity* (skills); and items 1–7 were labelled *research abilities* (abilities).

Regarding the motivation construct, two main dimensions were extracted, which confirmed the traditional means of assessing motivational issues in the academic context (Chen et al., 2018): 1) intrinsic (items 4–5); 2) extrinsic motivation (items 1–3) (Table 5 and Table 6). Cronbach's $\alpha$ showed reliable and valid measures of the constructs in both cases: motivation $\alpha = .617$; human capital (KSAs) $\alpha = .884$. It is generally accepted that the Cronbach 's $\alpha$ coefficient of 0.6–0.7 indicates an acceptable level of reliability, and 0.8–0.9 shows very good levels (Taber, 2018). Despite the high level of acceptability, the motivation scale included only a small number of items, which reduced the Cronbach 's $\alpha$ coefficient (van Griethuijs et al., 2015). Regarding the human capital scale, Cronbach's $\alpha = .884$ indicated the high reliability of the measure, thus avoiding the possible redundancy of two highly reliable Cronbach's $\alpha$ coefficients (0.95) (Hulin et al., 2001).

**Table 5:** Exploratory Factor Analysis of Human Capital (N = 471)

| | Items | Factors | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 1 | I know how to present and communicate my research findings. | .831 | | | | |
| 2 | I am able to fluently relate to other researchers. | .770 | | | | |
| 3 | I know how to manage research activities (thesis, research projects). | .739 | | | | |
| 4 | I know how to link observations with test results and come out with conclusions. | .703 | | | | |
| 5 | I am able to carry out research on my own. | .675 | | | | |
| 6 | I am able to adapt to changes within my research context. | .653 | | | | |
| 7 | I am able to identify research themes within my research context. | .635 | | | | |
| 8 | I have the necessary training in research methodologies and techniques. | | .732 | | | |
| 9 | I have the necessary theoretical training to conduct research within my scientific field. | | .723 | | | |
| 10 | I know the most relevant publication within my scientific field. | | .716 | | | |
| 11 | I have the required skill to obtain and manage the necessary information for the research. | | .677 | | | |
| 12 | Creative | | | .797 | | |
| 13 | Has initiative | | | .718 | | |
| 14 | Inspired | | | .626 | | |
| 15 | Observation skills | | | .522 | | |
| 16 | Disciplined | | | | .873 | |
| 17 | Organized | | | | .838 | |
| 18 | Perseverant | | | | .687 | |
| 19 | Able to accept criticism | | | | | .817 |
| 20 | Self-critical | | | | | .729 |
| 21 | Altruistic | | | | | .526 |
| | Eigenvalues | 7.042 | 2.251 | 1.370 | 1.338 | 1.091 |
| | Explained variance | 33.54 | 10.72 | 6.52 | 6.37 | 5.19 |
| | Cronbach's alpha .884 | | | | | |
| | Kaiser-Meyer-Olkin Measure of Sampling Adequacy: .896<br>Bartlett's Test of Sphericity:<br>Approx. chi-square: 4010.596<br>gl: 210<br>Significance: .000 | | | | | |

**Table 6:** Exploratory Factor Analysis of Motivation (N = 471)

| | Item | Factor | |
|---|---|---|---|
| | | 1 | 2 |
| 1 | I research for research merit. | .857 | |
| 2 | I research for financial rewards. | .754 | |
| 3 | I research for promotion. | .741 | |
| 4 | Research is part of my activity. | | .871 |
| 5 | I research for my own personal satisfaction. | | .843 |
| | Eigenvalue | 2.010 | 1.372 |
| | Explained variance | 40.19 | 27.44 |
| | Cronbach's alpha .617 | | |
| | Kaiser-Meyer-Olkin Measure of Sampling Adequacy: .599<br>Bartlett's Test of Sphericity<br>Approx.0 chi-square: 417.064<br>gl: 10<br>Significance: .000 | | |

### *Cluster analysis*

As explained in previous sections, although diverse studies were focused on the analysis of academic attributes that affect research performance, there is no clear consensus in the literature on the means of determining those traits and measuring them. Because of the lack of previous research using a profile approach to examine academics' attributes, in this study an exploratory analysis of the data is conducted (Hsu & Sandford, 2007). From an inductive perspective, the exploratory analysis provides empirical evidence for different academic profiles by applying a cluster analysis (Alverson & Skölberg, 2000). Hence, when the constructs were clarified using a one-way ANOVA and cross-tabulation, we checked the relevance of each human capital and motivation dimension in the analysis. We found that all variables except "accuracy" were significant (Table 3).

A K-means cluster analysis was then applied to identify different groups in the sample. This technique offers internally consistent and conceptually interpretable profiles that show relevant external differences (Schmitt et al., 2007). To facilitate the group selection, a hierarchical cluster analysis was applied as recommended by Ketchen and Shook (1996). A hierarchical classification was obtained from a dendrogram and the examination of a balanced number of cases per cluster. The conceptual meaning of the groups yielded four different types of researchers in the K-means cluster analysis (Figure 1).

## Discussion and conclusions

The present study offers an exploratory analysis and preliminary conclusions on academic traits and scientific productivity. It proposes a complementary set of competences and motives in a novel typology of researchers. Regarding the literature review, although several studies were focused on the antecedents of scientific performance, there was a lack of consensus on the human capital attributes that affect productivity. We therefore focused on works that examined academic attributes, instead of those that presented a broad view of the determinants of research results. In general, the literature on this topic is diverse, providing different focuses and measures. Moreover, we found that many studies were based on the assumption that "more is better." Many previous studies did not consider the question of whether academics had the required research skills instead of a specific quantity of them. In this context, we proposed a typology of academics to offer an alternative view —the "profile" approach— to examine researchers' human capital and motivation.

Because of the exploratory nature of our study, we used a Delphi panel to define constructs and measures. The results of the empirical analysis provided four different academic profiles: high vocational academics (group 1); motivated academics (group 2); self-starter academics (group 3); and reactive academics (group 4). In summary, the study contributes to the extant literature on intellectual capital by providing a novel typology of researchers, which implies the need to adopt an alternative point of view in the analysis of individual attributes in the academic context. In doing so, the research contributes to the literature by deepening human capital as a crucial dimension of the intellectual capital at universities and by extending the traditional understanding of this intangible resource.

### *Cluster description, comparison, and discussion*

C1: High vocational academics

The first group derived from the cluster analysis included 115 academics (41.7% in the sciences). Specifically, the cluster presented relatively high scores in each human capital dimension (Figure 1), showing a balanced human capital profile. Regarding motivation, the group had a significantly low score in extrinsic motivation and a relatively high and positive score in intrinsic motivation. These scores may indicate that the academics in this group could have several competences, such as identifying research topics and discussing and interpreting results. They also could have extensive theoretical and methodological knowledge, and they could identify relevant journals and publications in their areas. In addition, according to the reflexivity score, they would be able to conduct research from a proactive perspective and accept self-criticism and criticism from others. Hence, this group may understand research as a social phenomenon that is focused on the career of the researcher, collaborations, publications, and reputation in the research context what it would configure the "trading vision" of research (Brew, 2001).

Regarding motivation patterns, extrinsic factors of motivation may negatively affect the motivation of researchers in this group. In fact, the results suggested that academics may be more intrinsically motivated to do research because they view research as a vocation. That is, they consider prestige, contributions to science, and conducting research as their responsibilities more important than receiving a high salary or promotion. This pattern could be associated with senior and subsequently more experienced and established academics (Kooij et al., 2011). Additionally, the preliminary results for productivity suggested that this group had the highest h-index (Table 4), which is consistent with the results of the ANOVA test of scientific fields and the h-index (Table 3). These results indicate that sciences and health sciences are the most productive fields.

This cluster also supports our argument that there is a need to extend the traditional "more is better" approach. As shown in Figure 1, results present a balanced combination of human capital traits, leading to better research results. The results were also congruent with the arguments revealed in the literature review, thus supporting the joint and positive influence of human capital attributes and motivation preferences on academics' performance (Van Iddekinge et al., 2018). This profile was labelled high vocational academics because of the high scores in intrinsic motivation. As we will discuss in the following paragraphs, the strongest differences appeared between this cluster and the profile of reactive academics.

C2: Motivated academics

The second cluster was composed of 184 academics, mainly in the sciences (42.6%), engineering and architecture (14.7%) and arts and humanities (13%). This cluster encompassed the greatest number of academics in engineering and architecture and the arts and humanities. It included academics who showed high scores on both motivation dimensions, the most relevant of which was extrinsic motivation. They presented high scores in scientific knowledge and medium scores in the remainder of the human capital dimensions. These preliminary results may suggest that theoretical and methodological training and the knowledge and the use of relevant journals and publications are particularly important aspects when they conduct research in their respective scientific areas. Regarding motivation, although they presented positive scores in both dimensions, these academics may perceive that tenure, full professorship, high salaries, and promotions are main factors that motivate their research. In particular, as shown in Table 4, this human capital and motivation profile led to the second-highest h-index. Similar to the previous cluster, because the predominant scientific field is science, the cluster showed high levels of productivity. As in the previous cluster, the interaction between human capital and motivation may lead to better results (Van Iddekinge et al., 2018). Considering the relatively high scores on both dimensions of motivation, this cluster was labelled motivated academics. As shown in Figure 1, an important dissimilarity regarding the level of scientific knowledge and research abilities was shown between motivated academics and self-starter academics, which will be discussed in the following paragraphs.

C3: Self-starter academics

The third cluster consisted of 93 researchers who were mainly in the social and legal sciences (31.2%) and the sciences (30.1%). This group showed the highest score in research abilities, but the lowest score in scientific knowledge and reflexibility. This combination of attributes indicated that these researchers may tend to establish collaborations with diverse colleagues to conduct research and to compensate for their lack of scientific knowledge by accessing information in several scientific fields (Seibert et al., 2017). A clear balance between intrinsic and extrinsic motivation factors appeared in this cluster. These academics may tend to master certain stages of research, such as identifying topics, linking facts and results, discussing findings, and conducting and leading research. However, the results suggest that the knowledge about main publications and journals in the area or about the methodologies used in conducting research are subordinate to research skills in this group. In addition, self-criticism and criticism by others were not significant factors. The academics in this cluster were motivated both extrinsically and intrinsically to conduct research. This cluster occupied the third position in productivity (Table 4). Based on the high levels of research abilities as the most salient attribute and the combination of intrinsic and extrinsic motivation, we identified this cluster as self-starter academics.

C4: Reactive academics

The last cluster comprised 74 academics, and it was balanced in terms of scientific fields: social and legal sciences (29.7%), engineering and architecture (21.6%), sciences (20.3%), arts and humanities (14.9%), and health sciences (13.5%).

This cluster was characterized by low scores in most human capital dimensions except reflexivity, and it yielded very low levels of motivation and the predominance of extremely low intrinsic motivation (Figure 1). Based on these scores, the academics in this group may have found it especially relevant to reconsider their own research and their colleagues' research and to ask for and give feedback to improve the research in their area. The results suggested that a self-critical attitude, the capacity to accept criticism from others regarding their research, and the consideration of research as an altruistic activity were factors in this cluster. Although both motivation dimensions had low scores, it could be argued that intrinsic factors, such as satisfaction with their contribution to science or the responsibilities in their research context, would not foster these academics' intentions to research.

In this cluster, following Brew (2001) and Brew et al.'s (2016) conceptions of research, the results indicated that these academics could share the "*journey view" of research, in which "a person's identification as a researcher appear[s] diffuse and less focused*" (Brew et al., 2016, p. 694). This view could explain the relative low scores on human capital and intrinsic motivation in these individuals, who may be less engaged in research or in improving their abilities, skills, and competences because they do not truly understand the implications of research. In line with the profile of this cluster, it showed the lowest h-index (Table 4). Hence, the cluster was labelled reactive academics based on the low scores in the human capital and motivation of these researchers.

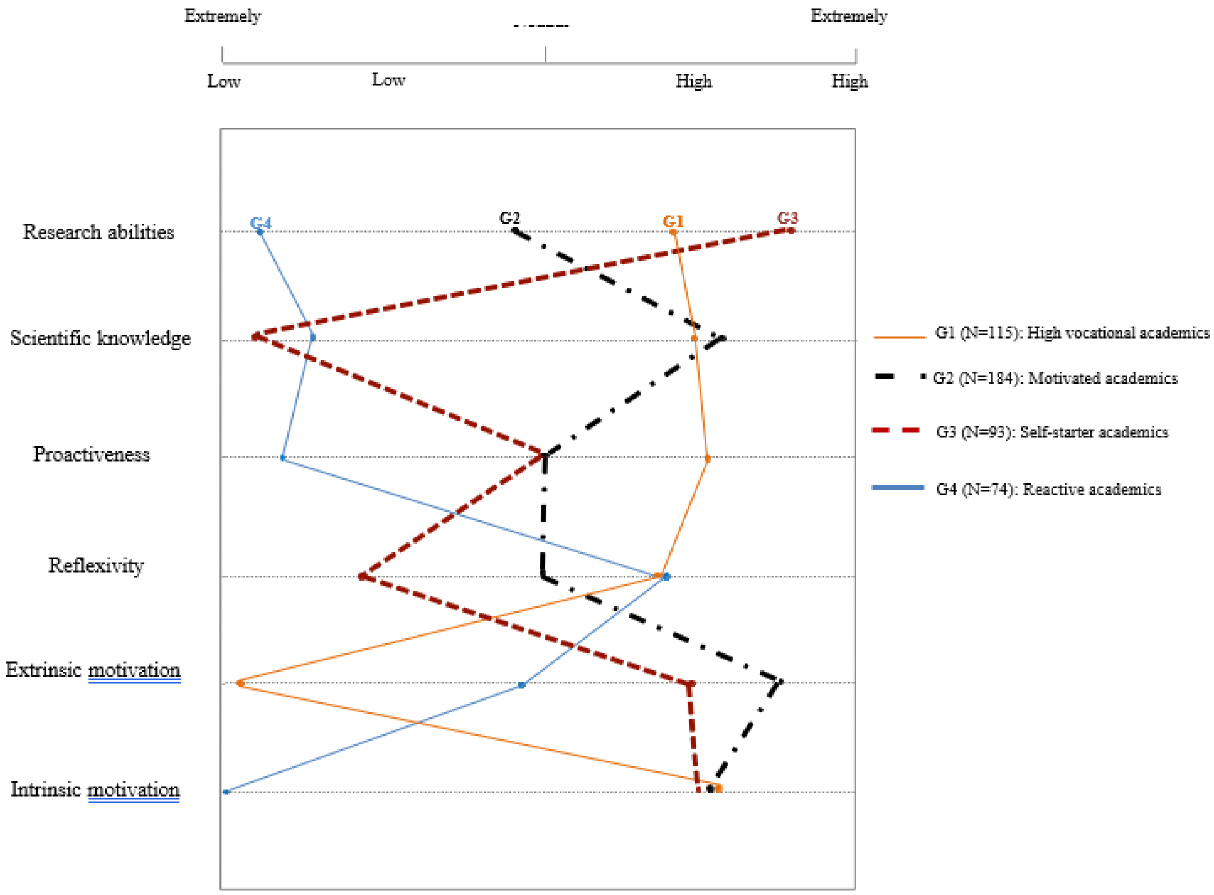
As Figure 1 shows, the proposed clusters had important differences and showed various combinations of human capital attributes and motivation levels. The principal differences appeared between reactive academics (group 4) and high vocational academics (group 1), which resulted in contrasting human capital and motivation profiles. Although both groups had similar reflexivity scores, they differed notably in the remain attributes of human capital. Reactive academics (group 4) showed the lowest scores in human capital traits, while high vocational academics (group 1) showed the most balanced and highest levels of human capital. The preliminary results suggest that the two clusters differed greatly in terms of productivity (Table 4), supporting the notion that combined, human capital and motivation may be strong antecedents of scientific productivity (Van Iddekinge et al., 2018).

The clusters motivated academics (group 2) and self-starter academics (group 3) displayed one strong dissimilarity. They exhibited contrasting levels of scientific knowledge and research abilities, which was possibly influenced by the requirements in predominant research areas. However, in this case, the differences in the h-index were not relevant (Table 4). In our view, low scores in human dimensions should not necessarily mean that the group lacked abilities or skills. Instead, these results may suggest the importance of collaboration in research processes, finding complementarities between academics, and the relevance of multi-disciplinarity in research groups (Olmos-Peñuela et al., 2014).

The results also revealed some interesting similarities among the groups, which, in our view, should be common issues in any research area. In particular, all groups showed levels of motivation, which is especially important in the context of research productivity (Ryan, 2014). In line with the previous literature, the clusters motivated academics and self-starter academics showed a combination of both types of motivation, which indicates that academics have both extrinsic and intrinsic motives for undertaking research (Olaya-Escobar et al., 2017). Additionally, with the exception of group 4, the groups displayed a certain level of reflexivity. They were self-critical, accepted criticism from others, and were altruistic in their research, which are crucial attributes in the research context. In contrast, the groups, except group 4, exhibited interesting levels of proactiveness. In research, proactivity refers to creativity, observation, and taking the initiative in research. In our view, academics should possess the human capital dimension, which enables them to conduct efficient research in any scientific field.

In brief, the typology contributes to the debate in the literature by providing an alternative perspective in analyzing academics' attributes, thus supporting the need to consider a profile of characteristics. Additionally, the typology reinforces previous arguments in the motivational literature that motivation is a driver of research competences and improved scientific results.

**Figure 1.** Comparison of academic profiles (cluster analysis)




| | G1 (N = 115) | G2 (N = 184) | G3 (N = 93) | G4 (N = 74) |
|---|---|---|---|---|
| Research abilities | . 2361061 | -.0976784 | .7404931 | -1.0596981 |
| Scientific knowledge | .3560758 | .5653304 | -1.0996141 | -.5993234 |
| Proactiveness | .2827298 | .0963483 | .0914354 | -.7614487 |
| Reflexivity | .1892393 | .0437858 | -.4647612 | .2040137 |
| Extrinsic motivation | -1.2077922 | .6855592 | .2111159 | -.0929806 |
| Intrinsic motivation | .3475158 | .3491947 | .2339824 | -1.7023852 |

Extremely low: < –1.5; Low: < -0.5; Neutral ≅ 0; High: > 0.5; Extremely high: > 1.5

### *Management implications, limitations, and future directions*

Regarding the managerial implications of our results, the present research elucidates issues that should be considered by diverse stakeholders. On one hand, the typology may be useful for individual researchers, such as scholarship holders or junior researchers because it could guide them in conducting a self-evaluation of their skills, motivation levels, and sources. The typology could also be useful in choosing research training options at the beginning of their careers. On the other hand, the typology offers research group leaders and principal investigators (group level) and public managers (university level) guidelines for designing and implementing policies and practices. Regarding principal investigators, by knowing the set of competences that describe their research group would be useful in improving team functioning and management. For example, they may identify internal synergies between team members and connect them with individuals who have complementary competences. Hence, promoting internal communication may be an important driver in connecting researchers and improving performance (van der Weijden et al., 2008). Furthermore, the typology may help leaders to use different tools to involve researchers with different levels and kinds of motivation, such as by giving them responsibilities based on their particular attributes.

From the perspectives of policy-makers and managers as well as the miscellaneous composition of the presented clusters, it is clear that these profiles may help universities to focus on the specific needs of researchers and scientific fields rather than proposing a homogeneous and universal set of policies. In this vein, the typology could be particularly useful in designing human resource policies and practices in managing human capital and motivation. Hence, instead of designing universal practices for all academic staff or different scientific fields, specific practices, such as training, research team practices, and research visits, could be oriented to specific needs. Examples include improving research networks, the English language domain, and communication skills.

In addition, because not all phases in research processes require the same academic abilities and skills to be implemented, there is a need to develop efficient tools to manage the internal dynamics of research groups. Hence, they would be able to cope with multi-disciplinarity and its effects on research performance (Olmos-Peñuela et al., 2014). To this end, policies oriented to generating internal and external social capital would be useful in groups 1 (high vocational academics), 2 (Motivated academics), and 3 (self-starter academics) (Youndt & Snell, 2004). Although the high vocational academics cluster presented relatively high levels of human capital and motivation, which suggested that these academics were able to apply a complete process of research in their scientific domain, it would be interesting to motivate and foster the collaboration between team members and among research groups with the goal of creating strong research networks (Kyvik & Reymert, 2017). In doing so, a broad view of research and the complementarities and synergies between groups could be result, thereby generating, for example, participation in international projects and research projects in collaboration with enterprises.

For example, motivated academics may understand that collaboration is a relevant tool for completing the human capital profile by increasing the level of research abilities, such as identifying topics and interpreting results, or proactiveness, thus providing other research groups with the scientific knowledge needed to conduct studies and research. Similarly, self-starter academics could benefit from collaboration by gaining human capital attributes, such as scientific knowledge and reflexivity, from other groups and researchers.

Developmental policies and practices, such as those regarding training and motivation practices (Youndt & Snell, 2004), are required to improve the human capital and motivation profile of the last cluster, reactive academics. Through specific training, these academics may acquire the required competences, such as applying methodologies and managing relevant sources of information. Seminars on researcher philosophy and practices could be offered to develop the specific knowledge required to conduct research in their scientific domains. The intrinsic motivation of reactive academics could be fostered by increasing their understanding of what a research career entails as well as their involvement with the university.

Our study has the following limitations, and the findings should be considered accordingly. Because the research examined possible combinations of human capital and motivation attributes, the results did not reveal the possible synergistic effects of such characteristics. Future research should be focused on examining the researchers' profiles in detail and determining the optimal combination of attributes required to conduct research efficiently. Another limitation of the study is that the sample was comprised only of respondents in Spain, which hinders the generalization of the results. To address this limitation, in future research, our preliminary results and conclusions could be compared with those obtained in different contexts. Additionally, the data in our study were collected from individual respondents, which may have led to possible biases. In a future study, a group survey could be developed to minimize the risk of bias. Our study also has limitations regarding productivity measurement. However, the focus of our study did not include researcher productivity. We introduced the h-index as an additional variable in the cluster analysis to obtain preliminary results showing how groups of researchers perform. We are aware of the limitations of the h-index as a productivity indicator. Although it is widely accepted, the h-index is constrained in establishing comparisons between researchers and disciplines (Hirsch, 2005). We are also conscious of the need to implement joint analyses of research productivity by using different measures. Therefore, we suggest that the analysis of scientific productivity be extended in future research.

## References


Agarwal, R., and Ohyama, A. (2013). "Industry or academia, basic or applied? Career choices and earnings trajectories of scientists", *Management Science*, Vol. 59 No. 4, pp. 950–970.

Aksnes, D.W., Rørstad, K., Piro, F.N., and Sivertsen, G. (2011). "Are female researchers less cited? A large-scale study of Norwegian scientists", *Journal of the American Society for Information Science and Technology*, Vol. 62 No. 4, pp. 628–636.

Alonso, S., Cabrerizo, F. J., Herrera-Viedma, E. and Herrera, F. (2009). "H-Index: A review focused in its variants, computation and standardization for different scientific fields", *Journal of Informetrics*, Vol. 3 No. 4, pp. 273–289.

Alverson, M. and Skölberg, K. (2000). *Reflexive methodology*. Sage, London.

Amabile, T. M. (1994). "The atmosphere of pure work: Creativity in research and development", *The social psychology of science*, pp. 316–328.

Baldini, N. (2011). "University patenting: patterns of faculty motivations", *Technology Analysis and Strategic Management*, Vol. 23, pp. 103–121.

Balsmeier, B., and Pellens, M. (2016). “How much does it cost to be a scientist?”, *The Journal of Technology Transfer*, Vol. 41 No. 3, pp. 469–505.

Banks, M. G. (2006). “An extension of the Hirsch index: Indexing scientific topics and compounds”, *Scientometrics*, Vol. 69 No. 1, pp. 161–168.

Becker, G. S. (1962). “Investment in human capital: A theoretical analysis”, *Journal of political economy*, Vol 70 No. 5 (Part 2), pp. 9–49.

Bentley, P. (2012). “Gender differences and factors affecting publication productivity among Australian university academics”, *Journal of Sociology*, Vol. 48 No. 1, pp. 85–103.

Bozeman, B., and Corley, E. (2004). “Scientists’ collaboration strategies: implications for scientific and technical human capital”, *Research policy*, Vol. 33 No. 4, pp. 599–616.

Bozeman, B., Dietz, J. S. and Gaughan, M. (2001). “Scientific and technical human capital: an alternative model for research evaluation”. *International Journal of Technology Management*, Vol. 22 No. (7–8), pp. 716–740.

Braun, T., Glänzel, W., and Schubert, A. (2006). “A Hirsch-type index for journals”, *Scientometrics*, Vol. 69 No.1, pp. 169–173.

Brew, A. (2001). “Conceptions of research: A phenomenographic study”, *Studies in Higher Education*, Vol. 26 No. 3, pp. 271–285.

Brew, A., Boud, D., Namgung, S. U., Lucas, L., and Crawford, K. (2016). “Research productivity and academics’ conceptions of research”, *Higher Education*, Vol. 71 No. 5, pp. 681–697.

Chen, H., Baptista Nunes, M., Ragsdell, G., and An, X. (2018), “Extrinsic and intrinsic motivation for experience grounded tacit knowledge sharing in Chinese software organisations”, *Journal of Knowledge Management*, Vol. 22 No.2, pp. 478–498.

Corley, E. A., Bozeman, B., Zhang, X., and Tsai, C. C. (2019). “The expanded scientific and technical human capital model: The addition of a cultural dimension”, *Journal of Technology Transfer*, pp. 1–19.

Costas, R., and Bordons, M. (2007). “The h-index: Advantages, limitations and its relation with other bibliometric indicators at the micro level”, *Journal of Informetrics*, Vol. 1 No. 3, pp. 193–203.

Deci, E. L., and Ryan, R. M. (2000). “The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior”, *Psychological Inquiry*, Vol. 11 No. 4, pp. 227–268.

Dietz, J. S., and Bozeman, B. (2005). “Academic careers, patents, and productivity: industry experience as scientific and technical human capital”, *Research policy*, Vol. 34 No. 3, pp. 349–367.

Dunkin, R. (2003). “Motivating knowledge workers”, *Higher Education Management and Policy*, Vol. 15, pp. 41–49.

Dzenopoljac, V., Yaacoub, C., Elkanj, N., and Bontis, N. (2017). “Impact of intellectual capital on corporate performance: Evidence from the Arab region”, *Journal of Intellectual Capital*, Vol. 18 No. 4, pp. 884–903.

Ferreira, A., and Franco, M. (2017). “The mediating effect of intellectual capital in the relationship between strategic alliances and organizational performance in Portuguese technology-based SMEs”, *European Management Review*, Vol. 14 No. 3, pp. 303–318.

Fullwood, R., Rowley, J., and Delbridge, R. (2013). “Knowledge sharing amongst academics in UK universities”, *Journal of Knowledge Management*, Vol. 17 No.1 pp. 123–136.

Gagné, M., Forest, J., Gilbert, M. H., Aubé, C., Morin, E., and Malorni, A. (2010). “The motivation at work scale: Validation evidence in two languages”, *Educational and Psychological Measurement*, Vol. 70 No. 4, pp. 628–646.

Gaughan, M., and Corley, E. A. (2010). “Science faculty at US research universities: The impacts of university research center-affiliation and gender on industrial activities”, *Technovation*, Vol. 30 No. 3, pp. 215-222.

González-Brambila, C., and Veloso, F. M. (2007). “The determinants of research output and impact: A study of Mexican researchers”, *Research Policy*, Vol. 36 No.7, pp. 1035-1051.

Goudard, M., and Lubrano, M. (2012). “Human capital, social capital and scientific research in Europe: An application of linear hierarchical models”, *The Manchester School*, Vol. 81 No. 6, pp. 876–903.

Harmon-Jones, E., Harmon-Jones, C., and Price, T. F. (2013). “What is approach motivation?”, *Emotion Review*, Vol. 5 No. 3, pp. 291–295.

Harris, G., and Kaine, G. (1994). “The determinants of research performance: A study of Australian university economists”, *Higher Education*, Vol. 27 No. 2, pp. 191–201.

Hebda, J. M., Vojak, B. A., Griffin, A., and Price, R. L. (2012). “Motivating and demotivating technical visionaries in large corporations: A comparison of perspectives”, *R&D Management*, Vol. 42 No. 2, pp. 101–119.

Hirsch, J. E. (2005). “An index to quantify an individual’s scientific research output”. *Proceedings of the National Academy of Sciences*, Vol. 102 No. 46, pp. 16569–16572.

Horodnic, I. A., and Zaiţ, A. (2015). “Motivation and research productivity in a university system undergoing transition”, *Research Evaluation*, Vol. 24 No. 3, pp. 282–292.

Hsu, C. C., and Sandford, B. A. (2007). “The Delphi technique: making sense of consensus”, *Practical assessment, research and evaluation*, Vol. 12 No. 10, pp. 1–8.

Hulin, C., Netemeyer, R., and Cudeck, R. (2001). "Can a reliability coefficient be too high?", *Journal of Consumer Psychology*, pp. 55–58.

Jonkers, K., and Tijssen, R. (2008). "Chinese researchers returning home: Impacts of international mobility on research collaboration and scientific productivity", *Scientometrics*, Vol. 77 No. 2, pp. 309–333.

Kamalanabhan, T. J., Uma, J., and Vasanthi, M. (1999). A delphi study of motivational profile of scientists in research and development organisations. *Psychological Reports*, Vol. 85 No. 3, pp. 743–749.

Karle, J. (1997). "The role of motivation in scientific research IV: The nature of basic research and its implications", *Interdisciplinary Science Reviews*, Vol. 22 No. 1, pp. 78–84.

Karlsson, T., and Wigren, C. (2012). "Start-ups among university employees: the influence of legitimacy, human capital and social capital", *The Journal of Technology Transfer*, Vol. 37 No. 3, pp. 297-312.

Ketchen, D. J., and Shook, C. L. (1996). "The application of cluster analysis in strategic management research: an analysis and critique", *Strategic Management Journal*, Vol. 17 No. 6, pp. 441–458.

Kleinginna, P. R., and Kleinginna, A. M. (1981). "A categorized list of motivation definitions, with a suggestion for a consensual definition", *Motivation and Emotion*, Vol. 5 No. 3, pp. 263–291.

Kooij, D. T., De Lange, A. H., Jansen, P. G., Kanfer, R., and Dikkers, J. S. (2011). "Age and work-related motives: Results of a meta-analysis", *Journal of Organizational Behavior*, Vol. 32 No. 2, pp. 197–225.

Kyvik, S., and Reymert, I. (2017). "Research collaboration in groups and networks: differences across academic fields", *Scientometrics*, Vol. 113 No. 2, pp. 951–967.

Landeta, J. (2006). "Current validity of the Delphi method in social sciences", *Technological Forecasting and Social Change*, Vol. 73 No. 5, pp. 467–482.

Lin, M. W., and Bozeman, B. (2006). "Researchers' industry experience and productivity in university–industry research centers: A "scientific and technical human capital" explanation", *The Journal of Technology Transfer*, Vol. 31 No. 2, pp. 269-290.

Llopis, O., and Foss, N. J. (2016). "Understanding the climate–knowledge sharing relation: The moderating roles of intrinsic motivation and job autonomy", *European Management Journal*, Vol. 34 No. 2, pp. 135–144.

Locke, E. A., and Latham, G. P. (1990). *A theory of goal setting and task performance*, NJ: Prentice Hall, Englewood Cliffs.

Manley, C. (1998). “Identifying common characteristics among researchers through citation analysis”, *Information Science*, Vol. 21 No. 2, pp. 75–85.

Mayrath, M. C. (2008). “Attributions of productive authors in educational psychology journals”, *Educational Psychology Review*, Vol. 20 No. 1, pp. 41–56.

McNie, E. C., Parris, A., and Sarewitz, D. (2016). “Improving the public value of science: A typology to inform discussion, design and implementation of research”, *Research Policy*, Vol. 45 No. 4, pp. 884–895.

Mehralian, G., Nazari, J. A., and Ghasemzadeh, P. (2018). “The effects of knowledge creation process on organizational performance using the BSC approach: The mediating role of intellectual capital”, *Journal of Knowledge Management*, Vol.22 No. 4, pp. 802–823.

Munshaw, S., Lee, S. H., Phan, P. H., and Marr, K. A. (2019). “The influence of human capital and perceived university support on patent applications of biomedical investigators”, *The Journal of Technology Transfer*, Vol. 44 No. 4, pp. 1216–1235.

Niu, X. S. (2014). “International scientific collaboration between Australia and China: A mixed-methodology for investigating the social processes and its implications for national innovation systems”, *Technological Forecasting and Social Change*, Vol. 85, pp. 58–68.

Nygaard, L. P. (2017). “Publishing and perishing: An academic literacies framework for investigating research productivity”, *Studies in Higher Education*, Vol. 42 No. 3, pp. 519–532.

Olaya Escobar, E. S., Berbegal-Mirabent, J., Alegre, I., and Duarte Velasco, O. G. (2017). “Researchers’ willingness to engage in knowledge and technology transfer activities: an exploration of the underlying motivations”, *R&D Management*, Vol. 47 No. 5, pp. 715-726.

Olmos-Peñuela, J., Castro-Martínez, E., and D’Este, P. (2014). “Knowledge transfer activities in social sciences and humanities: Explaining the interactions of research groups with non-academic agents”, *Research Policy*, Vol. 43 No. 4, pp. 696–706.

Piro, F. N., Aksnes, D. W., and Rørstad, K. (2013). “A macro analysis of productivity differences across fields: Challenges in the measurement of scientific publishing”, *Journal of the American Society for Information Science and Technology*, Vol. 64 No. 2, pp. 307–320..

Ployhart, R. E., Nyberg, A. J., Reilly, G., and Maltarich, M. A. (2014). “Human capital is dead: Long live human capital resources!”, *Journal of Management*, Vol. 40, pp. 371–398.

Ponomariov, B. L., and Boardman, P. C. (2010). “Influencing scientists’ collaboration and productivity patterns through new institutions: University research centers and scientific and technical human capital”, *Research Policy*, Vol. 39 No. 5, pp. 613–624.

Prpić, K. (1996). “Characteristics and determinants of eminent scientists’ productivity”, *Scientometrics*, Vol. 36 No. 2, pp. 185–206.

Quimbo, M.-A. T., and Sulabo, E. C. (2014). “Research productivity and its policy implications in higher education institutions”, *Studies in Higher Education*, Vol. 39 No. 10, pp. 1955–1971.

Ryan, J. C. (2014). “The work motivation of research scientists and its effect on research performance”, *R&D Management*, Vol. 44 No. 4, pp. 355–369.

Sangiorgi, D. and Siboni, B. (2017). “The disclosure of intellectual capital in Italian universities: What has been done and what should be done”, *Journal of Intellectual Capital*, Vol. 18 No. 2, pp. 354–372.

Sauermann, H., and Cohen, W. M. (2010). “What makes them tick? Employee motives and firm innovation”, *Management Science*, Vol. 56 No. 12, pp. 2134–2153.

Schmitt, N., Oswald, F. L., Kim, B. H., Imus, A., Merritt, S., Friede, A., and Shivpuri, S. (2007). “The use of background and ability profiles to predict college student outcomes”, *Journal of Applied Psychology*, Vol. 92 No. 1, pp. 165–179.

Schultheiss, O. C., Kordik, A., Kullmann, J. S., Rawolle, M., and Rösch, A. G. (2009). “Motivation as a natural linchpin between person and situation”, *Journal of Research in Personality*, Vol. 43 No. 2, pp. 268–269.

Seibert, S. E., Kacmar, K. M., Kraimer, M. L., Downes, P. E., and Noble, D. (2017). “The role of research strategies and professional networks in management scholars’ productivity”, *Journal of Management*, Vol. 43 No. 4, pp. 1103–1130.

Story, P., Stasson, M. F., Mahoney, J. M., and Hart, J. W. (2008). “A two-factor model of achievement motivation”, *Social Behavior and Personality*, Vol. 36 No. 5, pp. 707–708.

Taber, K. S. (2018). “The use of Cronbach’s alpha when developing and reporting research instruments in science education”, *Research in Science Education*, Vol. 48 No. 6, pp. 1273–1296.

Thienphut, D., Jiamprachanarakorn, S., Sirasirirusth, J., and Boonloisong, R. (2015). “Strategic human capital management for a new University: A case study of Suan Dusit Rajabhat University”, *Journal of Knowledge Management*, Vol. 19 No. 1, pp. 108–120..

Ulrich, W., and Dash, D. P. (2013). “Research skills for the future: Summary and critique of a comparative study in eight countries”, *Journal of Research Practice*, Vol. 9 No. 1, pp. 1–26.

Van der Heijde, C.M. and Van der Heijden, B.I.M. (2006). "A competence-based and multidimensional operationalization and measurement of employability", *Human Resource Management*, Vol. 45 No. 3, pp. 449–476.

van der Weijden, I., de Gilder, D., Groenewegen, P., and Klasen, E. (2008). "Implications of managerial control on performance of Dutch academic (bio) medical and health research groups", *Research Policy*, Vol. 37 No. 9, pp. 1616–1629.

van Griethuijsen, R. A., van Eijck, M. W., Haste, H., den Brok, P. J., Skinner, N. C., Mansour, N., and BouJaoude, S. (2015). "Global patterns in students' views of science and interest in science", *Research in Science Education*, Vol. 45 No. 4, pp. 581–603.

Van Iddekinge, C. H., Aguinis, H., Mackey, J. D., and DeOrtentiis, P. S. (2018). "A meta-analysis of the interactive, additive, and relative effects of cognitive ability and motivation on performance", *Journal of Management*, Vol. 44 No. 1, pp. 249–279.

Vanclay, J. K. (2007). "On the robustness of the h-index", *Journal of the American Society for Information Science and Technology*, Vol. 58 No. 10, pp. 1547-1550.

Vroom, V. H. (1964). Work and motivation, Wiley, New York.

Youndt, M. A., and Snell, S. A. (2004). "Human resource configurations, intelectual capital, and organizational performance", *Journal of Managerial Issues*, Vol. 16 No. 3, pp. 337–360.