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How does openness influence the impact of a scholar's research? An analysis of business scholars' citations over their careers

Mustapha Belkhouja
Grenoble Ecole de Management
12 rue Pierre Semard, 38000 Grenoble, France

*Hyungseok (David) Yoon
Leeds University Business School, University of Leeds
Maurice Keyworth Building, Leeds, LS2 9JT, United Kingdom

***Corresponding author**
Email address: h.yoon@leeds.ac.uk

Abstract
How do the effects of cognitive openness and structural openness on the research impact of business scholars vary over their careers? By analysing a longitudinal sample of 35,296 scholars who published in business and management journals, we show that the cognitive openness and the structural openness of business scholars have non-linear relationships with their research impact. In particular, we found that, whereas moderate levels of cognitive openness and structural openness are desirable for increasing young scholars' citations, a high level of cognitive openness and a low level of structural openness contribute to senior scholars' citations. This study contributes to our understanding of different search behaviour across business scholars' career paths and its implications for scholars' research impact.

Keywords: business scholar; career age; citation; openness; research impact; research performance

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1. Introduction

Business scholars are under pressure to engage in multidisciplinary (cognitive openness) and collaborative (structural openness) work to produce high-impact research, because of a growing expectation that business research should be more relevant to society (Rafols et al., 2012). Despite the importance of openness, we have relatively little understanding of its performance implications at the individual level. This is an important issue to consider because, even though most business research outputs are by-products of collaborative work (Liu et al., 2017), award-granting institutions and academic societies eventually highlight individual performance.

Most studies on individuals' openness or search behaviour have focused on investigating the effect on team or organizational performance (Dahlander et al., 2016; Kearney et al., 2009; Shin et al., 2012; Taylor and Greve, 2006). This gap is surprising, given that the task of searching for new ideas and partners through collaboration actually depends on a single individual, which eventually influences individual performance (Coff and Kryscynski, 2011; Kehoe and Tzabbar, 2015; Klein and Falk-Krzesinski, 2017; O'Kane et al., 2015). Similarly, business scholars are often rewarded with autonomy over their own work, but we know little about how individuals with autonomy search and recombine knowledge to produce high-impact research (Dahlander et al., 2016; Katz et al., 1995).

Motivated by these issues, we explain the research impact of business scholars by focusing on individual cognitive openness and structural openness. Our focus is based on the work by Klein and Falk-Krzesinski (2017), which addresses the need to evaluate individual research performance by considering the choice of discipline coverage and co-authorship. From a theoretical perspective, openness as represented in individual scholars' search behaviour is

consistent with the concepts of exploration and exploitation expressed by March (1991). Whereas exploration refers to uncertainty and risk-taking behaviours, exploitation is associated with efficiency-seeking and refinement behaviours. Exploration in the cognitive realm exposes scholars to new research domains and allows them to build bridge different disciplines (Colquitt and George, 2011); however, exploitation in the cognitive realm deepens scholars' core expertise or knowledge within the same research domain, which in both cases may increase the impact of scholars' research (Aschhoff and Grimpe, 2014).

Similarly, the scope of scholars' networks expands when they adopt an exploration strategy in a structural realm by collaborating with co-authors from institutions other than their own. External co-authorship helps them to secure a variety of resources and communication channels to enhance the impact of their research (Katz and Martin, 1997). At the same time, the impact of their research is increased by working with co-authors at the same institution and taking advantage of proximity to produce high-quality output (Hoegl and Proserpio, 2004). This is why the number of co-authored academic publications has increased over time (Crescenzi et al., 2016).

As noted, both exploration and exploitation behaviours embedded in the cognitive and structural realm of individual scholars shape their research impact. A few studies have examined how these behaviours affect the outcome of knowledge production and found not only competing results but also curvilinear relationships (Dahlander et al., 2016; Dell'Era and Verganti, 2010; Lee et al., 2015). Although these studies have made important contributions to understanding of the role of openness in knowledge production, we still lack understanding of the context in which the effects of openness on individual research performance are either attenuated or amplified.

Notably, cognitive and structural openness may have different implications on the impact of scholars' research if we consider career age. Even cognitively and structurally closed scholars could be highly cited if they have long been well established (Aschhoff and Grimpe, 2014). In fact, it is uncommon for inexperienced scholars to produce heavily cited works in the social sciences (Schilling and Green, 2011). Because it takes time for scholars to establish sufficient renown to take advantage of diverse knowledge and co-authors and produce high-impact research, junior business scholars are expected to be less inclined than senior business scholars to engage in different disciplines and/or with people from outside their organizational boundaries. With this in mind, our study also examines differences across the career age of scholars in the effects of openness on the impact of their research.

The context of our study, global business knowledge production, is ideal for examining proposed relationships between (a) cognitive openness and the impact of scholars' research and (b) structural openness and the impact of scholars' research, for the following reasons. First, producing highly cited business knowledge is the common goal of every business scholar, but individuals and organizations take different postures with regard to multidisciplinary research. Some universities and business schools ask their business scholars to conduct multidisciplinary research by extending their cognitive boundaries to recombine various knowledge domains (Rafols et al., 2012). Meanwhile, other institutions encourage their scholars to adopt a specialist approach, which may be more efficient for scholars to exploit and deepen their core knowledge domain.

In addition, business scholars rarely work alone but, rather, actively interact with either those who are nearby or those who are physically distant from them, thanks to advances in information and telecommunication technologies as well as globalization (Hoekman et al., 2010;

Katz and Martin, 1997). Although these macro-environmental changes have enlivened external co-authorship, some studies claim that they cannot substitute for face-to-face research conversations, as interaction quality plays an important role in enhancing the intrinsic quality of research (Freeman et al., 2014; Kruger et al., 2005; Ryazanova and McNamara, 2016). Other studies (Li et al., 2013; Melin, 2000) argue that interacting and collaborating with co-authors at other institutions not only contributes to enhancing the quantity and quality of research but also enhances the propensity to be cited, as it increases the number of available communication channels.

Our study makes several contributions. First, it extends the literature on openness by investigating the performance implications of exploration and exploitation behaviour embedded in individuals' cognitive openness and structural openness. This is important because individual business scholars working in such a knowledge-intensive industry are often rewarded with autonomy over their own work, but we know little about how individuals with autonomy search for and recombine knowledge (Dahlander et al., 2016; Katz et al., 1995). We therefore contribute to understanding on cognitive openness and structural openness and their relation to individual research performance.

Second, we shed new light on career age as an important boundary condition for different search behaviours in contributing to individual research performance. Although career age may directly influence individual research performance, by considering career age we explore the optimal level of openness for maximizing the impact of scholars' research (Aschhoff and Grimpe, 2014). By testing the moderating effect of career age on the relationship between the two types of openness and individual citation counts, our study takes a crucial step towards a more holistic and integrated picture of managing research performance throughout a scholar's career.

Lastly, although several attempts have been made to identify the determinants of research performance in the social and natural sciences (Leahey et al., 2017; Parker et al., 2013; Schilling and Green, 2011), we have very little knowledge about business scholars and their research output. Notably, some believe that business and management research lacks impact (Rafols et al., 2012), and, in fact, some journal articles have never been cited more than once (Hamilton, 1990). Hence, we advance understanding on enhancing research impact by investigating the drivers of business scholars' citations from the perspectives of discipline coverage and the co-authorship strategy employed by individuals.

2. Theoretical background

Openness, represented as individuals' cognitive and organizational boundaries, affect the conditions necessary for combination to occur (Nahapiet and Ghoshal, 1998). For instance, the search behaviour in cognitive (knowledge boundary) and structural dimensions (organizational boundary) helps individuals to produce high-impact research (Melin, 2000). Individuals' search behaviour embedded in cognitive and structural realms can be explained by March's (1991) dichotomy between exploration and exploitation (Perretti and Negro, 2006). Several studies on openness and search behaviour (Felin and Hesterly, 2007; Laursen and Salter, 2006; Love et al., 2011) draw upon March's dichotomy by focusing on outward-looking aspects of exploration and exploitation.

In the cognitive realm, whereas exploration refers to collaborating with scholars in different knowledge domains or disciplines, exploitation refers to collaborating with scholars in the same knowledge domain. Both outward-looking exploration and exploitation enable scholars to obtain new cognitive capital. Whereas exploration extends shared understanding and applies

new knowledge in the discipline to an enlarging collective, exploitation deepens shared understanding and known knowledge within the same cognitive boundary (Li et al., 2013; Perretti and Negro, 2006). Whereas the former strategy helps a scholar acquire a broader perspective of the discipline, the latter encourages a scholar to become a specialist (Li et al., 2013).

These outward-looking exploration and exploitation behaviours in the cognitive realm focus on collective heterogeneity via team composition (Cunningham et al., 2016; O'Kane et al., 2015; Shinn, 1982), but Felin and Hesterly (2007) argue that nested (individual-level, a priori) heterogeneity may provide a better explanation of knowledge search behaviour with a focus on inward-looking exploration and exploitation. Although a few scholars have argued for the primacy of the individual (Simon, 1991), most have focused on a collective locus of knowledge from a cognitive perspective (Felin and Hesterly, 2007). As Nooteboom (2009: 66-67) states, 'people will perceive, interpret, understand and evaluate the world differently to the extent that they have constructed their cognition along different, weakly connected life paths'. Likewise, individual cognitive openness creates opportunities for the recombination of heterogeneous knowledge inputs (Nelson and Winter, 1982). Accordingly, we address how cognitive openness or a multidisciplinary background that scholars already possess can shape their research impact.

In addition to cognitive openness, search behaviour in the structural realm is important, as the fate of research output is influenced not only by the existing composition but also by forming a new team of co-authors (Schilling and Green, 2011; Schilling and Phelps, 2007). On the one hand, an internal or bonding view, as suggested by Coleman (1988), focuses on the emergence of effective norms that promote trustworthiness within a community and thus strengthen performance outcome (Rost, 2011). This corresponds with scholars' exploitation behaviour in the structural realm, as it confines scholars to a smaller group (Li et al., 2013).

On the other hand, Burt (1992) highlights the importance of external ties for competitive advantage by adopting an external or bridging view. Likewise, scholars' exploration behaviour in the structural realm helps scholars to expand the scope of their network (Li et al., 2013). Business scholars actively interact with either those who are near their offices or those who are physically distant. Although business scholars take the formation of virtual teams for granted because of globalization and enhanced connectivity (Eisend and Schmidt, 2014), we do not have a complete picture of how structural openness adopted by individual scholars can shape the impact of their research.

3. Hypotheses development

3.1. Cognitive openness and the impact of scholars' research

Following the work of Nelson and Winter (1982) and Nooteboom (2009), we define cognitive openness as the extent to which individuals are open to other knowledge domains, which is reflected in their past record of journal publication. Exposure to heterogeneous knowledge domains improves the novelty and quality of individual research output, as cognitive diversity stimulates new elaborations and trials (Rodan and Galunic, 2004). Research outputs that draw from the same knowledge domain or academic discipline for extensions of ideas tend to become more insular over time and hamper the emergence of novel solutions (Colquitt and George, 2011). Business scholars with exposure to disparate intellectual domains should be competent to communicate their research output to broad audiences, thereby generating a higher research impact (Leahey et al., 2017). Because atypical and novel combinations of ideas have a greater impact (Schilling and Green, 2011; Uzzi et al., 2013), audiences that expect new business ideas or insights should be attracted to research work produced by scholars with a

multidisciplinary background. Moreover, cognitive openness leads to epistemic curiosity, which triggers information seeking and motivates individuals to develop an understanding of differing and dissenting perspectives that could eventually enhance the impact of research (Mitchell et al., 2009).

Although the diversity of knowledge possessed by one individual is a way of expanding the scientific frontier of research outputs, a contrasting view holds that such multidisciplinary individuals may have difficulty producing highly impactful work. This is simply because covering multiple knowledge domains limits mastery and dilutes identity, resulting in a 'jack-of-all-trades' who is a master of none of them (Leahey et al., 2017). In fact, individuals' heterogeneous knowledge base may not add more value to generating novel outcomes but, rather, make absorption and integration more difficult after a certain point (Lee et al., 2015). Likewise, a high level of cognitive openness from exposure to a variety of knowledge domains and experimentation with new combinations based on having a multidisciplinary background does not necessarily add value to a scholar's core expertise (Fleming, 2001; Foster et al., 2015). In this vein, recent studies (Arora et al., 2016; Dell'Era and Verganti, 2010; Laursen and Salter, 2014) argue that cognitive openness stimulates elaboration and enhances performance up to a point, after which it becomes detrimental. Hence, we posit our first hypothesis as follows:

H1. Cognitive openness and the impact of scholars' research have an inverted-U-shaped relationship.

3.2. Structural openness and the impact of scholars' research

Following the work of Gouldner (1957), which theorized that, whereas 'locals' demonstrate commitment and loyalty by orienting themselves toward affairs internal to the organization, 'cosmopolitans' are oriented toward collaborators outside their organization, we define structural openness as the extent to which individuals are open to collaborating with people from outside their organization. Business scholars can enhance their research impact by gaining access to external parties in order to obtain complementary resources (Nahapiet and Ghoshal, 1998). Fruitful collaborations with external co-authors can increase scholars' research impact, as they provide access to databases, expertise, prestige, funds, equipment, and language skills that those scholars might lack (Eisend and Schmidt, 2014; Katz and Martin, 1997). In addition, structural openness provides individuals with access to a valuable source of information (e.g. 'who you know' affects 'what you know'). The access allows individuals to obtain a valuable piece of information through efficient screening embedded in a network and effectively promote their research output (Ter Wal et al., 2016).

Despite the benefits of structural openness, individuals may 'over-search', and this will have negative consequences for the impact of their research (Laursen and Salter, 2006). Koput (1997) explains that over-searching makes individuals manage and choose from a wide range of external resources that may come at the wrong time and in the wrong place to be properly integrated into these scholars' knowledge base. Similarly, over-dependence on external co-authors may hinder individuals from allocating the proper level of attention to implementing and producing high-impact research. Furthermore, the development of novel research projects entails experiencing high levels of ambiguity and uncertainty, which necessitates ongoing coordination of task activities (Hoegl and Proserpio, 2004). Such ongoing synchronization of task activities

can be better achieved if scholars' co-authors are from the same institution. Taken together, we expect that, at a certain point, structural openness becomes disadvantageous to the impact of a scholar's research. Hence, we posit our second hypothesis as follows:

H2. Structural openness and the impact of scholars' research have an inverted-U-shaped relationship.

3.3. Moderating role of career age

Another important factor in explaining the impact of scholars' research is career age, which is the length of each individual scholar's research experience. Prior studies reveal both positive and negative effects of career age on research performance (Aschhoff and Grimpe, 2014). Holly (1977) finds a curvilinear relationship in which an increase in research performance occurs before a tenure announcement and a rapid decrease in research productivity occurs after a tenure announcement. This shows that the variation in individual research performance depends on the length of time spent in academia (Eisend and Schmidt, 2014). We therefore investigate the optimal level of openness to understand the maximization of the impact of scholars' research based on career age.

Solo-authored research output produced at the beginning of scholars' research career does not yield many citations, because of a lack of know-how on conducting and generating high-impact research. Junior business scholars can overcome this shortcoming by exposing themselves to a variety of cognitive or knowledge domains to develop their research competence and gain enough absorptive capacity. However, junior business scholars may find it cognitively taxing and time consuming to grasp new ideas and perspectives from other disciplines. Those who do not have enough publishing experience or know-how to properly position and frame their research

papers may have a hard time producing quality output that generates a high number of citations. In this sense, junior scholars may be more likely to occupy narrow information environments and to be stuck in an academic knowledge corridor close to their core expertise (Huyghe et al., 2016). Likewise, as newcomers to academia, they need to create the external perception that they are legitimately operating in the scholarly community. In fact, specializing in a narrow knowledge domain is essential for scholars early in their career to establish an academic reputation (Gittelman and Kogut, 2003; Link and Scott, 2005).

From a structural perspective, working with external co-authors can produce frustration and conflict (Leahey et al., 2017). In particular, junior scholars may not have enough experience to collaborate with co-authors outside their own organization. Such a lack of co-authorship experience may give junior scholars problems related not only to their productivity but also to the quality of their research output. However, junior scholars can search for and gain access to complementary resources outside their organizational boundaries through research collaboration with co-authors at other institutions. This is why many business schools and universities encourage their doctoral students to visit institutions in other countries to accumulate co-authorship experience before entering the academic job market.

Senior scholars have more opportunities than junior scholars for exposure to other cognitive or knowledge domains and for collaborating with researchers at other institutions (Huyghe et al., 2016). Although experienced business scholars might enjoy exploring new knowledge domains and collaborators to produce impactful research, Eisend and Schmidt (2014) find that the strategy of openness becomes less advantageous for business scholars after they gain research experience, as the need for complementary knowledge decreases. Likewise, individuals' accumulated research experience could make them complacent and more inclined to exploit

existing competencies by relying on familiar knowledge and routines. This leads to increasingly incremental ideas, thereby diminishing the likelihood of generating a breakthrough idea (Audia and Goncalo, 2007). As individuals accumulate experience in a certain routine, they may gain competence and expertise in that routine. In other words, even as acquired knowledge makes individuals proficient at performing a particular task, it may also lead them to overestimate their chances of future success in that domain and to focus on exploiting existing capabilities, instead of exploring new ones (March, 1991).

From a purely structural point of view, senior scholars may have more experience than junior scholars in interacting and collaborating with co-authors at organizations other than their own. In this sense, resource- and reputation-rich senior scholars know how to attract and manage their external co-authors better than junior scholars. However, the method of communication may be detrimental to senior scholars' structural openness. Whereas the younger generation of scholars may be more accustomed to virtual and long-distance communication methods in their research activities, older scholars may prefer face-to-face conversation and thus collaborating with those who are located nearby (Freeman et al., 2014; Ryazanova and McNamara, 2016).

Overall, competing perspectives exist on the role of a scholar's career age on the relationship between the two types of openness and the impact of scholars' research. This reasoning leads us to posit the following hypotheses:

H3a. The relationship between cognitive openness and the impact of scholars*'* research is contingent on *those scholars'* career age.

H3b. The relationship between structural openness and the impact of scholars*'* research is contingent on *those scholars'* career age.

Insert Figure 1 here

4. Methods

4.1. Data and sample

Using the Web of Science database, we created a dataset of articles published from 1994 to 2013 in all the peer-reviewed journals that cover all the relevant research subjects in business and management. This enabled us to identify 159,169 journal articles published in 320 business and management journals. The Web of Science database contains detailed information on each journal article, including author names, author affiliations, article title, year of publication, type of publication, journal name, and—of particular interest to us—the number of citations. After cleaning the data, removing all the papers that lack relevant information, such as author names or author affiliations, and checking for other inconsistencies, we end up with 116,270 journal articles with complete information (73% of the 159,169 journal articles) to 20 disciplines based on the ABS journal guide classification, as shown in Table 1.

Insert Table 1 here

Because the level of our analysis is individual business scholars, we rearranged the data, creating individual yearly records for all the authors (scholars). Each scholar is given credit for an annual number of citations. For instance, if a journal article with three authors received 10 citations in a particular year, each author is credited with 10 citations for that year. Hence, the yearly number of citations for each scholar is the number of citations earned in that year by all the articles that scholar has published. To accurately measure prior knowledge output (past

publications and citations) as well as career age, we restricted our sample to scholars who started publishing in 1997. In other words, we excluded from our sample all scholars who published journal articles before 1997 to avoid any left censoring bias.

We further limited our sample to scholars who published at least two articles over the period of analysis (1997-2013) to avoid possible misunderstanding of the cognitive openness measure and ensure that our results are not driven by unproductive individuals. For instance, the low score of cognitive openness for a scholar with one publication is simply due to that scholar's low productivity and not due to specializing in a single knowledge domain. After considering these issues, we obtained a final sample in an unbalanced panel, with 282,031 observations for 35,296 authors over the period 1997 to 2013.

4.2. Variables

4.2.1. Dependent variable

Our dependent variable (Yearly citations) measures the impact of a scholar's research by computing the number of citations that scholar received in a given year, which is viewed as 'frozen footprints on the landscape of scholarly achievements' (Cronin, 1984). Scholars' citation counts give a good indication of their research impact, and, for this reason, they are factored into promotion and tenure decisions (Leahey et al., 2017). Following previous studies (e.g., Azoulay et al., 2013; Furman and Stern, 2011), we used the yearly number of forward citations that each journal article receives to construct a yearly citation count per scholar, as explained in the data and sample section.

4.2.2. Independent and moderating variables

To construct our independent variable Cognitive openness, we first assigned the 20 subject areas or disciplines proposed by the ABS Guide 2015 to the 320 journals included in our dataset and then counted how many different disciplines a given author has covered according to his journal publications up to the current year. Our approach is justified, as prior studies (Dell'Era and Verganti, 2010; Mitchell et al., 2009; Wang et al., 2017) show that being exposed to diverse knowledge domains affects the quality and impact of research.

Our second independent variable, Structural openness, refers to the extent to which scholars collaborate with co-authors at institutions other than their own. Individuals who have external co-authors can gain access to complementary resources and expertise that shape the quality and impact of their research output (Tzabbar et al., 2013). The variable was constructed by dividing the yearly lagged cumulative number of external co-authors by the yearly lagged cumulative number of co-authors of a given scholar, which ranges from 0 (exclusively internal co-authorship) to 1 (exclusively external co-authorship).

The moderating variable Career age is the length of a scholar's academic research career up to the focal year, which is an important element behind individual research performance (Dahlander et al., 2016; Simonton, 1997). After identifying the year of a scholar's first publication (journal article), we measured career age as the time that elapsed between the year of the first publication and the observation year (Aschhoff and Grimpe, 2014).

4.2.3. Control variables

We control for a wide range of variables that may influence variation in the number of yearly citations. First, because highly cited scholars are productive (Parker et al., 2013), we

control for the past productivity of scholars using their cumulative number of publications over the previous five years (Publications). Similarly, we control for the cumulative number of an author's publications in the Financial Times' top 45 journals list over the previous five years (FT45 publications), because articles published in top journals are more likely to be cited (Judge et al., 2007; Leimu and Koricheva, 2005a; Parker et al., 2013). Because scholars' prior citations represent their academic recognition, which can influence scholars' current citations (Heckman and Borjas, 1980; Stuart, 2000), we control for the cumulative number of citations received by a scholar's publications over the previous five years (Prior citations).

Second, we control for institution-specific effects by including the variable High-status institution, as the prestige of the institution signals the potential quality of research, thereby attracting citations (Crane, 1965; Helmreich et al., 1980; Judge et al., 2007). We created a binary variable coded as 1 (one) if the focal scholar is affiliated with a high-status institution in a given year based on the annual UT Dallas (UTD) Top 100 worldwide business school research ranking, and 0 (zero) otherwise. The UTD Naveen Jindal School of Management has created a database to track institutions' publications in 24 leading business journals and provide top 100 business school research rankings since 1990 (Jensen and Wang, 2018).

Third, we control for specific co-author characteristics, because the focal scholar's academic network may boost an individual's research exposure in different communities. Co-authored publications tend to receive more citations than those with a single author (Asknes, 2003; Kostoff, 2007; Leimu and Koricheva, 2005b; Nemeth and Goncalo, 2005). We included the variable Unique co-authors by counting the number of researchers with whom each focal scholar has published up to the focal year. We also control for how often the focal scholar has worked with the same co-authors in the past. After identifying all the co-authors with whom each

focal scholar has already worked until the focal year, we calculated the strength of each co-authorship as the number of times the focal scholar has previously worked with each co-author. The variable Repeated co-authorship was operationalized as the average strength of all prior co-authorships.

In addition, we control for a scholar's mobility (Mobility) by counting how many times a focal scholar has moved to different institutions since obtaining the first affiliation up to the focal year. Mobility helps scholars to expand their scholarly network, thereby contributing to their research performance (Mortensen and Neeley, 2012).

Furthermore, scholars may benefit from the reputation of their co-authors in enhancing research impact. In fact, scholars can earn more citations by co-authoring with highly cited scholars or scholars who are affiliated with high-status institutions, which is known as the Matthew's effect (Merton, 1968). We included two variables to capture the Matthew's effect derived from co-authors: the cumulative number of citations received by scholars' co-authors over the previous five years (Co-authors' citations) and the number of unique co-authors affiliated with high-status institutions (High-status co-authors), according to the UTD Top 100 worldwide business school research ranking.

Because the yearly citations may vary over time, we control for systemic period effects to capture all macro time trends using dummy variables for calendar years in our sample period. Finally, most of the variables were naturally logged to facilitate interpretation of the estimates and reduce the problem of highly skewed distributions.

4.3. Estimation approach

The dependent variable (Yearly citations) is a count variable that takes only nonnegative integer values. The linear regression model is inadequate for modelling such variables, because the distribution of residuals will be heteroscedastic and nonnormal. A Poisson model is typically suggested to deal with such dependent variables (Hausman et al., 1984). However, the Poisson distribution relies on the strong assumption that the mean and variance are equal, which is untenable, because an over-dispersion is detected in the sample in many cases. The use of a Poisson model would underestimate the standard errors and inflate the statistical significance of variables (Cameron and Trivedi, 2013). A commonly used alternative is the negative binomial model, which better fits the distribution of our dependent variable and allows for robust over-dispersion (Hausman et al., 1984).

Observationally equivalent scholars may differ because of some unobservable or unmeasured characteristics. Such heterogeneity could be captured by using random- or fixed-effects estimations. We first conducted a Hausman (1978) test to check whether fixed- or random-effects models were more appropriate, however, the results were inconclusive, as the Hausman test did not converge for our data. Hence, we estimated both fixed- and random-effects models, including all the independent and control variables, and obtained qualitatively similar results.

Finally, we preferred to use the random-effects model to test our hypotheses for three reasons: (1) the random-effects model does not exclude scholars who had no citations during the observation period, which is not the case for the fixed-effects model (more observations); (2) the random-effects model is more efficient than the fixed-effects model, as it accounts for both within and between individual variations when calculating the standard errors; and (3) the

random-effects model allows for time-constant covariates estimation (more information). The random-effects negative binomial model was adjusted according to the method of maximum-likelihood estimation.

Insert Table 2 here

Regarding the correlation matrix (see Table 2), most of the bivariate correlations are moderate. Although we note that yearly citations are highly correlated with prior citations (0.70), this is to be expected. To check whether multicollinearity is a concern, we calculated the variance inflation factors (VIFs) for each variable. The maximum VIF score was 3.10, which is below the recommended tolerance level of 10. Each scholar in our sample received 9.35 citations on average during the observation period from 1997 to 2013 (M = 9.35, S.D. = 15.31).

5. Results

The results for each model, including coefficients, standard errors, and significance, are in Table 3. Model 1 estimates the effects of the control variables on the impact of scholars' research. Model 2 tests the linear and nonlinear effects of cognitive openness and structural openness on the impact of scholars' research. Model 3 examines the moderating effect of scholars' career age on relationships between the two types of openness and the impact of scholars' research. With each model, the log-likelihood value significantly increases, indicating an improvement in model fit with the addition of the proposed variables. The Wald measure of overall fit indicates a significant chi-square for each model ($p < 0.01$), confirming that the three models are significant and acceptable for interpretation.

We observe consistent effects of the control variables across all the models. Based on the results of Model 1, Publications, FT45 publication, Prior citations, and High-status institution have positive and significant effects on the impact of scholars' research. These findings confirm that scholars who are productive, publish in high-quality journals, have a good academic reputation, and are affiliated with prestigious institutions tend to earn more citations. Unique co-authors, Repeated co-authorship, and Mobility also have positive and significant effects on the impact of scholars' research, demonstrating the importance of scholars' academic network. In addition, the results reveal that scholars may benefit from their co-authors' reputation to increase their own research impact, as shown by the positive and significant signs of Co-authors' citations and High-status co-authors. In other words, co-authoring with highly cited scholars or scholars affiliated with high-status institutions can enhance the research impact of the focal scholar, which, as mentioned earlier, is known as the Matthew's effect.

Insert Table 3 here

5.1. Effects of cognitive openness and structural openness on the impact of scholars' research

To test H1 and H2, Model 2 estimates the main and squared effects of both cognitive openness and structural openness on the impact of scholars' research. The main effects of cognitive openness and structural openness on the impact of scholars' research are positive and significant ($\beta = 0.11$, $p < 0.01$; $\beta = 0.14$, $p < 0.01$) whereas their respective squared effects are negative and significant ($\beta = -0.01$, $p < 0.01$; $\beta = -0.18$, $p < 0.01$). Figure 2 depicts the curvilinear relationships (inverted-U-shaped) between these two types of openness and the impact of

scholars' research. The positive effect of cognitive openness on the impact of scholars' research is present until a given point and then drops after reaching the optimal level, which supports H1. Similarly, the structural openness and the impact of scholars' research are positively associated up to a certain level and then the relationship between these two variables becomes negative, which validates H2. These results suggest that moderate levels of cognitive openness and structural openness are required to optimize the impact of scholars' research.

Insert Figure 2 here

5.2. The moderating effect of career age

Model 3 reports the results of the full model, with the inclusion of the interaction terms between the two types of openness and scholars' career age. The linear effect of cognitive openness on the impact of scholars' research is positive and significant ($\beta = 0.51$, $p < 0.01$) whereas its squared effect is negative and significant ($\beta = -0.07$, $p < 0.01$). By contrast, the interaction between cognitive openness and career age is negative and significant ($\beta = -0.20$, $p < 0.01$), while the interaction between cognitive openness squared and career age is positive and significant ($\beta = 0.03$, $p < 0.01$). This means that an inverted-U-shaped relationship between cognitive openness and the impact of scholars' research observed in the early years of scholars' career changes in later stages of their career. In other words, the relationship between cognitive openness and the impact of scholars' research is contingent upon career age, as expected in H3a. Similarly, structural openness shows a significant and positive linear effect ($\beta = 0.77$, $p < 0.01$) and a significant and negative quadratic effect ($\beta = -0.68$, $p < 0.01$) at the beginning of scholars' careers. However, these effects become negative and positive respectively ($\beta = -0.37$, $p < 0.01$; β

= 0.29, $p < 0.01$), as career age increases. As expected in H3b, our results confirm that the relationship between structural openness and the impact of scholars' research is contingent upon career age.

Insert Figure 3 here

As interpreting the results of non-linear models is not trivial, we include Figure 3, which shows that the inverted-U-shaped relationships between the impact of scholars' research and both cognitive and structural openness first flatten as career age increases and turn into U-shaped relationships when career age increases further, albeit in different manners. This phenomenon is called a 'shape-flip', because the shape of the curves flips from an inverted U-shape to a U-shape (Haans et al., 2016). More explicitly, cognitive and structural openness have diminishing effects on the research impact of junior scholars. This suggests that moderate levels of cognitive and structural openness are required to optimize junior scholars' citations (see Figure 3, when career age equals five years). These curves flatten and become almost a straight line when career age increases (see Figure 3, when career age equals 10 years) then turn into a U-shape at later stages of a career (see Figure 3, when career age equals 15 years) which illustrates how the increase in cognitive openness is beneficial for senior scholars' citations, whereas the increase in structural openness is detrimental. The additional analyses on the marginal effects of cognitive and structural openness on the impact of scholars' research, at different levels of scholars' career age (5, 10, and 15 years), further support H3a and H3b.

In sum, our results suggest particular strategies that foster the impact of individual scholars' research depending on their career age: (1) moderate levels of cognitive openness and

structural openness for junior scholars and (2) a high level of cognitive openness and a low level of structural openness for senior scholars.

5.3. Robustness checks

We performed several additional analyses to ensure the robustness of our findings. First, we used the population-averaging method to estimate the negative binomial model (see Table 4), which also controls for individual heterogeneity and the existence of any unobserved systemic differences across individuals (Mannucci and Yong, 2017). The resulting coefficients can be interpreted as the response averaged over the population of individuals. This method accounts for the correlation in the dependent variable across observations over time—generated by the repeated yearly measurements and by other forms of nesting—by estimating the correlation structure of the error terms (Liang and Zeger, 1986). Given the potential time serial correlation between repeated measurements of the dependent variable, we used the AR(1) specification (autoregressive model of order 1) to correct for the within-panel correlation, as it seems to have a better fit with the data than other alternatives. Second, we used a three-year window instead of a five-year window to calculate all the prior measures (Publication, FT 45 Publication, and Prior citations). In both cases, the results remained stable and were qualitatively similar.

Insert Table 4 here

6. Discussion and conclusion

6.1. Theoretical implications

In the context of global business knowledge production, individuals draw upon a variety of knowledge domains and collaborate with co-authors who are outside their organizational boundaries (Klein and Falk-Krzesinski, 2017), but our understanding of individuals' search behaviour and its relation to individual research performance is limited. By using a large dataset on the research output of 35,296 business scholars, we found that the positive effects of cognitive openness and structural openness on the impact of scholars' research decrease and become negative at a certain point. After considering the moderating effect of career age, we found that whereas the cognitive openness of young scholars should be moderate, the cognitive openness of senior scholars should be high, relying on their diverse knowledge base. We also found that whereas the structural openness of young scholars should be moderate, the structural openness of senior scholars should be low, relying on co-authors at their own institution. Our findings show that different levels of cognitive openness and structural openness are required to enhance the impact of scholars' research at different career stages.

These findings contribute more broadly to discussions on exploration and exploitation theory and their implications in openness literature. Scholars using exploration and exploitation theory traditionally recommend focusing on making a choice between exploration (open) and exploitation (closed), in order to avoid being mediocre at both (Koryak et al., 2018). By showing that cognitive and structural openness have diminishing effects on the impact of scholars' research, our findings highlight the importance of balancing search behaviour (moderate level of openness) to ensure superior performance. In this vein, our study makes important theoretical contributions by showing ambidextrous search behaviour at the individual level matters for the

impact of scholars' research on average, especially for junior scholars. By contrast, when it comes to the impact of senior scholars' research, our findings show that a choice between exploration (open) and exploitation (closed) is desirable to avoid being mediocre at both. In this sense, our study highlights the importance of investigating the configuration of openness, rather than adopting a simple dichotomy between being open and being closed (Wang, 2016).

Notably, our analysis on the role of cognitive openness and structural openness offers an important micro-foundation for a theory on why the performance of human capital varies over time (Coff and Kryscynski, 2011). Although we know that individual performance varies over a career (Mannucci and Yong, 2017; Simonton, 1997), we have relatively little understanding of the variation in individual needs for cognitive and structural stimulus over that career. Our findings point out the necessity of looking at the dynamic unfolding of knowledge breadth and external co-authorship to understand how individuals generate impactful knowledge. In particular, our study challenges the assumption of an individual's cognitive homogeneity by arguing that internal variations in individuals' cognitive system shape their ability to produce high-impact research. Specifically, whereas previous studies focused on a cognitive division of labour or work within research teams (Kearney et al., 2009; O'Kane et al., 2015; Shin et al., 2012), we argue that cognitive diversity within an individual as a measure of cognitive openness is an important factor in explaining research performance. By developing and testing a theoretical framework that encompasses both the cognitive process and co-authorship strategies, we advance our understanding of how and why the impact of scholars' research varies over time.

6.2. Managerial implications

Our study offers important implications for university and business school leaders (e.g. chancellor, president, research dean) who manage the research performance of their faculty members. Universities and business schools have been struggling to identify and put in place the measures necessary for fostering impactful research by their scholars and to sustain it over time.

The conventional wisdom or advice that a young scholar can expect from the university leaders is that early in their career scholars need to gain the perception among their peers that they are legitimately operating in the academic community by specializing in a narrow knowledge domain. However, our analysis indicates that for junior scholars to have a research impact, they need to have a moderate level of cognitive openness, which should be reflected in their ambidextrous search behaviour.

In addition, our findings suggest that senior scholars benefit greatly from exposure to different knowledge domains. This could also explain why some senior scholars struggle to produce high-impact research: late-career researchers might need different resources and stimuli to be creative and generate novel ideas (Mannucci and Yong, 2017). Contemporary society expects scholars to play a central role in addressing major social challenges and issues through research, and today's great challenges are not bounded by a single specialized scholarly discipline.

Furthermore, our analyses demonstrate that, to generate high-impact research, young scholars need to actively engage in both internal and external networking. As for senior scholars, our findings suggest that co-authoring with colleagues at the same institution is more efficient in generating high-impact research. Some universities prefer their faculty members to publish papers with external collaborators rather than internal collaborators, as the evaluation metric for

accreditations and academic rankings takes into account the number of publications per faculty member. Nevertheless, interacting and co-authoring with scholars at the same institution should not be discouraged or controlled, given that communication and complex ideas to produce impactful knowledge require deep learning and interaction. Therefore, senior scholars can play a mentorship role through face-to-face meetings to help junior scholars at the same institution produce high-impact research.

6.3. Limitations and future research agenda

Because of the large size of our sample, we could not collect additional information on individual business scholars' socioeconomic characteristics (e.g. degree level, salary, academic rank) and the relationship between co-authors (e.g. PhD supervisor, colleague). Nevertheless, we considered multi-level factors by including a focal scholar, co-author, and institution-specific variables in our empirical model. In addition, when investigating the citation and search behaviour of individual scholars, we did not consider other types of publications, such as books and editorials, because of the large sample size (35,296 scholars). Instead, we focused on articles published in peer-reviewed journals (159,169 journal articles), as they are the most relevant scholarly output for business scholars. In fact, REF (Research Excellence Framework) and other research accreditation or rankings only consider peer-reviewed journal articles in research evaluation.

Despite these shortcomings, the results of our study in a global setting offer greater external validity than previous studies by taking advantage of a large global sample. Previous studies explaining the research performance of business scholars relied on survey data, which is confined to a single discipline or a few countries (Eisend and Schmidt, 2014; Judge et al., 2007;

Mingers and Xu, 2010; Ryazanova et al., 2017). The sample and variables employed to examine our hypotheses are valid, and our findings are robust, as we tested the same empirical specifications using different estimation methods (random effects and population average for the negative binomial model) and different windows (three and five years).

Our study raises additional questions and offers future research opportunities. We suggest that citation analyses in the business and management research field and beyond need to be approached in a more systemic and nuanced way with a multi-level approach. So far, studies have made little effort to categorize or explain this varying extent and nature of research impact from the receptive side (e.g. journal audiences who read and cite the journal articles). Whereas some articles are cited by scholars in the vicinity of their core research community or institution, other articles are cited by people who far away (e.g., outside their cognitive or structural boundaries). Future studies could investigate the antecedents of the overall local and global research impact by incorporating analyses of both journal articles and individual scholars. Last but not least, the choice of scholars' core discipline may affect their research impact, as the construction of their academic foundation (cognitive) and co-authorship strategy (structural) differs across disciplines (Liu et al., 2017). In this sense, future studies could investigate how the choice of disciplines can shape the impact of scholars' research.

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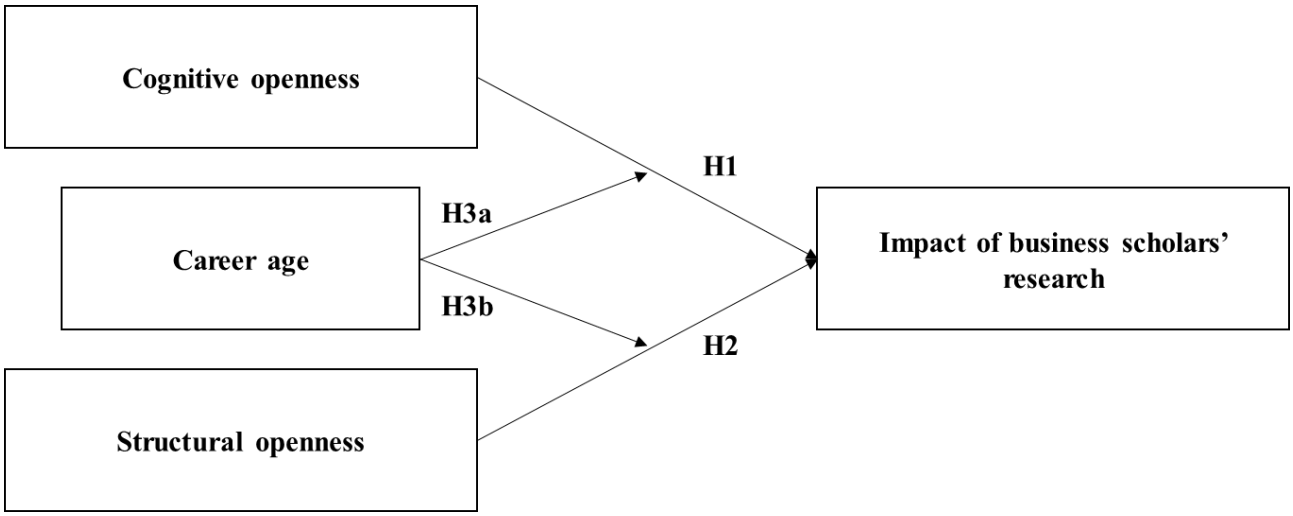
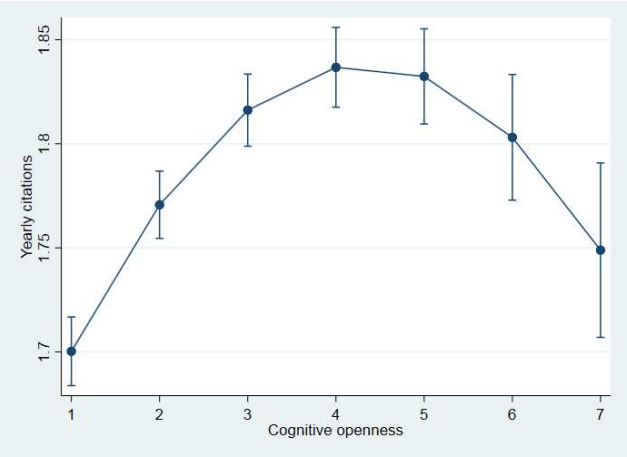


Figure 1. Research model



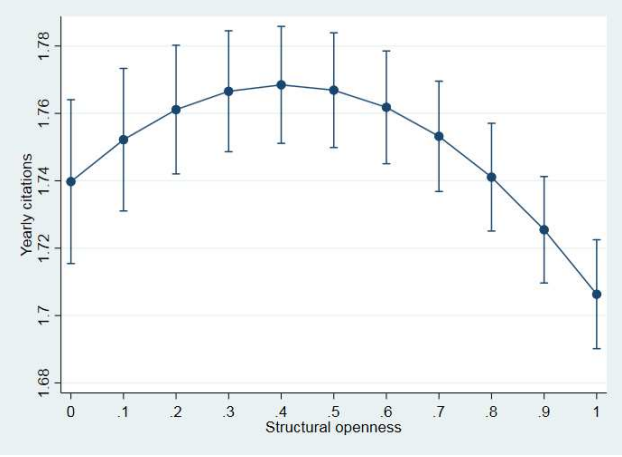
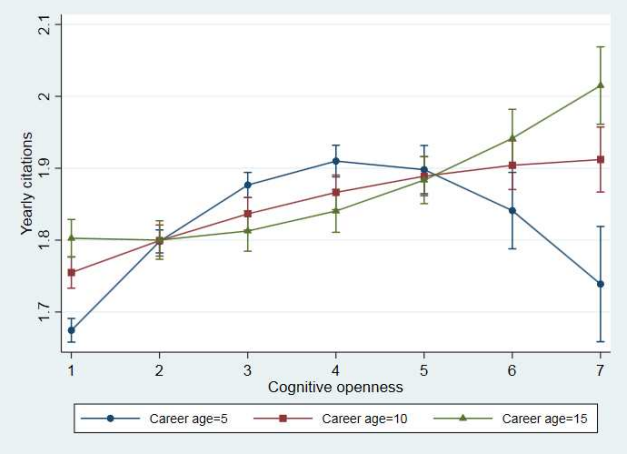


Figure 2. Predictive marginal effects of cognitive openness and structural openness on the impact (yearly citations) of scholars' research, with 95 percent confidence intervals. The figures are based on estimates from Model 2.



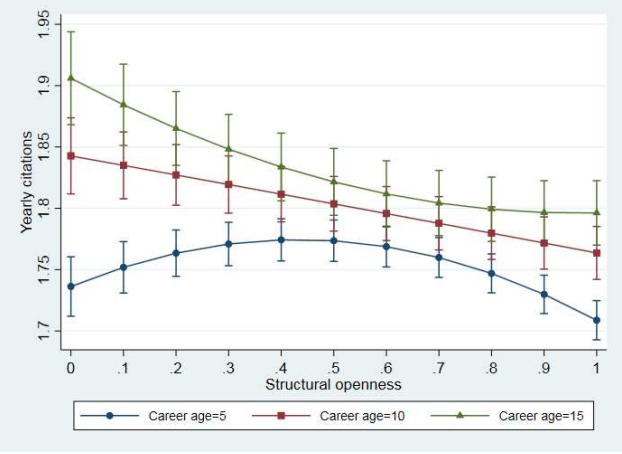


Figure 3. Predictive marginal effects of cognitive openness and structural openness on the impact (yearly citations) of scholars' research, with 95 percent confidence intervals at three different levels scholars' career age (5, 10, and 15 years). The figures are based on estimates from Model 3.

Table 1. Distribution of journal articles over disciplinary areas

*DISCIPLINES	ARTICLES	
	COUNT	PERCENTAGE
Accounting	4,750	4.09%
Business history and economic history	871	0.75%
Economics, econometrics, and statistics	7,531	6.48%
Entrepreneurship and small business management	2,959	2.54%
General management, ethics, and social responsibility	19,986	17.19%
Finance	17,978	15.46%
Human resource management and employment studies	3,867	3.33%
International business and area studies	3,563	3.06%
Information management	2,671	2.30%
Innovation	4,373	3.76%
Management development and education	516	0.44%
Marketing	12,321	10.60%
Operations and technology management	5,047	4.34%
Operations research and management science	9,831	8.46%
Organization studies	7,666	6.59%
Psychology	5,207	4.48%
Public sector and health care	222	0.19%
Sector studies	331	0.28%
Social sciences	2,514	2.16%
Strategy	1,910	1.64%
TOTAL	**116,270**	**100%**

*Source: Authors' database matched with a variety of business and management disciplines as categorized by ABS (Academic Journal Guide).

Table 2. Correlation matrix and descriptive statistics

		1	2	3	4	5	6	7	8	9	10	11	12	13
	Dependent variable													
1	Yearly citations	1.00												
	Independent variables													
2	Cognitive openness	0.34***	1.00											
3	Structural openness	0.06***	-0.02***	1.00										
4	Career age [a]	0.40***	0.34***	-0.03***	1.00									
	Control variables													
5	Publications [a]	0.14***	0.31***	-0.03***	-0.18***	1.00								
6	FT45 publications [a]	0.25***	0.14***	0.01***	-0.02***	0.42***	1.00							
7	Prior citations [a]	0.70***	0.39***	-0.02***	0.69***	-0.03***	0.15***	1.00						
8	High-status institution	0.13***	0.00	-0.04***	0.04***	0.03***	0.26***	0.11***	1.00					
9	Unique co-authors [a]	0.35***	0.44***	0.16***	0.33***	0.32***	0.18***	0.41***	0.01***	1.00				
10	Repeated co-authorship [a]	0.16***	0.11***	-0.01***	0.17***	0.19***	0.09***	0.20***	-0.02***	-0.04***	1.00			
11	Mobility [a]	0.33***	0.44***	0.06***	0.40***	0.27***	0.14***	0.41***	0.02***	0.40***	0.12***	1.00		
12	Co-authors' citations [a]	0.47***	0.32***	0.06***	0.50***	0.09***	0.18***	0.65***	0.09***	0.51***	0.11***	0.31***	1.00	
13	High-status co-authors [a]	0.30***	0.19***	0.07***	0.15***	0.17***	0.37***	0.27***	0.36***	0.39***	-0.01***	0.22***	0.36***	1.00
	Mean	9.35	1.54	0.80	1.60	0.85	0.28	2.02	0.27	1.45	0.13	0.28	3.51	0.40
	S.D.	15.31	0.79	0.28	0.78	0.47	0.43	1.58	0.45	0.55	0.23	0.42	2.05	0.51
	Min	0	1	0	0	0	0	0	0	0.69	0	0	0	0
	Max	150	7	1	2.83	2.40	2.40	6.68	1	4.66	2.30	2.20	9.60	2.77

[a] Logarithm transformed.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3. Predicting the impact (yearly citations) of scholars' research with the random-effects negative binomial model

Yearly citations	**Model 1**	**Model 2**	**Model 3**
Constant	-1.58***	-1.53***	-2.04***
	(0.07)	(0.07)	(0.07)
Publications	0.21***	0.20***	0.19***
	(0.00)	(0.00)	(0.00)
FT45 publications	0.11***	0.11***	0.11***
	(0.00)	(0.00)	(0.00)
Prior citations	0.56***	0.48***	0.51***
	(0.00)	(0.00)	(0.00)
High-status institution	0.04***	0.04***	0.04***
	(0.00)	(0.00)	(0.00)
Unique co-authors	0.13***	0.12***	0.11***
	(0.00)	(0.00)	(0.00)
Repeated co-authorship	0.24***	0.26***	0.22***
	(0.01)	(0.01)	(0.01)
Mobility	0.04***	0.02***	0.02***
	(0.00)	(0.00)	(0.00)
Co-authors' citations	0.07***	0.08***	0.08***
	(0.00)	(0.00)	(0.00)
High-status co-authors	0.02***	0.03***	0.03***
	(0.00)	(0.00)	(0.00)
Cognitive openness		0.11***	0.51***
		(0.01)	(0.02)
Structural openness		0.14***	0.77***
		(0.03)	(0.07)
Career age		0.17***	0.39***
		(0.01)	(0.01)
Cognitive openness squared		-0.01***	-0.07***
		(0.00)	(0.00)
Structural openness squared		-0.18***	-0.68***
		(0.02)	(0.05)
Cognitive openness × Career age			-0.20***
			(0.01)
Structural openness × Career age			-0.37***
			(0.03)
Cognitive openness squared × Career age			0.03***
			(0.00)
Structural openness squared × Career age			0.29***
			(0.03)
Year dummies	Yes	Yes	Yes
Number of observations	281,930	281,930	281,930
Number of authors	35,296	35,296	35,296
Log likelihood	-668,015.82	-667,741.27	-662,066.02
Chi-square	506,408.18	502,544.14	485,561.03

Standard errors in parentheses.
*p< 0.10, **p< 0.05, ***p< 0.01

Table 4. Predicting the impact (yearly citations) of scholars' research with the population average negative binomial model

Yearly citations	**Model 1**	**Model 2**	**Model 3**
Constant	-2.17***	-2.29***	-3.06***
	(0.08)	(0.08)	(0.08)
Publications	0.45***	0.43***	0.39***
	(0.00)	(0.00)	(0.00)
FT45 publications	0.23***	0.23***	0.22***
	(0.01)	(0.01)	(0.00)
Prior citations	0.66***	0.66***	0.68***
	(0.00)	(0.00)	(0.00)
High-status institution	0.05***	0.05***	0.05***
	(0.01)	(0.01)	(0.01)
Unique co-authors	0.04***	0.03***	0.03***
	(0.01)	(0.01)	(0.01)
Repeated co-authorship	0.12***	0.12***	0.10***
	(0.01)	(0.01)	(0.01)
Mobility	-0.02***	-0.02***	-0.01
	(0.00)	(0.01)	(0.00)
Co-authors' citations	0.07***	0.07***	0.07***
	(0.00)	(0.00)	(0.00)
High-status co-authors	0.01**	0.01***	0.02***
	(0.00)	(0.00)	(0.00)
Cognitive openness		0.15***	0.89***
		(0.01)	(0.03)
Structural openness		0.15***	1.19***
		(0.04)	(0.08)
Career age		-0.02***	0.47***
		(0.01)	(0.02)
Cognitive openness squared		-0.03***	-0.13***
		(0.00)	(0.01)
Structural openness squared		-0.14***	-1.03***
		(0.03)	(0.07)
Cognitive openness × Career age			-0.39***
			(0.01)
Structural openness × Career age			-0.65***
			(0.04)
Cognitive openness squared × Career age			0.06***
			(0.00)
Structural openness squared × Career age			0.55***
			(0.03)
Year dummies	Yes	Yes	Yes
Number of observations	277,695	277,695	277,695
Number of authors	32,907	32,907	32,907
Chi-square	402,783.22	420,974.45	407,316.22

Cluster-robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$