The Effect of Having a Research Chair on Scientists' Productivity

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Abstract

Having combined data on Quebec scientists' funding and journal publication, this paper tests the effect of having a research chair on the scientists' performance. The novelty of this paper is to use matching technique to understand whether having a research chair is a real cause for better scientific performance. This method compares two different sets of regressions, which are conducted on different data sets: the one with all records and another with records of matched scientists only. Two chair and non-chair scientists are called matched with each other when they have closest propensity score in terms of age, number of articles, and amount of funding. The result shows that research chair is a significant determinant in complete data set but it is insignificant when only matched scientists are kept in data set. In other words, in the case of two scientists with similarity in terms of three mentioned factors, having a chair cannot significantly affect the scientific performance.

Conference Topic

Science policy and research assessment

Introduction

The scientists' academic performance has been extensively discussed and many of its determinants are currently known as potential motives for publishing papers in peer reviewed journals. Among others, age, gender, private and public funding, institutional setting, field and context are the most important determinants. The funding definitely plays the major role in knowledge production and shaping scientific productivity. Its positive effect has been extensively investigated in literature (Crespi & Geuna, 2008; Pavitt, 2000, 2001; Salter & Martin, 2001).

However, having a great academic performance does not depend solely on funding. The networking capability of scientist can also explain the number of journal papers. Most of the studies on the effects of network rely on co-authorship as a proxy of scientific collaboration (Katz & Martin, 1997; Melin & Persson, 1996). In addition to direct collaboration, there are also some other networking measures, which are known in the literature as determinant of publication. For instance, it is possible to show how a researcher links two other researchers by making separate collaborations with them. Newman (2001a, 2001b) finds that in physics, biomedical research, and computer science, most of the authors are connected with each other via one or two of their collaborators, a concept generally referred to as betweenness centrality. Beaudry and Allaoui (2012) also show a positive effect of betweenness centrality on the scientific productivity of Quebec's scientists.

In addition to the above measures of networking effect, the networking capacity of scientists partially depends on prestige of their academic affiliation. Turner and Mairesse (2005) show it for the outstanding performance of 'Grandes Ecoles' in France. Beside the name and brand of academic institutions, centers with specific research orientations such as 'centers for excellence' are also effective. According to Niosi (2002), the government of Canada launched 7 centers for biotechnology sectors in 1988, which financially supports the collaboration of university research, the specialized biotechnology firms, and the governmental laboratories. In addition to the funding support, however, this program comes up with improving intellectual property regulations, and developing human resources.

There are some other desirable factors similar to 'centers for excellence', which increase an individual's research motivation and influence the willingness or ability of scientists for conducting original research. In this paper, we focus on the effect having a 'research chair' as a possible determinant of scientific publication. On the one hand, it helps the holder of this position to absorb more money or to construct more effective network, which results in propelling future knowledge production. On the other hand, it may be the effect of past super performance of scientist, implying the intrinsic ability of scientists in conducting research or referring to the chair-holder extensive networking capacity.

By analysing data in an econometric model, it is possible to test the significant effect of 'being a chair holder' on the scientific productivity. The rest of paper is followings: Section 1 reviews theoretical framework and literature review. Section 2 explains how data is gathered and what the variables represent. In addition, it raises the related hypotheses and explains which econometric models can test these hypotheses. Section 3 presents the results of econometric model and the result of testing hypotheses. A conclusion will summarize the results of the paper.

Section 1 - Theoretical framework

The literature relevant to this article brushes on the importance of having a prestigious academic position or affiliation. Focusing on the role of university prestige in academic performance, Long, Allison, and McGinnis (1979) found a positive and significant correlation between the prestige of the scientist alma matter and prestige of subsequent employment affiliation. The authors also indicated that graduating from a prestigious university has a positive effect on citations (but not on publication counts). The paper also provides a justification for the effect of prestige arguing that the best students are admitted to the most prestigious universities and subsequently the graduates of the prestigious universities are generally recruited by other similar institutions. Furthermore, such scientists who studied in and have been recruited by prestigious universities are better able to interact with new gifted students (Long et al., 1979). This paper tries to argue that academic prestige can push forward research and its quality. More recently, Zhou, Lü, and Li (2012) show that papers cited by prestigious scientists, regardless of the number of citations, are of a higher quality than papers which are cited by 'ordinary' scientists.

The prestige can be seen from the reverse direction of causality. West, Smith, Feng, and Lawthom (1998) investigate the relationship between departmental climate, such as degree of formalization, support for career development and support for innovation on the one hand, and official rated effectiveness of universities on the other hand. They conclude that the causality direction is from former to latter, showing that prestige of universities is an effect and not a cause for appropriate departmental climate and necessary institutional setting for conducting research.

Nevertheless, measuring academic prestige itself is another story. Frey and Rost (2010) compare three types of university ranking based on the number of articles, number of citations, and membership of editorial board or of academic associations. The paper indicates that these rankings are not compatible with each other and suggests the use of multiple measurements. Van Raan (2005) criticize the applicability of university rankings such as the Shanghai ranking for evaluating academic excellence by noting that the 'affiliation', as an important factor reflecting research atmosphere, is not well addressed in those ranking. In addition to the university ranking, it is important to assess individual research productivity to have a better sense of prestige. Henrekson and Waldenström (2007) introduce three types of indicators, measuring research performance: (1) measures based on weighted journal publications, (2) measures based on citations to most cited works, and (3) measures based on the number of publications.

To measure prestige with more robust measure, it is possible to consider the honor as the measure of prestige, which is awarded based on a deliberate assessment in specialized and independent committees. Different types of research chair are example of awards. In Canada, there are three types of research chair: (1) the research chairs which are awarded by industry and called industrial chair; (2) the research chairs which are awarded by Canadian funding agencies such as NSERC, SSHRC, and CIHR; and (3) the 'Canada research chairs', whose holders are assumed to already achieve research excellence in one main fields of research: engineering and the natural sciences, health sciences, humanities, and social sciences. The purpose of this program is to "improve our depth of knowledge and quality of life, strengthen Canada's international competitiveness, and help train the next generation of highly skilled people through student supervision, teaching, and the coordination of other researchers' work".[1] Considering this specific measure of prestige, it is possible to find out the effect of being a 'chair-holder' on scientific productivity. Therefore, our first hypothesis reads as:

Hypothesis 1

Being chair-holder increases the scientist's number of publications.

The hypothesis 1 just tests the performance of chair-holders compared to other scientists and it does not seek for the cause and effect. Considering the fact that the chair-holders are the well-funded scientists too, this hypothesis cannot detach the funding effect of chair from its other effects (mainly from prestige and networking effect). In other words, there are evidences in literature about the benefits and goals of research chair program other than funding, but hypothesis 1 is not able to test them.

Some articles try to highlight the functions and characteristics of research chair. Cantu, Bustani, Molina, and Moreira (2009) show the research chair program would be a good strategy for implementing knowledge-based development. In study on German universities, Schimank (2005) argues that chair-holders are small businessmen with high job security and no bankruptcy in addition to the good level of freedom of teaching and research, indicating that research chair has characteristics of job security and sovereignty.

According to some official documents, affecting scientific productivity is not the direct goal of research chair. In the tenth-year evaluation report for Canada research chair (CRC),[2] the authors conclude that CRC program is an effective way for Canadian universities to "attract and retain leading researchers" from other countries. The report does not say that having a research chair is determinant and cause of chair's scientific production: "the extent to which this success can be related directly to the CRC is difficult to quantify". It is also possible to bring some evidence that having a research chair is not a cause for other factors such as salary. Courty and Sim (2012) show that although having Canada Research Chair (CRC) initially increases the professors' salary, such increase erodes quickly over the time. This means that getting a research chair does not necessarily result in long term salary jump.

Regarding the mentioned points, it is possible to look at the research chair as the effect of scientists' characteristics (including age, number of articles, and number of citations), while it aims to expand academic network and absorb highly skilled talents. To control for the effect of scientist's past performance on having a research chair and to detach the funding advantage of chair, we propose our second hypothesis:

Hypothesis 2

Keeping the main scientists' characteristics (age, number of articles, and amount of grant) constant, having a research chair does not have significant positive effect on scientists' productivity.

[1] http://www.chairs-chaires.gc.ca/about_us-a_notre_sujet/index-eng.aspx

[2] http://www.chairs-chaires.gc.ca/about_us-a_notre_sujet/publications/ten_year_evaluation_e.pdf

This hypothesis can be tested by matching technique, which will be explained in the methodology section. The important note here is that 'being a research chair' cannot be the only determinant in right-hand-side of regression equations. We should look for some control variables, which are mentioned in literature as determinants of scientific production. Among others, age, gender, funding, field, and university characteristics are the most important determinants of scientific production which should be controlled when the effect of research chair on scientific productivity are being tested.

In terms of age, there are two groups of evidences in literature about its effect on scientific productivity. First, some articles assess the life cycle trend in economic activity, referring to the non-linearity of human productivity during life (Becker, 1962). The second group of articles generally find that scientists' academic performance (number of articles and number of citations) decreases as they age (Bonaccorsi & Daraio, 2003; Diamond, 1986; Levin & Stephan, 1991). Some articles like Gonzalez-Brambila and Veloso (2007) also indicate that age does not have any effect on the number of articles but it positively affect the number of citations. Gender effect is known as a significant determinant of scientific productivity in literature. Long (1990) explains that women's opportunities for collaboration are significantly less than those of men's because women have young children. However, in another study, Long (1992) shows that women are less productive in the first decade of their career but are more productive afterwards. Research funding is another important determinant of scientific productivity. Pavitt (2001) also refers to the importance of public support for scientific infrastructure development and highlights its role in the effectiveness of public grants. In another study, Pavitt (2000) argues that fudging for infrastructure of expertise, equipment and networks is necessary for development and implementation of research. A body of literature investigates the effect of university characteristics on the scientific productivity. There are also some papers about the effect of faculty size. Buchmueller, Dominitz, and Lee Hansen (1999) indicate that graduate school faculty size is a significant determinant of the research proficiency of graduates. Jordan, Meador, and Walters (1988, 1989) indicate that research productivity is positively associated with department size but that effect becomes weaker as the size increases. In an opposite direction, Kyvik (1995) rejects both hypotheses that large departments are more productive and that faculty members of large departments better assess the research environment.

There also some evidences about differences between fields and context. Blackburn, Behymer, and Hall (1978) show that the fields of humanities and sciences have different pattern of scientific production. To justify the differences between disciplines, Baird (1986) shows that for instance large research laboratory in chemistry, scholarly apprenticeship approach in history, and research over practice in psychology are important factors in scientists' productivity, which are field-dependent factors. In another comprehensive study, Baird (1991) refers to the productivity and citation pattern differences among disciplines and argues that size, internal university support and federal support can explain such differences. All of the mentioned evidence in literature shows that scientific productivity may have different determinants including academic prestige and other control variables such as funding, gender, age, and university-specific characteristics.

Section 2 - Data and methodology

Data and variables

In order to validate these two hypotheses, we built a data set based on the integration of data on funding and journal publications for Quebec scientists. For publications, Elsevier's Scopus provides information on scientific articles (date of publication, journal name, authors and their affiliations). In terms of funding, there is a database for researchers in Quebec universities

(*Système d'information sur la recherche universitaire* or SIRU) gathered and combined by the Ministry of Education, Leisure and Sports. The SIRU database lists the grants and contracts information, including yearly amount, source, and type during the period of 2000-2010 for all Quebec university scientists. The appendix 1 reviews the names and description of variables in data set.

Methodology and econometrics model

To measure the effect of 'being a research chair' on the scientist's performance, a regression equation is fitted to the available data using a panel regression. In such regression, the left-hand-side (LHS) variable of regression is the number of articles [*ln(nbArticle)*] as a measure of scientific productivity. In terms of right-hand-side (RHS) variable, the main independent variables are the dummy variables of research chair [*dChair1*, *dChair2*, *dChair3*, *dChair4*, *dChair5*]. However, the dependent variable of regression in LHS should be also controlled for the other determinants of articles count. Among others, age [*Age*], gender [*dFemale*], and funding are the important ones. We also control for the fixed effect of university, year, and research field in order to account for any impact that our explanatory variables do not cover.

It is important to note that two variables of [*ln(PublicfundingO)*] and [*ln(nbArticle)*] are determined by each other and co-evolved during time, which is the source of endogeneity. Thus it means that simple ordinary least square or panel models are biased. The main reason for this potential endogeneity is that scientists are assessed for public funding based on their CV and past performance while at the same time, publication and research quality significantly depends on the funding capability of researchers. Using instrumental variables (IV) instead of endogenous variable is a common suggested method in literature to address endogeneity problem. If there is more than one instrument for an endogenous variable, it is necessary to perform a two-stage regression, in which the first stage estimates the endogenous variable (named here as instrumented variable) based on a list of instrumental variables. In the first stage of our model, the amount of public funding [*ln(PublicfundingO)*] is estimated by the rank of scientist in the field in terms of three-year average of funding (for the purpose of operational costs and direct expenditure of research) [*PubORank*], the rank of scientist in the field in terms of three-year average of articles count [*PublRank*], and natural logarithm of three-year average of aggregate public sector funding in the field [*ln(totFund)*]. These three variables play the role of instruments for public funding. It should also be noted that public funding is not determined by the instruments in the same year. Hence the one-year lags of instruments are being used in the first-stage regression. The second stage is similar to the previous model in which there is no endogeneity.

1st stage: $ln(PublicfundingO)_{it}$ *= f(* $PubORank_{it-1}, PublRank_{it-1}, ln(totFund)_{it-1}$ *)*

2nd stage: $ln(nbCitation)_{it}$ *= f(* $ln(PublicfundingO)_{it}$ *,* $ln(PrivatefundingO)_{it}$ *,* $ln(NFPfundingO)_{it}$*,* $(dChair1|dChair2|dChair3|dChair4|dChair5)_{it}$*, dFemale, Age,* Age^2*, research field dummies, year dummies, university dummies)*

The main purpose of this research is to show how much having a research chair as an external support is important and significant in promoting scientific publication. To test the first hypothesis, it is sufficient to run the two-stage panel regression on the whole data set whether 'having a research chair' is a significant RHS variable, either as a real cause or a channel for other variables/causes. According to the chair characteristics, the networking and prestige effect of 'having a research chair' may be mixed with the effect of funding. To address this issue, we use matching technique and compare two chair and non-chair scientists who have close funding to each other (and have some other similar characteristics). Like what Bérubé and Mohnen (2009) did, it is possible to find pairs of chair and non-chair by using the psmatch2 command in Stata and delete the unmatched records. The selection is made by generating propensity score and choosing the pairs of scientists with closest scores to each other. The new data set consists of twin scientists who are similar to each other in terms of funding, gender, and division of studies.[3]

By controlling the mentioned criteria and keeping matched scientists only, 'having a research chair' becomes a better and more informative signal for the prestige and networking of scientists. In this case, the effect of 'being chair' on scientific productivity does not include funding effect or it is not related to the division or gender of scientist. To test the second hypothesis, only matched pairs of scientists are being used in regression analysis to identify whether having a research chair is a significant cause for scientific productivity.

One of the important stages in matching technique is to check the quality of matching. It means there should be no difference between the averages of mentioned criteria (gender, funding, and division of studies) when the comparison is made between chair and non-chair scientists among the matched pairs. However, there can be a difference when the comparison is made in original database and before any entry deletion. Table 1 summarizes such comparisons to show that the matching is done with an acceptable quality for *dChair3*, *dChair4*, and *dChair5*.

Table 1. Make a comparison between mean to show the quality of matching.

	Comparison over whole database				Comparison over matched scientists "**After Matching**"			
	Gender	Funding	Research field[4]	number of scientist	Gender	Funding	Research field	number of scientist
dChair3=0	0.2959	86217	0.4284	7359	0.1023	403051	0.2286	293
dChair3=1	0.2013	464106	0.3447	293	0.2013	464106	0.3447	293
Is difference significant at 5% level?	Yes	Yes	Yes		Yes	No	No	
dChair4=0	0.2954	95871	0.4318	7508	0.1111	369080	0.0416	144
dChair4=1	0.1319	351785	0.0833	144	0.1319	351785	0.0833	144
Is difference significant at 5% level?	Yes	Yes	Yes		No	No	No	
dChair5=0	0.2987	82183	0.4344	7234	0.1483	367494	0.1698	418
dChair5=1	0.1818	420920	0.2655	418	0.1818	420920	0.2655	418
Is difference significant at 5% level?	Yes	Yes	Yes		No	No	No	

Section 3 - Result and discussion

Based on the models presented in methodology section, we need to first run the regressions on the whole dataset (Table 2) which show that all types of chair have positive and significant effect on scientific productivity. However after keeping only matched scientists in dataset, who are similar to each other in terms of gender, funding, and research field, the regression equations indicate significant and positive result only for Canada research chair (Table 3) Industrial chairs and chairs appointed by Canada research council (NSER, SSHRC, and CIHR) do not have an independent positive effect on scientific productivity. Considering the hypotheses in previous section, it possible to validate the first hypothesis and partially validate the second hypothesis. One may question whether research chairs in general are independent cause for research productivity or they are proxy for other known factors in literature. Considering literature and mentioned mission of research chairs in their mandate,

[3] We have three divisions: 'engineering and the natural sciences', 'health sciences', and' humanities, and social sciences'

[4] Test whether dummy variable of Social Science and Humanities is equal to 1.

Table 2. Regression results over all samples for *dChair3* and *dChair4* (the second stage of 2SLS).[1]

ln(nbArticle)$_{it}$	*IV1*	*IV2*	*IV3*	*IV4*	*IV5*	*IV6*	*IV7*	*IV8* `	*IV9*	*IV10*	*IV11*
ln(PublicfundingO)$_{it}$	0.0433 ***	0.0417 ***	0.0417 ***	0.0416 ***	0.0417 ***	0.0416 ***	0.0415 ***	0.0415 ***	0.0417 ***	0.0416 ***	0.0416 ***
	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
ln(PrivatefundingO)$_{it}$	0.0112 ***	0.0109 ***	0.0105 ***	0.0109 ***	0.0105 ***	0.0113 ***	0.0108 ***	0.0111 ***	0.0110 ***	0.0109 ***	0.0110 ***
	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007	0.0007
ln(NFPfundingO)$_{it}$	0.0076 ***	0.0074 ***	0.0074 ***	0.0075 ***	0.0075 ***	0.0074 ***	0.0092 ***	0.0092 ***	0.0074 ***	0.0075 ***	0.0074 ***
	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0006	0.0006	0.0006
Age$_{it}$	0.0021	0.0038	0.0038	0.0038	0.0038	0.0037	0.0036	0.0036	0.0038	0.0038	0.0038
	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
sq_Age$_{it}$	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***	-0.0001 ***
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
dFemale$_{i}$	-0.0911 ***	-0.0847 ***	-0.0848 ***	-0.0847 ***	-0.0848 ***	-0.0815 ***	-0.0700 ***	-0.0686 ***	-0.0832 ***	-0.0841 ***	-0.0827 ***
	0.0109	0.0108	0.0108	0.0108	0.0108	0.0110	0.0112	0.0113	0.0109	0.0109	0.0109
dFemale$_{i}$****ln(PrivatefundingO)***$_{it}$						-0.0023		-0.0013			
						0.0016		0.0016			
dFemale$_{i}$****ln(NFPfundingO)***$_{it}$							-0.0065 ***	-0.0064 ***			
							0.0013	0.0013			
dChair3$_{it}$		0.3331 ***	0.3105 ***	0.3444 ***	0.3233 ***	0.3332 ***	0.3323 ***	0.3324 ***	0.3330 ***	0.3413 ***	0.3404 ***
		0.0249	0.0268	0.0271	0.0284	0.0249	0.0249	0.0249	0.0251	0.0252	0.0254
dChair4$_{it}$		0.1025 ***	0.1006 **	0.0891 **	0.0894 **	0.1020 ***	0.0998 ***	0.0996 ***	0.1195 ***	0.0942 ***	0.1114 ***
		0.0352	0.0432	0.0387	0.0451	0.0352	0.0352	0.0352	0.0360	0.0356	0.0362
dChair3$_{it}$****ln(PrivatefundingO)***$_{it}$			0.0060 **		0.0064 **						
			0.0026		0.0027						
dChair4$_{it}$****ln(PrivatefundingO)***$_{it}$			0.0000		-0.0003						
			0.0033		0.0034						
dChair3$_{it}$****ln(NFPfundingO)***$_{it}$				-0.0026	-0.0033						
				0.0024	0.0024						
dChair4$_{it}$****ln(NFPfundingO)***$_{it}$				0.0026	0.0026						
				0.0031	0.0031						
dFemale$_{i}$****ln(PrivatefundingO)***$_{it}$****dChair3***$_{it}$									0.0005		0.0024
									0.0063		0.0064
dFemale$_{i}$****ln(PrivatefundingO)***$_{it}$****dChair4***$_{it}$									-0.0177 **		-0.0212 **
									0.0077		0.0079
dFemale$_{i}$****ln(NFPfundingO)***$_{it}$****dChair3***$_{it}$										-0.0102 **	-0.0104 **
										0.0050	0.0050
dFemale$_{i}$****ln(NFPfundingO)***$_{it}$****dChair4***$_{it}$										0.0125	0.0175 **

[1] *, **, and *** show the significance level at 0.05, 0.02, and 0.01 respectively - Year dummies, field dummies, and university dummies are significant. The minimum year activity, average year activity, and maximum year activity are 1, 10.6, and 12 respectively.

ln(nbArticle)$_{it}$	*IV1*	*IV2*	*IV3*	*IV4*	*IV5*	*IV6*	*IV7*	*IV8* `	*IV9*	*IV10*	*IV11*
										0.0081	0.0083
Constant term	0.4681 ***	0.4210 ***	0.4218 ***	0.4200 ***	0.4204 ***	0.4222 ***	0.4218 ***	0.4223 ***	0.4202 ***	0.4210 ***	0.4205 ***
	0.0683	0.0680	0.0680	0.0680	0.0680	0.0680	0.0680	0.0680	0.0680	0.0680	0.0680
Number of observations	80772	80772	80772	80772	80772	80772	80772	80772	80772	80772	80772
Number of scientists	7652	7652	7652	7652	7652	7652	7652	7652	7652	7652	7652
$\chi 2$	13859.3	14234.6	14251.6	14244.3	14258.4	14236.5	14277.1	14277.9	14239.7	14241.7	14246.4
sigma	0.5689	0.5664	0.5661	0.5662	0.5660	0.5664	0.5662	0.5662	0.5664	0.5664	0.5664
rho	0.4235	0.4183	0.4178	0.4180	0.4176	0.4184	0.4181	0.4182	0.4183	0.4183	0.4184
R^2 within groups	0.0617	0.0630	0.0629	0.0631	0.0630	0.0631	0.0633	0.0634	0.0631	0.0631	0.0632
R^2 overall	0.3367	0.3456	0.3460	0.3455	0.3458	0.3457	0.3464	0.3464	0.3457	0.3456	0.3457
R^2 between groups	0.5044	0.5148	0.5154	0.5145	0.5151	0.5148	0.5156	0.5156	0.5148	0.5147	0.5148

Table 3. Regression results over only matched pairs of scientists for *dChair3* and *dChair4* (the second stage of 2SLS).[2]

ln(nbArticle)$_{it}$	*IV23*	*IV24*	*IV25*	*IV26*	*IV27*	*IV28*	*IV29*	*IV30*	*IV31*	*IV32*	*IV33*
ln(PublicfundingO)$_{it}$	0.0702 ***	0.0680 ***	0.0692 ***	0.0680 ***	0.0691 ***	0.0680 ***	0.0679 ***	0.0679 ***	0.0682 ***	0.0678 ***	0.0679 ***
	0.0059	0.0059	0.0060	0.0059	0.0060	0.0059	0.0059	0.0059	0.0059	0.0059	0.0059
ln(PrivatefundingO)$_{it}$	0.0053 ***	0.0059 ***	0.0076 ***	0.0059 ***	0.0072 ***	0.0062 ***	0.0059 ***	0.0062 ***	0.0066 ***	0.0060 ***	0.0067 ***
	0.0019	0.0019	0.0025	0.0019	0.0026	0.0021	0.0019	0.0021	0.0020	0.0019	0.0020
ln(NFPfundingO)$_{it}$	0.0038 **	0.0042 **	0.0041 **	0.0077 **	0.0074 **	0.0041 **	0.0045 **	0.0044 **	0.0041 **	0.0045 **	0.0043 **
	0.0018	0.0018	0.0018	0.0025	0.0026	0.0018	0.0019	0.0019	0.0018	0.0019	0.0019
Age$_{it}$	0.0217 **	0.0244 **	0.0260 **	0.0249 **	0.0265 **	0.0244 **	0.0244 **	0.0244 **	0.0246 **	0.0242 **	0.0243 **
	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104	0.0104
sq_Age$_{it}$	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***	-0.0003 ***
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
dFemale$_i$	-0.1217 **	-0.1230 **	-0.1215 **	-0.1224 **	-0.1210 **	-0.1160 **	-0.1138 **	-0.1081 **	-0.0889 **	-0.1173 **	-0.0848 **
	0.0545	0.0533	0.0533	0.0532	0.0533	0.0562	0.0572	0.0595	0.0555	0.0549	0.0567
dFemale$_i$*ln(PrivatefundingO)$_{it}$						-0.0020		-0.0018			
						0.0051		0.0051			
dFemale$_i$*ln(NFPfundingO)$_{it}$							-0.0022	-0.0020			
							0.0049	0.0049			
dChair3$_{it}$		0.1696 ***	0.1625 ***	0.2062 ***	0.1954 ***	0.1697 ***	0.1696 ***	0.1698 ***	0.1689 ***	0.1766 ***	0.1756 ***
		0.0451	0.0483	0.0483	0.0506	0.0451	0.0451	0.0452	0.0453	0.0454	0.0456

[2] *, **, and *** show the significance level at 0.05, 0.02, and 0.01 respectively - Year dummies, field dummies, and university dummies are significant. The minimum year activity, average year activity, and maximum year activity are 1, 10.9, and 12 respectively.

ln(nbArticle)$_{it}$	IV23	IV24	IV25	IV26	IV27	IV28	IV29	IV30	IV31	IV32	IV33
dChair4$_{it}$		-0.0401	0.0475	-0.0267	0.0524	-0.0398	-0.0400	-0.0397	-0.0157	-0.0479	-0.0240
		0.0553	0.0650	0.0595	0.0677	0.0553	0.0553	0.0553	0.0560	0.0556	0.0562
dChair3$_{it}$*ln(PrivatefundingO)$_{it}$			0.0015		0.0026						
			0.0040		0.0040						
dChair4$_{it}$*ln(PrivatefundingO)$_{it}$			-0.0122 **		-0.0118 **						
			0.0048		0.0048						
dChair3$_{it}$*ln(NFPfundingO)$_{it}$				-0.0078 **	-0.0080 **						
				0.0037	0.0037						
dChair4$_{it}$*ln(NFPfundingO)$_{it}$				-0.0031	-0.0019						
				0.0044	0.0044						
dFemale$_{i}$*ln(PrivatefundingO)$_{it}$*dChair3$_{it}$									-0.0012		0.0001
									0.0081		0.0082
dFemale$_{i}$*ln(PrivatefundingO)$_{it}$*dChair4$_{it}$									-0.0280 ***		-0.0311 ***
									0.0102		0.0103
dFemale$_{i}$*ln(NFPfundingO)$_{it}$*dChair3$_{it}$										-0.0087	-0.0091
										0.0065	0.0065
dFemale$_{i}$*ln(NFPfundingO)$_{it}$*dChair4$_{it}$										0.0120	0.0174 *
										0.0103	0.0104
Constant term	-0.0326	-0.1656	-0.2236	-0.2009	-0.2565	-0.1650	-0.1656	-0.1649	-0.1795	-0.1607	-0.1719
	0.2714	0.2711	0.2719	0.2715	0.2723	0.2712	0.2712	0.2712	0.2711	0.2712	0.2712
Number of observations	9097	9097	9097	9097	9097	9097	9097	9097	9097	9097	9097
Number of scientists	836	836	836	836	836	836	836	836	836	836	836
$\chi 2$	2185.96	2231.62	2230.58	2237.66	2237.25	2231.39	2230.92	2230.54	2235.76	2234.8	2239.7
sigma	0.6921	0.6842	0.6844	0.6835	0.6836	0.6843	0.6844	0.6845	0.6840	0.6842	0.6843
rho	0.4798	0.4675	0.4677	0.4672	0.4672	0.4676	0.4678	0.4680	0.4675	0.4678	0.4682
R2 within groups	0.1385	0.1393	0.1392	0.1398	0.1398	0.1394	0.1394	0.1394	0.1399	0.1399	0.1406
R2 overall	0.3300	0.3409	0.3406	0.3411	0.3407	0.3411	0.3410	0.3411	0.3409	0.3408	0.3413
R2 between groups	0.4584	0.4730	0.4729	0.4728	0.4726	0.4731	0.4729	0.4731	0.4724	0.4722	0.4726

it is possible to argue that having a chair improve networking capability or funding amount of scientists.

In the second hypothesis we try to make a distinction between the effect of funding and having a research chair. By running regression model only on matched pairs of scientists, having a chair cannot be a proxy for criteria of matching (age, gender, and research field) anymore. We can verify the hypothesis 2 for industrial chair and research chairs appointed by research council but this hypothesis cannot be validated for 'Canada research chair' because its effect is still positive and significant even after matching. Some justification can be provided for this finding. The first is that Canada research chair intends to be prestige sign of research in Canada. Based on its mandate, the Canada research chair program aims to attract and retain some of most accomplished and promising minds in the world. It is more prestigious than other research chairs and other scientists may also have more willingness to conduct collaborative research with the Canada research chair holders. As the second justification, it should be noted that industrial chairs are appointed by firms to promote research, probably with major benefits for firms. In other words, this type of chair is not necessarily and originally designed for the sake of scientific publication. The chairs appointed by research councils may have quite similar characteristic. Looking at these chairs' description, most of chair holders are appointed as industrial chair. There are some evidence in literature indicating that industrial funding forces researchers to shift to more applied research, neglecting their normative responsibilities for knowledge development (Geuna & Nesta, 2003; Partha & David, 1994).

In addition to the effect of chair on scientific productivity, there are also some interesting results for other control variables in econometric model. Funding from different sources is always a significant determinant of scientific productivity, which has positive sign. Funding from private sector and funding from not-for-profit sector are directly put in regression equation while funding from public sector is first estimated by instrumental variables and then inserted to regression model.

The age of scientists seems to affect scientific productivity with an inverted-U shape pattern. However, considering its peak, which is 10 years old and less than the normal age for scientific activity, it is possible to argue that scientific productivity of scientists decreases in age. The gender of scientist, as another individual attribute, shows a significant impact. It indicates that women are less likely to publish journal paper compared with men. Both of these findings have some similar evidence in literature as discussed in previous section for age (Bonaccorsi & Daraio, 2003; Diamond, 1986; Levin & Stephan, 1991) and gender (Long, 1990).

The results verify the fixed effect of university and research discipline in addition to the year-specific effect on scientific production. Our regression analysis also tests the interactive effects of RHS variables. The first interactive effect is the interaction between gender and funding. From technical point of view, it is not possible to estimate the interactive effect with an endogenous variable in 2SLS models because its amount is estimated in the first stage and we are not using the raw value reported in dataset. However, we can estimate the effect of interaction with private funding and not-for-profit funding, which both are not significant. The only exception is in table 2 where the regression is run on whole dataset and interaction of gender and not-for-profit is negative and significant, which means that women may benefit from not-for-profit funding less efficiently compared with men.

The variables measuring interaction between having a chair and amount of funding are the next possible interaction in regression analysis, most of which are not significant. However, if there is significance, it is positive before matching and negative after matching. It refers to the more impact of funding for the chair people in general (complete data set) but when the chairs are compared to scientists, who are similar to them in terms of funding, gender, and research field, they benefit from the funding less efficiently compared to non-chairs. The last group of interactive variables are the combination of two previous groups: interaction between funding, chair, and gender. There are some negative and significant effects for this type of interaction, showing the combined results of previous interactive variables.

Conclusion

In this article we show that having a research chair is a significant determinant of scientific publication when the regression is run over whole data set. As previously explained, a distinction should be made to clarify different attributes of research chair and their effect on scientific productivity. For instance, it is a fact that research chairs receive more grants due to their chair so the question here is to check if positive effect of research chair on scientific productivity remains significant after controlling for the funding amount of chair. To investigate the causality of this relationship, the matching technique is applied to control for some common characteristics of chair and non-chair scientists and to highlight the channel through which this positive effect has happened.

To conduct this matching technique, we only keep pairs of chair and non-chair scientists, matched together based on funding, gender, and research field, and delete the rest of scientists from data set. This methodology is effective to understand other attributes of research chair (except funding) that have significant and positive effect on scientific productivity. After such matching, the results show that the effect of Canada research chair on scientific productivity remains significant and positive while the effect of industrial chairs and the chairs appointed by Canada research council (NSER, SSHRC, and CIHR) become insignificant. This finding indicates that there are some special attributes in Cana research chair, which do not exist in other chairs. Those attributes may significantly push scientific productivity. Among other attributes, Canada research chairs may have better prestige to absorb talents or they are well designed to conduct scientific research for publication.

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Appendix 1 – Variable description.

Variable name	*Variable description*
dChair1	Dummy variables taking the value 1 if a scientist has a research chair awarded by industry (industrial chair)
dChair2	Dummy variables taking the value 1 if a scientist has a research chair awarded by Canadian funding agencies (NSERC, SSHRC, and CIHR)
dChair3	Dummy variables taking the value 1 if a scientist has a Canada research chair
dChair4	Dummy variables taking the value 1 if *dChair1* or *dChair2* are equal to 1
dChair5	Dummy variables taking the value 1 if any of *dChair1*, *dChair2*, or *dChair3* is equal to 1
ln(PublicfundingO)	Natural logarithm of the three-year average of public sector funding for the purpose of operational costs and direct expenditure of research
ln(PrivatefundingO)	Natural logarithm of the three-year average of private sector funding for the purpose of operational costs and direct expenditure of research
ln(NFPfundingO)	Natural logarithm of three-year average of funding from not-for-profit institutions (NFP) for the purpose of operational costs and direct expenditure of research
ln(nbArticle)	Natural logarithm of the yearly number of articles
PubORank	Normalized rank of scientist in the field in terms of three-year average of funding for the purpose of operational costs and direct expenditure of research
PublRank	Normalized rank of scientist in the field in terms of three-year average of articles count
ln(totFund)	Natural logarithm of three-year average of aggregate public sector funding in the field
Age	Age of a scientist
dFemale	Dummy variable taking the value 1 if the scientist is a woman and 0 otherwise
dULaval, dUMcGill, …, dUdeM	Dummy variables indicating the university affiliation of researcher
dMedical, dHumanities, …, dScience	Dummy variables indicating the field of researcher
d2000, d2001, …., d2012	Dummy variables indicating the year