CEB Working Paper

Centre Emile Bernheim
Research Institute in Management Sciences

Solvay Brussels School
Economics & Management

Effects of work environments and collaborations on productivity in Vietnamese social sciences: evidence from 2008-2017 Scopus data

Tung Manh Ho, Ha Viet Nguyen, Thu-Trang Vuong, Hiep Hung Pham, Nancy K. Napier and Quan-Hoang Vuong

Measuring factors affecting scientific productivity is an issue that often draws attention of the scientific community and policy-makers. In Vietnam, the studies about this have just begun for a few years with limited data. Especially, there has been little understanding about what affects the performance on the social sciences research publication productivity yet.

This research, using OLS method, analyses the data of 406 Vietnamese social scientists in Scopus within a period of 2008-2017. The results confirm the impact of work environments shown in the varying degrees of influence of collaborations on scientific output $\beta_{au.ttl(Uni)} = 0.183$, $P < 0.0001$; and $\beta_{au.ttl(Ins)} = 0.042$, $P < 0.0001$(N = 406). However, in the high-performance group, the magnitude of the effects drops by 27%, while the benefits of collaborating are also reduced by 30.6% or 42.9%, depending on the type of work environments. International collaborations can boost both sheer total number of publications ($\beta_{au.fc} = 2.778$; $P < 0.0001$) and adjusted productivity ($\beta_{au.fc} = 1.626$; $P < 0.0001$). Nevertheless, increment in the number of unique foreign collaborators only raises the authors' number of published works ($\beta_{au.fr(ttlitems)} = 0.322$; $P < 0.0001$) but doesn't improve the contribution of Vietnamese scientists ($\beta_{au.fr(cp)} = 0.066$; $P = 0.30$).

Keywords: Scientific productivity, research fields, university, research institute, collaborations

JEL Classifications: I23, O32

CEB Working Paper N° 17/018
June 2017

Université Libre de Bruxelles - Solvay Brussels School of Economics and Management
Centre Emile Bernheim
ULB CP114/03 50, avenue F.D. Roosevelt 1050 Brussels BELGIUM
e-mail: ceb@admin.ulb.ac.be Tel.: +32 (0)2/650.48.64 Fax: +32 (0)2/650.41.88

ULB

Effects of work environments and collaborations on productivity in Vietnamese social sciences: evidence from 2008-2017 Scopus data

Tung Manh Ho
Vietnamese Academy of Social Sciences, Institute of Philosophy
59 Lang Ha, Ba Dinh, Hanoi, Vietnam
Email: tungmanhho@gmail.com

Ha Viet Nguyen
Vietnam Panorama Media Monitoring
109 D5 Giang Vo, Ba Dinh, Hanoi, Vietnam
Email: vietha.tnguyen93@gmail.com

Thu-Trang Vuong
Campus Européen de Dijon, Sciences Po Paris
14 Avenue Victor Hugo, 21000 Dijon, France
Email: thutrang.vuong@sciencespo.fr

Hiep Hung Pham
Department of International Business Administration, Chinese Culture University
55 Hwa Kang Road, Yangming Shan 11114, Taipei, Taiwan R.O.C.
Email: phamhunghiep@gmail.com

Nancy K. Napier
Boise State University, College of Business and Economics
1910 University Drive, Boise, ID, USA
Email: nnapier@boisestate.edu

Quan-Hoang Vuong
Université Libre de Bruxelles, Centre Emile Bernheim
50 Ave. Franklin D. Roosevelt, Bruxelles B-1050, Belgium
Email: qvuong@ulb.ac.be

Abstract

Measuring factors affecting scientific productivity is an issue that often draws attention of the scientific community and policy-makers. In Vietnam, the studies about this have just begun for a few years with limited data. Especially, there has been little understanding about what affects the performance on the social sciences research publication productivity yet.

This research, using OLS method, analyses the data of 406 Vietnamese social scientists in Scopus within a period of 2008-2017. The results confirm the impact of work environments shown in the varying degrees of influence of collaborations on scientific output $\beta_{au.ttl(Uni)} = 0.183$, $P < 0.0001$; and $\beta_{au.ttl(Ins)} = 0.042$, $P < 0.0001$(N = 406). However, in the high-performance group, the magnitude of the effects drops by 27%, while the benefits of collaborating are also reduced by 30.6% or 42.9%, depending on the type of work environments. International collaborations can boost both sheer total number of publications ($\beta_{au.fc} = 2.778$; $P < 0.0001$) and adjusted productivity ($\beta_{au.fc} = 1.626$; $P < 0.0001$). Nevertheless, increment in the number of unique foreign collaborators only raises the authors' number of published works ($\beta_{au.fr(ttlitems)} = 0.322$; $P < 0.0001$) but doesn't improve the contribution of Vietnamese scientists ($\beta_{au.fr(cp)} = 0.066$; $P = 0.30$).

Keywords: Scientific productivity, research fields, university, research institute, collaborations

JEL Codes: I23, O32

INTRODUCTION

Over the years, a number of methods measuring scientific productivity were invented by researchers around the world (Abramo & D'Angelo 2014; Costas 2014; Kyvik 1989; Lee & Bozeman 2005; Ruiz- Castillo & Batista et al. 2006). Apart from sheer total number of publications, various different indicators were created to measure the productivity such as the average number of authors per article (Lee & Bozeman 2005); the type of publication (Kyvik 1989); the average citing times (Ruiz-Castillo & Costas 2014); or even a compound of different factors (Abramo & D'Angelo 2014), etc. Scientific productivity varies across faculties and fields. Whereas existing papers revealed differences in productivity between faculties, some others proved that there was no distinction, or the shape of field productivity distributions was very similar across some certain fields (Batista et al. 2006; Kyvik 1990, Kyvik 1989; Ruiz-Castillo & Costas 2014). These contradictions were partly due to the

difference in the methods of calculation and analysis. However, a noteworthy argument given by Kyvik (1990) stated that the difference in the pace of new knowledge development would lead to different rates of productivity across disciplines. In fields where new discoveries were made in rapid successions and new methods were continuously introduced, researchers may have problems coping and thus become obsolescent. In fields where knowledge production occurred at a slower pace, scientists may have a greater chance to be productive throughout their careers.

In addition, scientific productivity is also influenced by work environments. The research by Allison & Long (1990) showed that high-performing scientists often work at prestigious university departments. The more prestigious the place of work, the higher the scientist's productivity; and the impact of workplace on productivity was stronger than the influence of productivity on the decision of choosing workplace. In terms of affiliation, Hayati & Ebrahimy (2009) also argued that universities dominated the number of studies, while in terms of quality there was no difference between universities and other research institutions. Furthermore, a conclusion of Bland et al. (2005) revealed that the productivity of a department was influenced by individual and organizational attributes, meanwhile group productivity was more affected by institutional and leadership characteristics. It should be noted that in Vietnam, there remained the mindset that universities were only for teaching and research was supposed to be done by institutions. It was only recently that Vietnamese universities realized the importance of international publications, not only for the sake of creating knowledge but also to boost their reputation.

Another element that factors into a researcher's performance is collaborations, which can increase scientific output in both quantity and quality. A number of publications have affirmed that co-working boosted production of scientific contents (Bordons et al. 1996; Hampton & Parker 2011; Landry et al. 1996; Lee & Bozeman 2005; Pao 1992). And if collaborations were shown to be less influential to scientific production in certain domains (Bordons et al., 1996; Bote et al., 2013; Duque et al., 2005; Hampton & Parker 2011; Leimu & Koricheva 2005; Pao 1992), it is acknowledged that collectively-authored articles usually had better quality and were thus more likely to be published and cited (Arunachalam & Doss 2000; Figg et al. Smart & Bayer 1986). On another note, the number of citations per article depended on the type of cooperation being domestic or international (Sooryamoorthy 2009). Papers involving international collaboration were often published in journals of better quality and had more citations (Arunachalam & Doss 2000; Glänzel 2001; Nguyen et al. 2017). Vietnam is a developing country with low scientific productivity, even compared to countries in the neighboring region, only equivalent to 13.33% of Singapore and 29% of Thailand in the period of 1991-2010 (Nguyen et al. 2011; Yi & Pham 2011; Yi at el. 2013). The total scientific output in Vietnam has increased by about 16 papers per year during the 1996-2001 period and increased by 20%

from 2002 to 2010. While that may seem like an improvement, it should be noted that international collaborations accounted for about 77% of all publications; among collaborating countries, Japan was the largest, followed by United States, France, South Korea, and United Kingdom (Manh 2015; Nguyen et al. 2017). Notably, most of these international projects were led by foreign key authors (Manh 2015). Mathematics was the only field where domestic collaborations outnumbered international, while biology and agriculture were sectors overtaken by overseas teamwork, with 80%-90% of published works involving foreign colleagues.

In an effort to improve this situation, the Ministry of Education and Training has recently issued circular No. 08/2017/TT-BGDĐT on 14 April, 2017, according to which all doctoral students must have at least 2 publications indexed in Scopus and/or Web of Science (WOS), and the doctoral dissertation instructor must also have international publications. Out of all academic fields in Vietnam, social sciences are the most concerned by this circular, having recently been criticized for their low productivity in both total number and adjusted number compared to natural science and technology (Nguyen 2016; Vuong et al. 2013).

As scientists in general and social scientists in particular scrambled to meet new standards, questions concerning productivity arose:

Which factors affect scientific output, and how? If collaborations are a major part of scientific production, what is their role?

On these matters, there is a lack of data and profound analyses. Therefore, this study aims to analyze the impact of fields of research, work environments and collaborations on the performance of researchers, measured by their adjusted scientific productivity. The construction and calculation methods of this indicator are described in detail in the Materials and Methods section.

OBJECTIVES

The analyses will be presented to clarify two extremely important research questions:

RQ1: Does the working environment and collaboration affect adjusted productivity of scientists? How do these influences change among high-performing authors?

RQ2: How different are the impacts of international versus domestic collaborations?

MATERIALS AND METHODS

The data for this study was derived from a dataset on the publications of Vietnamese scientists in the field of social sciences, in the period of 2008-2017, collected by Vuong & Associates. The survey, which took place within two months from March to April 2017, was conducted under the license V&A/03/2017, issued on March 15th, 2017.

The data collection process was monitored regularly to ensure its authenticity, following these steps: Firstly, the research team collected data from sources such as personal and institutional websites

of authors, websites of the journals in which their works were published, Google Scholar, and Scopus. Then, we compared each author's information online to check the reliability and created linkage between the authors and their affiliations. When the process was finished, the research team obtained a complete dataset of 410 scholars' information, consisting of: (i) age, sex, region; (ii) affiliated units; (iii) fields of study; (iv) the number of publications in Scopus, (v) the number of research years since Master graduation; (vi) the number of researchers they collaborated with; (vii) having the professorship title or not, etc.

Based on the literature review and the dataset, the following factors are likely to hold important implications for the interpretation of observed publishing patterns and productivity. Therefore, they are more likely to play significant roles in the regression analysis that follows:

- "ttlitems": the total number of articles published in international journals under the Scopus category of an author during the survey period (2008-2017);
- "cp": the relative count of publications. This count was adjusted using the method of sequence-determines-credit (SDC) (Tscharntke et al. 2007). The value of "cp" was calculated based on the order of an author in an article's author list. If the author's name was the first one listed, the relative output was considered to be 1/1; if the author was second on the list, a value of 1/2 would be attributed to the relative output; if the author was listed third, the value would be 1/3, and so on. The final value was the sum of all adjusted values;
- "au.ttl": the total number of times the author in question has collaborated with colleagues, unit: times. For this variable, we do not count the number of collaboratively produced *publications*, rather the number of *collaborators* that the subject in question worked with for each paper in total. The same co-authoring peer could was also counted +1 every time he/she appeared in the list of co-authors with the subject, and on numerous occasions (refer to Ho et al. 2017).
- "affil": the institution to which an author is affiliated. Values are divided into two groups: "Uni" (universities), and "Ins" (other institutions);
- "au.vn": the number of all Vietnamese scientists appearing in the entire body of work of the subject in question, including both co-authors and the author in question, unit: people. Each co-authoring peer was counted only once;
- "au.fr": the number of foreign collaborators in the entire body of work of the subject in question, unit: people. Similarly, each foreign peer was counted only once;
- "au.fc": a binary indicating whether or not an author collaborated with an international colleague. If the author in question had worked with a foreign co-author at least once, the value of "au.fc" would be "Yes", otherwise, it would be "No".

After eliminating profiles that lacked records, we obtained a set of 406 observations which was then processed and analyzed using statistical software R (v3.3.1). To answer the research questions, the linear regression analysis method is used with the general model as follows:

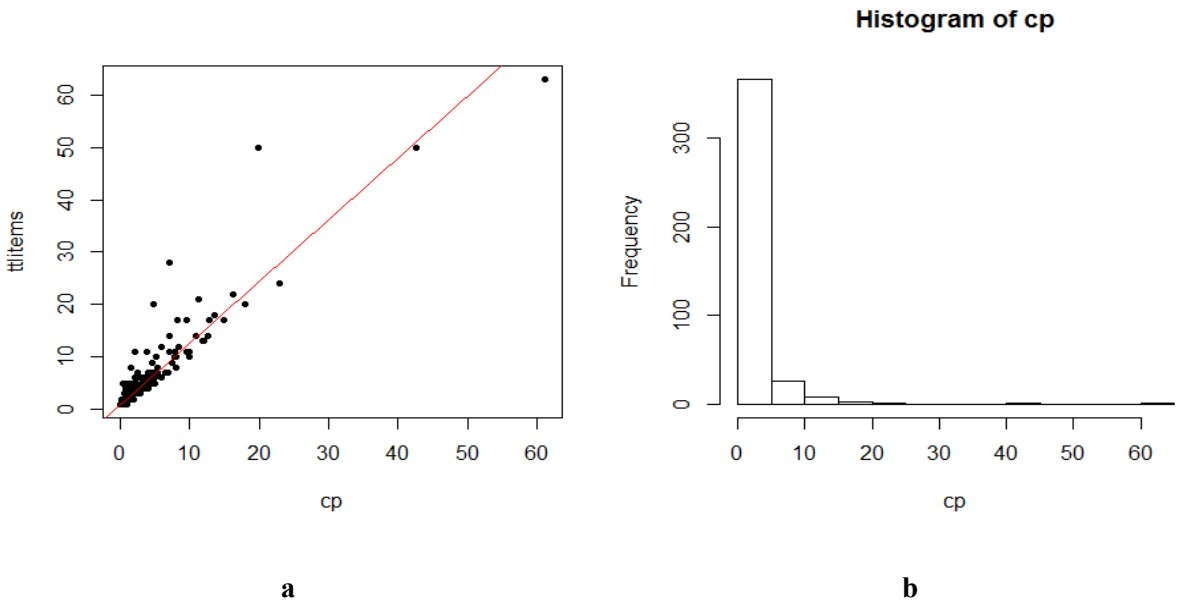
$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k$$

With the condition that *k* variables must have the same size n with the dependent Y . Y is a numeric variable while X_i can be numeric or categorical (Craven & Islam 2011). After being processed in R, the results perform the values of β_i, representing the linear effects of the predictors X_i on the response Y . When independent variables consist of both numeric and categorical variables, these variables may have an interaction that changes the value of regression coefficients (*R in Ecology and Evolution* 2011). The value of z and p are used as a basis to determine the significance of the regression coefficients with $P < 0.05$ being considered to be statistically significant.

ANALYSIS

The average scientist versus the high-performance scholar: domains and work environments Our dataset offers two ways to assess scientific productivity, by two indicators: the total number of publications ("ttlitems") and the relative count ("cp"). The relationship between these two was shown in Fig.1a. As can be seen in Fig.1a, the representative points appear to be scattered in the form of an upward-sloping line. The red line geometrically represents the correlation between "ttlitems" and "cp": the higher the relative count of their publications in 2008-2017, the larger the volume of their entire decade-old body of work.

In this article, we focus on analyzing the influence of all other factors on "cp" as the dependent variable, rather than "ttlitems". We chose relative count to be our response variable, because the values of "cp" were adjusted relatively to the significance of the author to the projects in which they participated, thus representing the true strength of the author as well as their tenacity and persistence.



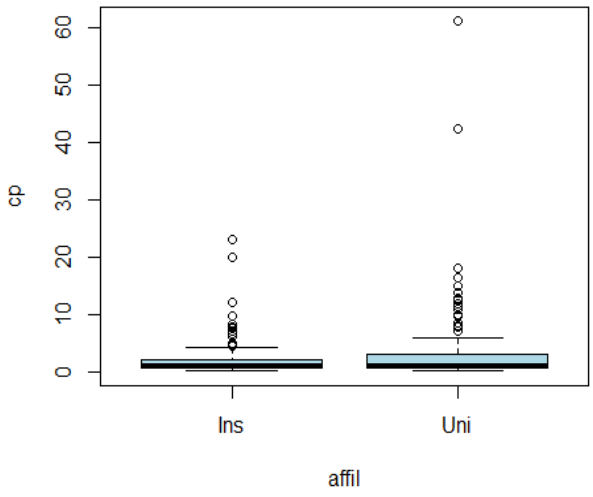
a **b**

Figure 1. Chart depicting relative output in relation to normal count

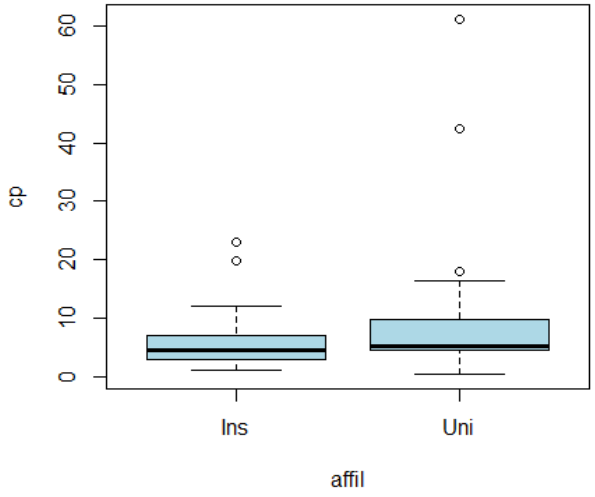
Fig. 1b shows the distribution authors by relative publication count. It can be seen that the majority of authors produced an output of 1-5 over the 10-year period from 2008 to 2017, which proved that the adjusted productivity of social Vietnamese scientists is very low. This may be due to the humble total number of their publications, their limited contribution in research studies, or both. Based on Fig.1b, scientists with an outstanding relative count (≥5) are separated into another group called "high-performance group". This subset of 86 observations will be analyzed in comparison with the full sample.

An analysis on data concerning academic affiliations showed that in general, 60.8% Vietnamese social scientists are affiliated to universities ("Uni") and 39.2% to research institutions ("Ins"). For the high-performance group, the proportions are 61.6% and 38.4% respectively. There are no significant differences.

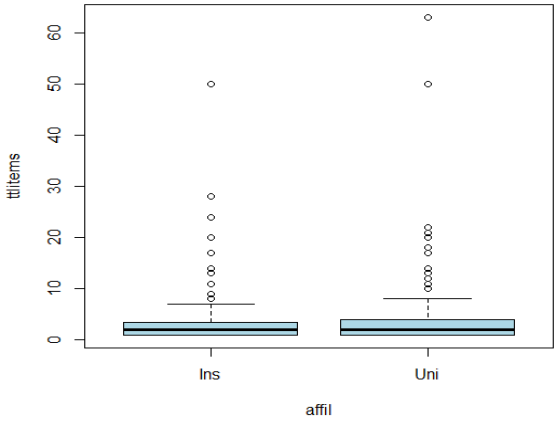
A few charts comparing the two groups by institutional affiliations are given in Fig.2.



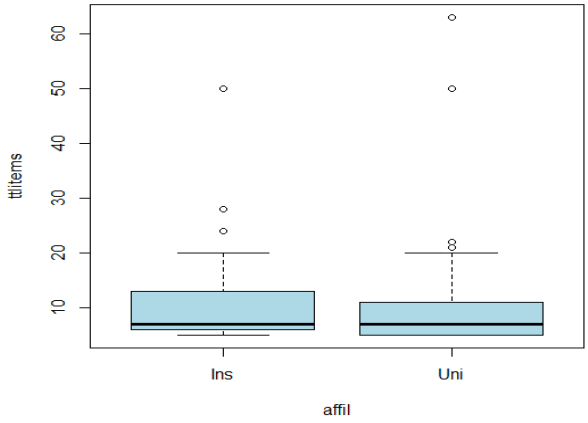
a. Relative count against affiliation (N=406)



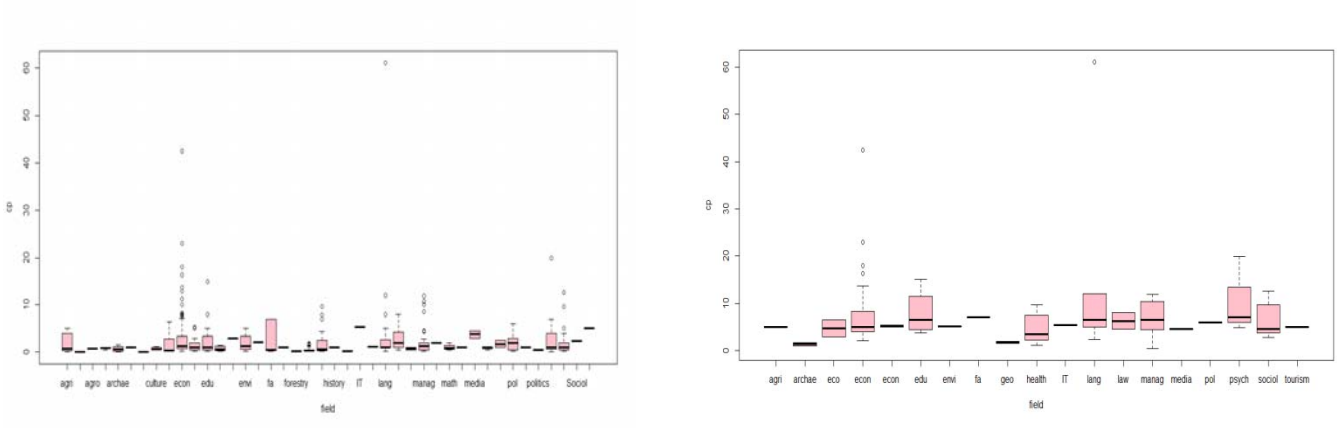
b. Relative count against affiliation (n=86)



b. Normal count against affiliation (N=406)



c. Normal count against affiliation (n=86)



e. Relative count across fields (N=406)

f. Relative count across fields (n=86)

Figure 2. A few descriptive statistics comparing the entire population and high-performing group

In Fig. 2a and b, the average relative number of publications in "Uni" are higher than in "Ins" (2.74 and 1.92 (N = 406); 8.48 and 5.85 (N = 86), relatively). On the contrary, Fig. 2c and Fig. 2d show that the average normal counts of "Uni" are lower than those of "Ins" (3.62 and 3.64 (N = 406); 10.69 and 11.09 (n = 86), respectively). This contrast implies that those who work in or are affiliated to universities, while they might publish fewer articles, tend to hold more important positions in studies compared to those in other institutions.

On the other hand, Fig. 2e and f show largely differential productivity across domains. Overall, the three most productive fields are tourism, media, and language, with the average of 5.0; 3.75; and 3.71. In the high-performing group only, the most productive authors are in the three following fields: language, psychology, and economics, with average relative productivity rates of 15.58; 10.56; and 8.27, respectively.

Productivity influenced by type of collaborations and affiliation

The "high productivity" group has a different collaborating tendency compared to the entire population. Scientists working in universities also tend to cooperate differently from their colleagues in other institutions (see Table 1).

Table 1. The average number of author's unique collaborators according to affiliations

	N = 406			n = 86		
	"Ins"	"Uni"	**Sum**	"Ins"	"Uni"	**Sum**
"au.vn"	4.30	3.00	**3.51**	8.15	3.89	**5.52**
"au.fr"	4.10	2.39	**3.06**	11.61	6.13	**8.23**

In table 1, "au.vn" and "au.fr" represent the average number of unique domestic and international collaborators with whom the authors once worked. These variables are to be understood

as the number of authors and not the number of publications: For example, suppose that an individual Vietnamese social scientist cooperated with the same group of three, including one Vietnamese and two foreigners, in multiple articles. Their "au.vn" value would be 2 (counting both their domestic peer and themselves) and "au.fr" would amount to 2.

In Table 1, with N = 406, the value of "au.fr" = 2.39 and "au.vn" = 3.00 at "Uni" indicates that, on average, a university researcher worked with more local peers than overseas colleagues. The same observation could be made with "Ins" researchers. In light of this, there seems to be more domestic scientists involved in Vietnam-based publications than international scholars. However, the tendency within the high-performance group shows a stark contrast: the number of foreign collaborators is approximately 50% higher than that of the domestic researchers.

In addition, people belonging to research institutes have more collaborators (both domestic and foreign) than those in universities. This trend is even more pronounced among the most productive scientists when the values of "au.fr" and "au.fr" at "Ins" are approximately twice as great as at "Uni".

RESULTS

Influence of work environments and collaborations on relative scientific productivity

We focused on studying the impact of institutional affiliations ("affil") under the hypothesis that scientists working in different research environments will have varying degrees of productivity. In this study, the working environment is divided into two main units: universities ("Uni"), and other research institutions ("Ins") such as research institutes, companies, enterprises, etc. In addition, the collaborative element is represented by the number of times an author collaborates with other individuals to publish ("au.ttl").

Firstly, by checking relationships between variables, we obtained not only significant correlations between "au.ttl" and "affil" on one hand and "cp" on the other, but also interaction between "au.ttl" and "affil" themselves. Test results are given in Table 2.

Table 2. Test results of the relationships between "au.ttl", "affil" and "cp", N = 406

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
au.ttl	1	1562	1561.7	106.53	< 2e-16
affil	1	184	183.6	12.53	0.00045
au.ttl:affil	1	1097	1097.4	74.86	< 2e-16

The influence of "au.ttl" on "cp" will change in each different category of "affil". In other words, researchers from universities and from other institutions will be influenced differently by the factor of collaboration, resulting in different research output (*R in Ecology and Evolution* 2011).

We modeled the influence of "au.ttl" on "cp" separately in the two groups "Uni" and "Ins". The results are provided in Table 3.

Table 3. Estimation results of "cp" against "au.tll" according to "affil", N = 406

"Uni"	Intercept	"au.ttl"
	β_0	β_1
"cp"	0.883** [2.633]	0.183*** [10.609]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; z-value in square brackets. Residual standard error: 4.495 on 245 degrees of freedom. F-statistic: 112.6 on 1 and 245 df, p-value: < 2.2e-16. Adjusted R-squared: 0.312		
"Ins"	Intercept	"au.ttl"
	β_0	β_1
"cp"	1.151*** [5.435]	0.042*** [9.147]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; z-value in square brackets. Residual standard error: 2.451 on 157 degrees of freedom. F-statistic: 83.66 on 1 and 157 df, p-value: 2.92e-16. Adjusted R-squared: 0.334		

These relations are expressed in the following equations:

$$cp_{(Uni)} = 0.883 + 0.183 \times au.ttl \quad \text{(Eq.1)}$$

$$cp_{(Ins)} = 1.151 + 0.042 \times au.ttl \quad \text{(Eq.2)}$$

Seeing as both coefficients differed from (Eq.1) to (Eq.2) are different, it was obvious that the impact of "affil" has changed the magnitude of the effect of "au.ttl" on "cp".

Effect of collaboration and work environments on productivity of high-performance group

As mentioned above, authors with a total work of 5 publications or greater are considered to be well-performing. The analyses in this section are intended to confirm the influence of the work environment and collaboration on the top-performance social scientists in Vietnam. The effects of these factors on the high-performance group would then be put into perspective with that on the entire population of authors. Test results also disclosed the effect of "au.ttl" and "affil" to response variable "cp" and affirmed the interaction between the two independent variables (Table 6 in the Appendix).

Regression results are performed in Table 7, which is included in the Appendix. According to this, coefficients of "au.ttl" are $\beta_0 = 4.905$ ($P < 0.001$) and $\beta_1 = 0.127$ ($P < 0.001$) for the "Uni" group and 4.360 ($P < 0.0001$) and 0.024($P < 0.05$) respectively for "Ins".

The regression equations are established as in (Eq.3) and (Eq.4):

$$cp_{(Uni)} = 4.905 + 0.127 \times au.ttl \quad \text{(Eq.3)}$$

$$cp_{(Ins)} = 4.360 + 0.024 \times au.ttl \quad \text{(Eq.4)}$$

Comparing domestic with international cooperation

Teamwork in research has been proven to play an important role in the scientific performance of individuals or even a group of authors (Bordons et al. 1996; Hampton & Parker 2011; Landry et al. 1996; Lee & Bozeman 2005; Pao 1992). However, the spatial scope of collaboration has received less attention in the extant literature; more precisely, we ask ourselves: Is international collaboration more effective than domestic cooperation in boosting scientific output? With the variable "au.fc" indicating whether or not an author once worked with foreigners, the model is constructed with the response "cp" and the predictor "au.fc". The results are as follows:

Table 4. Estimation results of "cp" against "au.fc", N = 406

	Intercept	"au.fc"
		"Yes"

	β_0	β_1
"cp"	1.352*** [3.475]	1.626*** [3.390]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; z-value in square brackets. 4.585 on 404 degrees of freedom. F-statistic: 11.49 on 1 and 404 df, p-value: 0.00077. Adjusted R-squared: 0.025		

The estimation equation is:

$$cp = 1.352 + 1.626 \times Yes.au.fc \quad \text{(Eq.5)}$$

With $\alpha = 0.05$ the estimated coefficient of "au.fc" is statistically significant. Thus, there is a definite difference between those who only work with Vietnamese colleagues and those who work with both local and international partners. The question is: does relative output increase with the number of domestic and foreign peers? Performing a regression of "cp" agianst "au.vn" and "au.fr" on a sample of 267 authors collaborating with both domestic and international partners, we obtained the results reported in table 5.

Table 5. Estimation results of "cp" against "au.vn" and "au.fr", n = 267

	Intercept	"au.vn"	"au.fr"
	β_0	β_1	β_2
"cp"	1.589** [3.254]	0.288** [2.852]	0.066 [1.048]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; z-value in square brackets. Residual standard error: 5.404 on 264 degrees of freedom. 7.472 on 2 and 264 df, p-value: 0.0007. Adjusted R-squared: 0.046			

The above results indicate that, with 95% significance, only the intercept and the coefficient of "au.vn" are statistically significant, while "au.fr" does not show any influence on "cp". The regression equation is expressed as follows:

$$cp = 1.589 + 0.288 \times au.vn + 0 \times au.fr \quad \text{(Eq.6)}$$

The insignificance of "au.fr" turned out to be noteworthy and the underlying rationale for such statistical issue is quite meaningful. The lack of correlation between "au.fr" and "cp" prompted us to further examine the variable "au.fr" by performing the same regression models as (Eq.5) and (Eq.6), this time with "ttlitems" as the dependent variable rather than "cp". The results unveiled the effect of "au.fc" on "ttlitems" with $\beta_0 = 1.799$ ($P < 0.0001$) and $\beta_1 = 2.778$ ($P < 0.0001$) (Table 8 in the Appendix).

Moreover, unlike with "cp" as the response variable, the regression results between "au.vn", "au.fr" and "ttlitems" showed a significant correlation between "au.fr" and "ttlitems" with $\beta_0 = 1.252$ ($P < 0.05$); $\beta_{au.vn} = 0.510$ ($P < 0.0001$); $\beta_{au.fr} = 0.322$ ($P < 0.0001$) (Table 9). The specific regression equations are shown respectively below:

$$cp = 1.799 + 2.778 \times Yes.au.fc \quad \text{(Eq.7)}$$

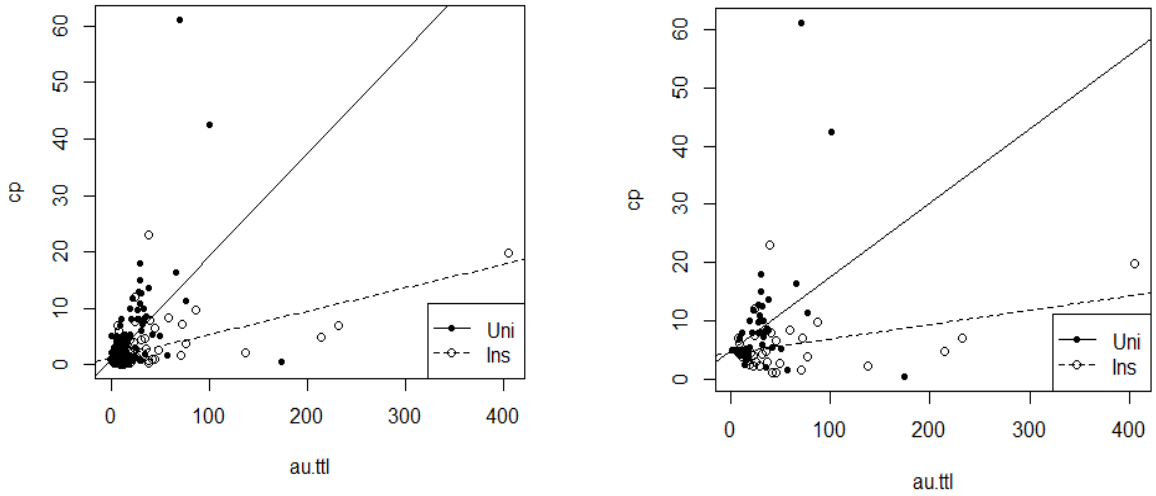
$$cp = 1.252 + 0.510 \times au.vn + 0.322 \times au.fr \quad \text{(Eq.8)}$$

Although it has no correlation with the relative output, the number of unique foreign collaborators is demonstrated to associate with total number of publications. The meaning of its estimate coefficients will be further analyzed in Discussion.

Discussion

It could be inferred from the analyses that both workplaces and collaborations affect scientific productivity. Comparing the coefficients of "au.ttl" in (Eq.1) and (Eq.2), one can see that β_1 in (Eq.1) is greater than β_1 in (Eq.2). The difference means that work environments impact the researchers' performance through changing the effect of collaborations. In other words, with the same increase in times of collaboration, authors working at universities will have more productivity growth than those working in other institutions. More precisely, when "au.ttl" increases one unit, the relative count of publications of university scholars would have an average increment of 0.183 units, while the relative count increase would be merely 0.042 for those affiliated with other institutions. A similar remark could be made for the most productive group: when "au.ttl" increases by one unit, "cp" will increase by 0.127 units at "Uni" and by 0.024 units at "Ins".

The impact of these factors is weaker on the high-performance group than on the entire population. This is illustrated in the following chart:



a (N = 406) **b** (n = 86)

Figure 3. Lines descrbing estimated relationships between "au.ttl" and "cp"

As can be observed, the distance between "Uni" and "Ins" lines in Fig. 3a is wider than in Fig.3b. Indeed, the difference in slopes between the two lines is 0.141 in Fig.3a while only 0.103 in Fig.3b. The reason is the effect of "affil" on "cp" in the high-performance group is not as strong as in the entire sample. Thus, the two lines representing two categories of "affil" in Fig.3b move closer to each other.

On the other hand, the collaborative element also presents a weaker effect on the productive authors than on the overall. Evidence is that the slopes of "Uni" and "Ins" lines in Fig. 3b (0.127 and 0.024, respectively) are smaller than those of corresponding lines in Fig. 3a (0.183 and 0.042). Regarding the differences between domestic and international cooperation, the coefficients $\beta_1 = 1.626 > 0$ in (Eq.5) and $\beta_1 = 2.778 > 0$ in (Eq.7) show the positive effect of international cooperation in boosting scientific output. On average, the relative output of those who have at least once worked with foreigners is 1.626 units greater than individuals who only cooperate locally. In terms of sheer number of publications, an increase of one unit of "au.fr" entails an increment of 2.778 publications. However, in terms of relative count of publications, there is no link between the number of unique international co-workers and an author's adjusted output, seeing as coefficient β_2 of "au.fr" in (Eq.6) is close to null. On the other hand, $\beta_1 = 0.288 (P < 0.001)$ in (Eq.6) proved that each increase of one unit in the number of domestic associates will increase the adjusted output by 0.288 units, on

average. In (Eq.8), in contrast, both β_1 and β_2 are statistically significant, suggesting that each increase in the number of local and foreign partners will increase an average of 0.510 and 0.322 units, respectively, in the total publications.

CONCLUSIONS

Productivity of Vietnamese social scientists is fairly low (mean = 2.42, 95% CI = 1.97-2.87). In a group, the role of each individual tends to stay fixed from projects to projects, suggesting that their contribution into collaborative works varies little during their career. It should be noted that those who work at or affiliate to universities are likely to hold more important positions in articles than those in other research institutions. This remark is noteworthy because it contradicts with the Vietnamese mindset that universities are primarily for teaching rather than producing knowledge. The situation could be explained by the fact that universities in Vietnam received financial aid from the government more often than other institutions, and while it wasn't always specifically meant for researchers alone, it did help encouraging research activities. In addition, thanks to their double function of teaching and researching, universities are generally more active than institutions. This pre-existing proactivity, coupled with the recent government-initiated incentives in favor of research work, motivated scientists to undertake the most important positions in a research group.

The influence of work environments on researchers' output is shown through the growth of adjusted publication count when the number of collaborating times ("au.ttl") increases. More precisely, individuals affiliated with universities are more affected by collaborations than those who work in institutions. More precisely, when the times of collaboration increase by one unit, the relative productivity of individuals working at the university increases 0.141 units more than other institutions; this figure is 0.103 in the group of high-performance authors. However, it should be noted that the importance of work environment and collaboration are somewhat reduced for those who achieve great output. In fact, the impact of work environments on most well-performing authors is reduced by nearly 27% compare to that on the average author. The boosting effect of collaborations on these high-performance authors also drops by 30.6% for those working in universities and 42.9% for those in other institutions.

Authors also tend to cooperate more with their local colleagues, although the trend is reversed among the best-performing authors: the average number of foreign partners in this group is 1.5 times higher local peers. Nevertheless, the positive impact of international cooperation on both adjusted and normal count of published works is still supported by estimation results. On average, those who once worked with foreigners have 2.5 times more publications and a 2.2 times higher relative output compared to those who only worked with domestic colleagues. It is remarked that an increase in

number of unique foreign co-workers only increases an author's number of published papers and does not enhance their contribution and – subsequently – significance in a science project. This can be explained as follows: in publications involving overseas collaboration, the leading authors are often not Vietnamese (Manh 2015), and these products are also often of excellent quality (Arunachalam& Doss 2000; Glänzel 2001; Manh 2015; Nguyen et al 2017). In other words, the appearance of a new foreign partner tends to increase the number of publications of a Vietnamese author. However, when the number of foreign collaborators increases considerably, they share themselves high-ranking positions in an author list, leading to the significances of Vietnamese co-authors being not enhanced. As a result, their relative output does not increase along with their publication count.

Last but not least, behind the figures of productivity and adjusted contribution as analyzed in the paper are the academic cultures of research institutions and universities. The process of working with the international publishing systems both improves research capacity and strengthens cultural elements that support collaborations and publishing efficiencies. This learning process will also yield deeper values with respect to the philosophy of science, first within groups of higher productivity and contribution (Vuong & Napier 2017), which will likely have created positive impacts on the whole population of Vietnamese social scientists in the long run.

ACKNOWLEDGMENT

We would like to thank Vuong & Associates for their excellent assistance in collecting and preparing data during the research process, particularly Dam Thu Ha, Nghiem Phu Kien Cuong and Nguyen Thi Phuong.

APPENDIX

Table 6. Test results of the relationships between "au.ttl", "affil" and "cp", n = 86

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
au.ttl	1	274	274.3	4.695	0.0331
affil	1	298	298.1	5.103	0.0265
au.ttl:affil	1	364	364.2	6.234	0.0145

Table 7. Estimation results of "cp" agianst "au.tll" according to "affil", n = 86

"Uni"	Intercept	"au.ttl"
	β_0	β_1

"cp"	4.905** [2.782]	0.127** [2.863]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; z-value in square brackets. Residual standard error: 9.045 on 51 degrees of freedom. F-statistic: 8.194 on 1 and 51 df, p-value: 0.006. Adjusted R-squared: 0.122		
"Ins"	Intercept	"au.ttl"
	β_0	β_1
"cp"	4.360*** [4.455]	0.024* [2.504]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1, z-value in square brackets. Residual standard error: 4.464 on 31 degrees of freedom. F-statistic: 6.272 on 1 and 31df, p-value: 0.018. Adjusted R-squared: 0.141		

Table 8. Estimation results of "ttlitems" agianst "au.fc", N = 406

	Intercept	"au.fc"
		"Yes"
	β_0	β_1
"ttlitems"	1.799*** [3.676]	2.778*** [4.605]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; z-value in square brackets. 5.768 on 404 degrees of freedom. F-statistic: 1121.21 on 1 and 404 df, p-value: 5.534e-06. Adjusted R-squared: 0.05		

Table 9. Estimation results of "ttlitems" against "au.vn" and "au.fr", n = 267

	Intercept	"au.vn"	"au.fr"
	β_0	β_1	β_2
"ttlitems"	1.252* [2.216]	0.510*** [4.366]	0.322*** [4.431]
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1; z-value in square brackets. Residual standard error: 6.252 on 264 degrees of freedom. F-statistic: 35.17 on 2 and 264 df, p-value: 2.876e-14. Adjusted R-squared: 0.204			

References

Abramo G, D'Angelo CA (2014) How do you define and measure research productivity?. Scientometrics 101(2):1129-1144. doi:10.1007/s11192-014-1269-8

Allison PD, & Long JS (1990) Departmental effects on scientific productivity. Am Sociol Rev 55(4):469-478

Arunachalam S, & Doss MJ (2000) Science in a small country at a time of globalisation: domestic and international collaboration in new biology research in Israel. J Inf Sci. 26(1):39-49. doi: 10.1177/016555150002600104

Batista PD, Campiteli MG, & Kinouchi O (2006) Is it possible to compare researchers with different scientific interests?. Scientometrics 68(1):179-189. doi:10.1007/s11192-006-0090-4

Bland CJ, Center BA, Finstad DA, Risbey KR, & Staples JG (2005) A theoretical, practical, predictive model of faculty and department research productivity. Acad Med 80(3):225-237. doi:10.1007/s11192-006-0090-4

Bordons M, Gomez I, Fernández M, Zulueta M, & Mendez A (1996) Local, domestic and international scientific collaboration in biomedical research. Scientometrics 37(2):279-295. doi:10.1007/BF02093625

Bote G, Vicente P, Olmeda-Gómez C, & Moya-Anegón F (2013) Quantifying the benefits of international scientific collaboration. J Assoc Inf Sci 64(2):392-404. doi:10.1002/asi.22754

Craven BD & Islam SM (2011) Ordinary least-squares regression. Sage Publications, p 224-228

Davidson Frame J & Carpenter MP (1979) International research collaboration. Soc Stud Sci. 9(4):481-497. doi: 10.1177/030631277900900405

Duque RB, Ynalvez M, Sooryamoorthy R, Mbatia P, Dzorgbo DBS, & Shrum W (2005) Collaboration paradox: Scientific productivity, the Internet, and problems of research in developing areas. Soc Stud Sci 35(5):755-785. doi:10.1177/0306312705053048

Figg WD, Dunn L, Liewehr DJ, Steinberg SM, Thurman PW, Barrett JC, & Birkinshaw J (2006) Scientific collaboration results in higher citation rates of published articles. Pharmacother 26(6):759-767. doi:10.1592/phco.26.6.759

Glänzel W (2001) National characteristics in international scientific co-authorship relations. Scientometrics 51(1):69-115. doi:10.1023/A:1010512628145

Hampton SE & Parker JN (2011) Collaboration and productivity in scientific synthesis. BioScience 61(11):900-910. doi:10.1525/bio.2011.61.11.9

Hayati Z & Ebrahimy S (2009) Correlation between quality and quantity in scientific production: A case study of Iranian organizations from 1997 to 2006. Scientometrics 80(3):625-636. doi:10.1007/s11192-009-2094-3

Ho TM, Vuong TT, Nguyen HV, Napier NK, & Vuong QH (2017). Nemo solus satis sapit: trends of research collaborations in Vietnamese social sciences, using 2008-2017 Scopus data. Working Papers CEB No. 17-017 (Université Libre de Bruxelles).

Kyvik S (1989) Productivity differences fields of learning, and Lotka's law. Scientometrics 15(3-4):205-214. doi:10.1007/BF02017199

Kyvik, S (1990) Age and scientific productivity Differences between fields of learning. High Educ. 19(1):37-55. doi:10.1007/BF00142022

Landry R, Traore N, & Godin B (1996) An econometric analysis of the effect of collaboration on academic research productivity. High Educ 32(3):283-301. doi:10.1007/BF00138868

Lee S & Bozeman B (2005) The impact of research collaboration on scientific productivity. Soc Stud Sci 35(5):673-702. doi: 10.1177/0306312705052359

Leimu R & Koricheva J (2005) Does scientific collaboration increase the impact of ecological articles?. BioScience 55(5):438-443. doi:10.1641/0006-3568(2005)055[0438:DSCITI]2.0.CO;2

Liang L & Zhu L (2002) Major factors affecting China's inter-regional research collaboration: Regional scientific productivity and geographical proximity. Scientometrics 55(2):287-316. doi:10.1023/A:1019623925759

Manh HD (2015) Scientific publications in Vietnam as seen from Scopus during 1996–2013. Scientometrics 105(1):83-95. doi:10.1007/s11192-015-1655-x

Nguyen TV, & Pham LT (2011) Scientific output and its relationship to knowledge economy: an analysis of ASEAN countries. Scientometrics 89(1):107-117. doi: 10.1007/s11192-011-0446-2

Nguyen TV, Ho-Le TP, & Le UV (2017) International collaboration in scientific research in Vietnam: an analysis of patterns and impact. Scientometrics 110(2):1035–1051. doi:10.1007/s11192-016-2201-1

Nguyen Van Tuan (2016) Nang suat khoa hoc Viet Nam qua cong bo quoc te 2001 – 2015. Tap chi Khoa hoc cong nghe Vietnam 2006(10):49-54

Pao ML (1992) Global and local collaborators: a study of scientific collaboration. Inf Process Manag 28(1):99-109. doi:10.1016/0306-4573(92)90096-I

R in Ecology and Evolution (2011) Comparing two regression slopes by means of an ANCOVA http://r-eco-evo.blogspot.com/2011/08/comparing-two-regression-slopes-by.html. Accessed 12 May 2017

Ruiz-Castillo J & Costas R (2014) The skewness of scientific productivity. J Informetr 8(4):917-934

Smart J, & Bayer A (1986) Author collaboration and impact: A note on citation rates of single and multiple authored articles. Scientometrics 10(5-6):297-305. doi:10.1007/BF02016776

Sooryamoorthy R (2009) Do types of collaboration change citation? Collaboration and citation patterns of South African science publications. Scientometrics 81(1):177-193. doi:10.1007/s11192-009-2126-z

Tscharntke T, Hochberg ME, Rand TA, Resh VH, & Krauss J (2007) Author sequence and credit for contributions in multiauthored publications. PLoS Biol 5(1):e18. doi:10.1371/journal.pbio.0050018

Vuong QH, & Napier NK (2017) Academic research: The difficulty of being simple and beautiful. European Science Editing 43(2):32-33. doi: 10.20316/ESE.2017.43.002

Vuong QH, Tran TD, Napier NK, & Dau TH (2013). Business education in the emerging economy of Vietnam: Twenty years of expectations, illusions, and lessons. In Alon I, Jones V, and McIntyre J (Eds.) Innovation in Business Education in Emerging Markets (pp. 96-112). New York, NY: Palgrave Macmillan.

Yi Y, Qi W, & Wu D (2013) Are CIVETS the next BRICs? A comparative analysis from scientometrics perspective. Scientometrics 94(2):615-628. doi:10.1007/s11192-012-0791-9