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Nemo Solus Satis Sapit: Trends of Research Collaborations in the Vietnamese Social Sciences, Observing 2008–2017 Scopus Data

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Abstract: "*Nemo solus satis sapit*"—no one can be wise enough on his own. This is particularly true when it comes to collaborations in scientific research. Concerns over this issue in Vietnam, a developing country with limited academic resources, led to an in-depth study on Vietnamese social science research, using Google Scholar and Scopus, during 2008–2017. The results showed that more than 90% of scientists had worked with colleagues to publish, and they had collaborated 13 times on average during the time limit of the data sample. These collaborations, both domestic and international, mildly boosted author performance. On the other hand, the modest number of publications by Vietnamese authors was reportedly linked to Vietnamese social scientists' heavy reliance on collaborative work as non-leading co-authors: for an entire decade (2008–2017), the average author assumes the leading role merely in two articles, and hardly ever published alone. This implies that policy-makers ought to consider promoting institutional collaborations while also encouraging authors to acquire the experience of publishing solo.

Keywords: scientific collaborations; higher education; research institutions; research policy; productivity; Vietnam

1. Introduction

It has long been recognized that scientific research has prospered in some places more than others, namely at universities on a national scale, and in developed countries on a global scale [1,2]. This is not a surprise, as the scholar is often required to devote time and energy to research in order to secure an academic position in today's competitive scientific world. Nor is it uncommon that the demand for higher quality output calls for collaboration. Collaborations, in turn, become a boost for the scientific output itself. In fact, Fonseca et al. and Ynalvez and Shrum proved that bursts of productivity mainly occurred under the influence of human relationships in their working environments [3,4]. This argument is further complemented by Lee and Bozeman, who explained

that collaboration strategies had a significant, positive effect on scientific output [5]. Moreover, there is evidence that a lack of collaboration in research was correlated to significant gender inequalities in scientific publishing [6], in the sense that female scientists collaborated less frequently with others, and also had fewer publications on average. Previous results indicated that there was a positive and meaningful correlation between qualitative and quantitative criteria in the scholarly scientific publications [1]. The quality of publications could also be boosted when the number of authors involved increases [7,8]. Smart and Bayer found that the acceptance rate of articles that were collaboratively authored tended to be higher than that for single-authored papers [3]. Furthermore, the number of times an article was cited correlated significantly with the number of authors and the number of institutions [7]. Those who were open to collaborations and those who seemed to adequately manage those collaborations produced in higher quantity, which resulted in higher impact [7]. In short, the merits of scientific collaboration in improving productivity and scientific content quality have been widely acknowledged.

Geography, politics, language, faculty and discipline have all played a strong role in determining who collaborated with whom in the scientific community [9–15]. In fact, scientists tended to prefer collaborating with people whose locations were not too far from theirs [11,13,16]. Developed Western countries and high impact institutions were the most collaborative amongst themselves [17]. That being said, international collaboration is increasing both among countries in the same region as well as around the world [18–21], which is not only enhancing productivity, but also increasing scientists' collaborative propensity and visibility [9,22]. The ratio of the number of international links and international papers turned out to be roughly proportional to the ratio of full publication counts [23]. Also, international co-authorship on average resulted in publications with higher citation rates than purely domestic papers [24]. However, this type of collaboration had no effect in some specific fields [25], nor did it significantly influence the benefits that the host countries derived from collaboration. However, it did seem to positively influence the benefits obtained by the countries with which they collaborated [18,26,27]. Cross-country collaboration was also not as globalized as one would have imagined, with several countries collaborating with one another much more than others. In China, for example, scientific collaborations were limited to just about 20 countries for nearly 95% of their international co-authored papers, of which 40% were published with American co-workers [28]. Nevertheless, in a developing country such as Vietnam, overseas collaborations are still highly regarded, often more than domestic co-authored works. Given that the relative geographic scope of collaborative works was often brought up as a potential indicator of scientific output in discussions within the Vietnamese scientific community, it would be interesting to examine the varying effect of work between international peers and domestic co-authors on a Vietnamese social scientist.

A large number of papers have already presented the benefits of collaborations on an individual scale by demonstrating a positive correlation between scientific output and collaboration practices [5,14,22,29,30]. However, there were just as many cases, especially in developing countries, that suggested that collaboration was not associated with any general increment in productivity [31]. In fact, nations with a less developed scientific infrastructure had a tendency for international co-authorship collaboration mainly as a means of cost sharing [15]. Additionally, scientific collaborations and its relationship with collaborations can be observed not only on an international scale, but also inter-institutional and inter-individual [32,33], and the reported non-significance of collaborations in boosting productivity also applied generally for collaborative works between groups [22–24]. It should be noted that the institutional structures of collaboration were reportedly not related to increased productivity, but were related to costs and funding trade-offs [34]. While collaborations that were formed to capitalize on funding opportunities may be important promoter in the long run, they were not effective in enhancing researcher productivity in the short run [35]. Additionally, a 2012 paper has reported that beyond an identified optimal level, collaboration not only doesn't boost productivity, it might even undermine the processes of knowledge creation and application [36].

Whether or not collaborations truly boosted the scientific output of individual scientists or institutional groups, it is an observed worldwide trend that solo authors and single-authored papers are declining in numbers and proportions, while mean authors are rising [37–41]. In the case of Vietnam, most of the collaborative works in which Vietnamese scientists took part involved international authors. Most importantly, it was very often the latter who led the projects; this was believed to show a lack of academic qualities on the part of Vietnamese authors [42–44]. On the other hand, there seems to be a certain connection between the experiences of being a key author and being a solo author. It has been reported in previous findings that the experience of being a key author in collaborative works can significantly boost the output of a scholar [43]. Given the scant literature on the corresponding role of first-authorship in boosting scientific output, we hope to shed more light on this precise subject matter in our study.

There is thus extensive literature suggesting that collaborative works have little to no positive effect on scientific output, which is in direct conflict with findings on the benefits of collaborations in scientific productivity. This dissensus on the influence of collaborations, positive or negative, or lack thereof, has prompted us to examine the role of collaborative works in boosting output in the budding scientific community of Vietnam.

The Context of Vietnam

Vietnam only started opening up to the world at the beginning of the 1980s, after the 1986 *Doi Moi* economic reforms [45]. The scientific community in Vietnam is young, as is the economy of the country itself. At present, Vietnam has hundreds of domestic journals, but only three among them are indexed in Scopus, and none are indexed in Clarivate Analytics Web of Science (formerly known as Thomson Reuters' Institute of Scientific Information, or ISI) [46]. Vietnamese academia is apparently not so robust in terms of quality.

For decades now, academic publications in the Vietnamese social sciences have been dismal as far as research quality and international recognition are concerned [47]. In Vietnam, the sheer total scientific output has increased by 17% per year, 77% of which were associated with international collaborations, with the United States and Japan being the leading collaborators [42,48]. These research collaborations were mainly led by foreign authors [42]. This remark corresponds to the modest scientific output of Vietnamese authors, given that authors who often take the leading role are likely to be more scientifically prolific, and such authors are few in number in Vietnam [43]. Papers with an overseas corresponding author also had higher citation rates than papers with a domestic corresponding author [42], meaning that foreign research workers were more appreciated, both qualitatively and quantitatively.

In Southeast Asia, despite Vietnam ranking fourth in the number of total scientific publications and third in terms of citations, it only accounted for 0.6% of the regional total [44] among six favored emerging markets countries, Colombia, Indonesia, Vietnam, Egypt, Turkey and South Africa, usually referred to as CIVETS [49]. Yet the data also indicated that Vietnam was in a phase of rapid growth regarding the build-up of research capacity [42]. These conflicting empirical findings called for a thorough examination. Furthermore, the extant literature on the Vietnamese scientific community focuses mainly on analyzing data on an aggregated level, such as reports by Manh (2015) [48] and Nguyen et al. (2016) [42], and has not derived indicators to measure and assess scientific productivity in the social sciences in Vietnam specifically. We hope to bridge this gap by examining a dataset of 410 Vietnamese researchers in the social sciences and investigate collective trends related to their scientific output and academic collaborations.

Analyses have been conducted to test the two following hypotheses:

Hypothesis 1. *The number of times the author had collaborated, and the number of domestic colleagues that the author had worked with, as well as independent research capability, exerted a positive influence on the author's scientific output.*

Hypothesis 2. *Co-authorship with both domestic and international peers and an author's leading role have both positively impacted the author's total research output.*

The goal of the study was to obtain insights about the importance of scientific collaborations and the role of the author in said collaborations in improving their output. We also expect to shed some light on the related social aspects of their relationships.

2. Materials and Methods

The subjects of this survey were social scientists of Vietnamese nationality with scientific publications indexed in the Scopus database from the beginning of 2008 to May 2017, who met at least one of the two following criteria:

(1) they had at least one publication about Vietnam or using data collected in Vietnam; OR
(2) they were affiliated with a Vietnamese institution.

These criteria were established to ensure that any scientist counted in our database has sufficient ties to Vietnamese academia—either by directly contributing to the literature on Vietnam, or by being affiliated to an official institution in Vietnam—to qualify for potential government funding. The research team counted no more than 10 such people, of whom only five have individual records of more than five eligible publications, which says that the excluded subsample is tiny. Therefore, their exclusion has not affected the generalization of our results at the national level for the 410-person sample, which almost represents the whole population of social scientists. While this exclusion does not affect the empirical trends and quality of observations, it does have useful practical implications. First, for policy-makers, the results help indicate where the government and its agencies can find appropriate expertise in the concerned social research fields. Second, for research and education centers, reputation and capacity can now be justified by established standards, which means that the public will be better informed for a variety of household and societal decisions.

The reality has shown that the majority of social scientists in the database met all of the criteria; and the combinations of criteria were mostly "AND", but not "OR". Even Vietnamese social scientists living abroad have established strong working relations with domestic institutions and frequently returned home on academic missions thanks to the increasingly open academic environment.

We have chosen Scopus as the primary source to collect authors for our database for two reasons: (1) Scopus has a very large coverage, with over 22,600 active titles in its database [50], which is nearly twice as much as the base covered by its second competitor, Web of Science (11,400 titles) [51]; and (2) data from Scopus have been used for highly influential rankings, such as *Times Higher Education* [52] and the *Quacquarelli Symonds* (usually referred to as QS)[53].

We decided to limit the time period to 2008–2017 because in 2008, the National Foundation for Science and Technology Develoment (NAFOSTED) [54] first went into operation, marking a turn in governmental focus on scientific activities in Vietnam, particularly with respect to funding. While our dataset is not static and will continue to grow as new publications and authors enter the Vietnamese academic circle, this article will only focus on the dataset that ended in mid-May 2017. All of the articles published after May 2017 by authors who fit into our criteria will not be counted in this study.

The dataset was established as follows: First, the research team used sources such as the authors' personal pages or institutional websites, Google Scholar, journals, and Scopus. Then, author information from different sources was compared and confirmed to establish accurate data, as well as to map a network among authors and between authors and institutions. We recorded the following traits: (i) age, gender, region; (ii) "career age", i.e., the time since the author's graduation or the start of his/her first research project (if there is information to confirm); (iii) number of publications; (iv) number of co-authors in one publication, and then, in the full list of his/her publications; (v) affiliations; (vi) fields of research; (vii) whether or not they were ranked as "professor".

The scientific productivity of the scientist was measured by the number of publications during 2008–2017 and represented by the variable "ttlitems", which was then employed in our models as

the dependent variable. Information on article titles, co-authors, journal titles, and time of publication was recorded for each and every survey subject, in a pre-designed data form.

The factors that were considered influential to scientific productivity, and used as independent variables in the analysis, consist of:

- "au.key": the number of publications in which the subject in question served as the corresponding and/or lead author, unit: item(s);
- "au.solo": the number of publications in which the subject was the single author, unit: item(s) ;
- "au.co": the number of publications in which the subject served as non-lead and non-corresponding co-author, unit: item(s);
- "au.vn": the number of all Vietnamese peers appearing in the entire body of work of the subject in question, including both co-authors and the author in question, unit: people. Note that this variable counts the author in question, as well as all his/her co-authoring peers. Each Vietnamese co-author that constituted this number was counted only once, even if he/she co-authored multiple publications with the subject in question;
- "au.fr": the number of foreign co-authors in the entire body of work of the subject in question, unit: people. Similarly, each foreign peer was counted only once;
- "au.ttl": the total number of times the survey subject has collaborated with other authors, unit: times. This is not to be confused with the number of publications produced in collaboration; rather, we counted the number of collaborators that the subject 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. To better understand this variable, consider the following example: An author named A has published three articles. The first publication was a collaboration among five co-authors: A, B, C, D and E. She collaborated with C and D on her second work. Her third article was a single-authored work ("solo"). For this author, her "au.ttl" value would be: 5 + 3 + 1 = 9 (times).

Note that these variables are attributes of each data point, and are measured for individuals, rather than the aggregation of all 410 social scientists in the dataset. This means that when we mention "number of publications" or "number of peers", we refer to that of *one* author rather than the *aggregated total number* of all scientists in the dataset.

We used the multivariate linear regression model in this paper, which facilitated the analysis of our continuous dependent variable. The general model is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon_i$$

The condition for the model is that k independent variables X_i and dependent variable Y must have the same sample size n. Y is a continuous variable, while X_i can be continuous or discrete variables [37]. The data would then be processed in R (3.3.1). The coefficients β_i represent the linear effects of the factors on the dependent variable Y. Based on z-values and corresponding p-values, it is possible to determine the statistical significance of the predictor variables in the model. In this study, we have proven that $p < 0.05$; therefore, the respective independent variables are considered to be statistically significant.

We also performed tests in order to confirm the validity of the model, most importantly the F-test with the pair of hypotheses H_0: $\beta_1 = \beta_2 = \beta_i = \ldots = 0$, and H_1, to ensure that at least one coefficient in the model did not equal 0. The test result determined the value of F-statistic and the coefficient: namely, if $p < 0.05$, the hypothesis H_0 would be rejected. It could thus be confirmed that the regression coefficients in the model are not simultaneously equal to 0 [38].

3. Results

The collected data showed that a majority of Vietnamese social scientists had a small volume of works. Nearly 84% (344 out of 410) had five or fewer publications, and only 10 authors had published over 20 academic papers (Figure 1).

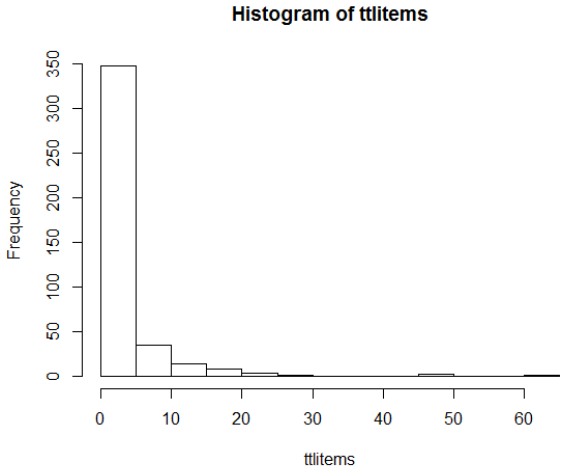


Figure 1. Distribution of scientists by number of publications during 2008–2017 ("ttlitems").

In addition, a great majority of Vietnamese social scientists had only ever written works in collaboration with their colleagues: only about 25% of surveyed scientists (103 out of 410 people) had published single-authored papers in the span of 10 years from 2008 to early 2017.

Table 1 shows some descriptive statistics for the continuous variables used in the study. While the mean number of publications ("ttlitems") amounted to 3.60, the average number of single-authored papers ("au.solo") was 0.73, with a relatively small standard deviation of 3.34. In other words, in the span of one decade (2008–2017), the average Vietnamese social scientist published less than one article as a solo author.

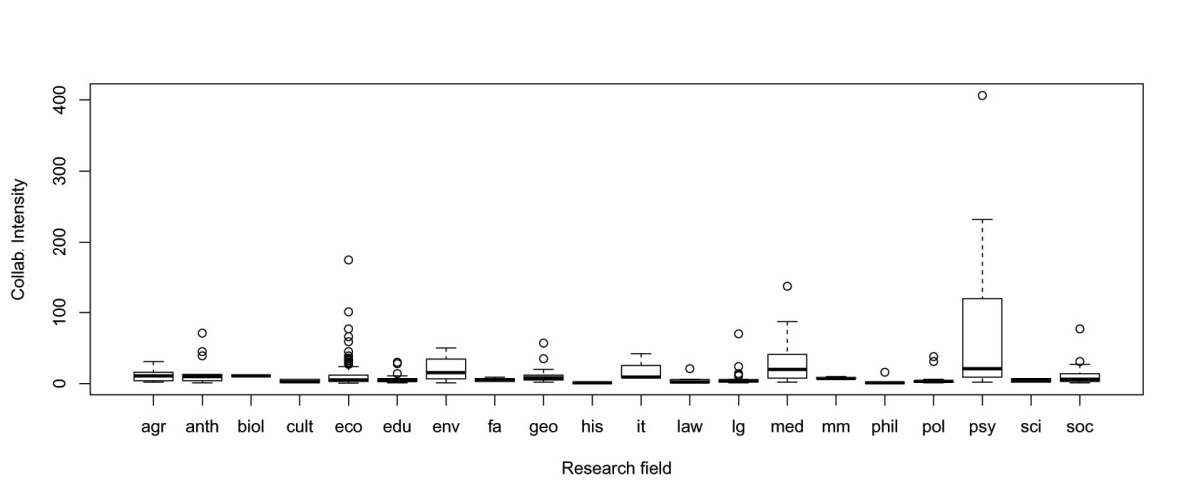
Table 1. A few descriptive statistics for continuous variables.

Variable	Min	Mean	Max	SD	*p*-Value
"ttlitems"	1	3.60	63	5.89	$p = 2.2 \times 10^{-16}$
"au.co"	0	2.87	50	4.33	$p = 2.2 \times 10^{-16}$
"au.solo"	0	0.73	58	3.34	$p = 1.2 \times 10^{-5}$
"au.key"	0	1.77	60	4.24	$p = 4.5 \times 10^{-16}$
"au.ttl"	0.5	13.30	406	29.89	$p = 2.2 \times 10^{-16}$
"au.fr"	0	3.03	50	5.92	$p = 2.2 \times 10^{-16}$

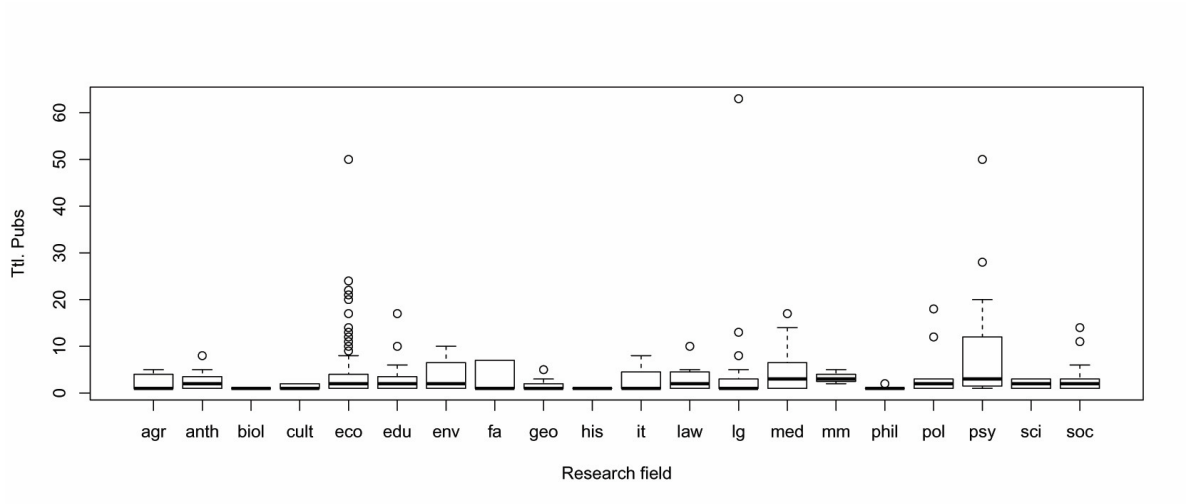
It seems that Vietnamese scholars in the social sciences were more inclined to collaborate than to write solo. Further, when they collaborated, they did not tend to lead, either: on average, a Vietnamese social scientist led less than two articles (mean value of "au.key" being 1.77), but co-authored as a non-leader in nearly three articles (mean value of "au.co" being 2.87), in the entire period of 2008–2017.

The maximum times of collaboration (refer to the description of variable "au.ttl" above) of the entire sample was 406, while its mean value amounted to only 13.3.

Regarding collaborations in various disciplines, some disciplines, such as economics, healthcare, and psychology seem to be more attractive than others (Figure 2a). The evidence is their dominant proportions, which are shown in Figure 2b. Economics was especially dominant, with 577 collaborative publications accounting for over 39% of the total. It should also be noted that authors were the most collaborative in the field of healthcare, which featured 60 collaborators (including both domestic and international authors). However, only 21% of the authors in these fields had five or more internationally published papers (Figure 2b).



(**a**) Research collaboration intensity by research field



(**b**) Research output range for typical research fields

Figure 2. Distribution of the number of times an author collaborated with other authors and scientific output against research fields.

The correlations between variables were calculated to preliminarily evaluate the relationships between factors, which were shown in Figure 3.

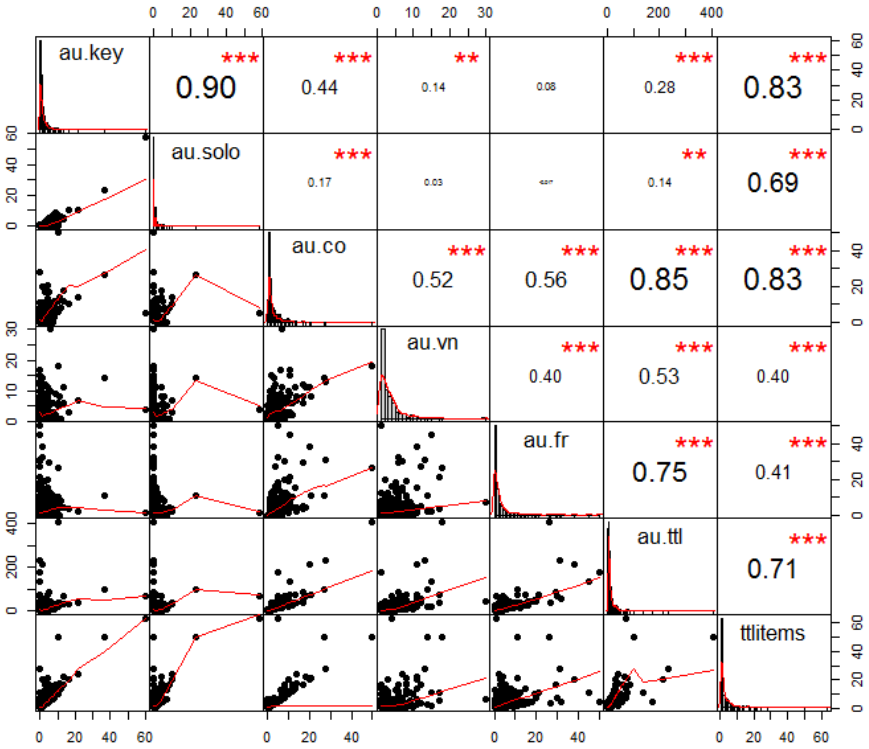


Figure 3. Correlation coefficients in pairs (**,*** denote conventional significance levels at 0.01 and 0.001, respectively).

It can be seen that all of the independent variables mentioned above had a significant impact on the dependent variable (number of publications, "ttlitems"), with $p < 0.001$. The correlation coefficient between the number of publications in which the author did not lead ("au.co") and number of total publications ("ttlitems") was 0.83, which implied a strong positive correlation between collaborations and scientific output. Most importantly, there is a striking correlation (coefficient 0.90) between first-authorship ("au.key") and single-authorship ("au.solo"). This correlation is non-trivial, since in the Vietnamese social sciences, researchers have held a belief that those who could independently establish their research capacity would tend to lead, and would be authorized to lead research groups. Although this sounds logical, this is the first time that such empirical evidence has been reported.

3.1. The Relationship between Scientific Output, Collaboration, and Domestic Peers

The first model was established with times of collaboration ("au.ttl"), the number of unique Vietnamese collaborators ("au.vn") and the number of single-authored articles ("au.solo") as predictors, and total publications ("ttlitems") as the response variable. As could be observed in the results presented in Table 2, all of the estimated coefficients were statistically significant with $p < 0.005$, which confirmed the hypothesis that a relationship existed between scientific output and collaborations. The model's goodness-of-fit test showed that $F = 818.3$ ($df_1 = 3$, $df_2 = 406$), and $p < 0.0001$, thus rejecting H_0 and showing that the relationship had been meaningful.

Table 2. Estimation results of "ttlitems" as influenced by "au.ttl", "au.vn" and "au.solo".

	Intercept	**"au.ttl"**	**"au.vn"**	**"au.solo"**
	β_0	β_1	β_2	β_3
"ttlitems"	0.824 ***	0.115 ***	0.134 **	1.067 ***
	[4.975]	[26.288]	[3.290]	[32.002]
	(9.67×10^{-7})	(2×10^{-16})	(0.0011)	(2×10^{-16})

Significance codes: '***' 0.001 '**' 0.01; *z*-value in square brackets; *p*-value in round brackets. Residual standard error: 2.226 on 406 degrees of freedom (*df*). Multiple R-squared: 0.8581, Adj. R-squared: 0.857. F-stat.: 818.3 on 3 and 406 *df*, *p*-value: 2.2×10^{-16}. "ttlitems": scientific productivity; "au.ttl": the total number of times the survey subject has collaborated with other authors; "au.vn": the number of all Vietnamese peers appearing in the entire body of work of the subject in question; "au.solo": the number of publications in which the subject was the single author.

In Table 2, times of collaboration ("au.ttl") assumed a positive coefficient (β_1 = +0.115, $p = 2 \times 10^{-16}$), which meant that the greater the total times of collaboration, the more articles the scientist had published during the period examined. Moreover, β_2 = +0.134 (p = 0.0011) indicated that domestic collaborations also had a positive correlation with scientific performance. Lastly, among all of the coefficients, the largest was β_3 = 1.067 for a variable number of single-authored papers ("au.solo"), which implied that more independent authors produced a larger quantity of works than those who wrote fewer articles alone.

Table 2 also reported R^2 = +0.8581. This statistic means that the independent variables in the model—times of collaboration ("au.ttl"), number of unique Vietnamese co-authors ("au.vn") and and number of solo publications ("au.solo")—explain 85.81% of the change of total publications ("ttlitems"). The relationships between these variables are depicted in the following equation:

$$\text{ttlitems} = 0.824 + 0.115 \times \text{au.ttl} + 0.134 \times \text{au.vn} + 1.067 \times \text{au.solo} \quad (1)$$

It can be inferred from Equation (1) that, controlling for other factors, an increase of one unit of the number of times of collaborations would result in the number of scientists' publications rising by 0.115 units on average. Similarly, one extra unit of domestic collaborator would mean a growth of 0.134 units in average scientific output.

Using Equation (1), we could determine an estimate of a scientist's body of work by looking at the number of times they collaborated, the number of domestic authors they had worked with while producing scientific content, and the number of articles they had published as a solo author. Namely, if a scientist had 30 single-authored works, and had collaborated 40 times with 15 domestic authors, the estimated total number of his/her papers would be calculated as follows:

$$0.824 + 0.115 \times 40 + 0.134 \times 15 + 1.067 \times 30 = 39.44$$

The result meant that the scientist had produced a total of more than 39 articles during their entire career, as estimated using the influential factors involved in our analysis.

3.2. The Significance of International Collaborations

In this model, while never ceasing to emphasize the importance of collaborations in scientific production in general, we specifically sought to figure out the role of international collaborations. Therefore, we chose to model our regression using the number of foreign co-authors ("au.fr"), the number of publications in which the author did not lead ("au.co"), and the number of publications led by the author ("au.key") as independent variables. As presented in Table 3, $p < 0.001$, which means all coefficients are statistically significant. In addition, the results showed that $F = 3381$ ($df_1 = 3$, $df_2 = 406$), and $p < 0.001$, once again rejecting the null hypothesis H_0. The relationships between the above factors and scientific output were thus technically affirmed, with the predictors explaining 96% of the variation of the response variable.

Table 3. Estimation results of "ttlitems" as influenced by "au.co", "au.fr" and "au.key".

	Intercept	**"au.co"**	**"au.fr"**	**"au.key"**
	β_0	β_1	β_2	β_3
"ttlitems"	−0.126 ^{c}	0.736 ***	0.052 ***	0.821 ***
	[−1.79]	[40.36]	[4.34]	[53.21]
	(0.074)	(2×10^{-16})	(1.78×10^{-5})	(2×10^{-16})

Significance codes: '***' 0.0001 'c' 0.1; *z*-value in square brackets; *p*-value in round brackets. Residual standard error: 2.226 on 406 *df*. Multiple R^2: 0.8581, Adj. R^2: 0.857. *F*-stat.: 818.3 on 3 and 406 *df*, *p*-value: $<2.2 \times 10^{-16}$. "au.co": the number of publications in which the author did not lead; "au.fr": the number of foreign co-authors; "au.key": the number of publications led by the author.

The equation describing the relationships between factors in Table 3 was established as follows:

$$\text{ttlitems} = -0.126 + 0.736 \times \text{au.co} + 0.052 \times \text{au.fr} + 0.821 \times \text{au.key} \quad (2)$$

As in the previous part of our analysis, we were able to use Equation (2) to estimate a scientist's decennial production (2008–2017) by looking at the number of collaborative articles, the number of publications in which they were a key author, and the number of foreign colleagues with whom they had collaborated.

The value +0.736 ($p < 0.001$) of β_1, which represents the coefficient of the number of papers in which the author did not lead ("au.co"), showed that when the number of co-authored publications increased by one paper and other factors were controlled, scientific output would increase by 0.736 on average. Similarly, the coefficient $\beta_3 = +0.821$, $p < 0.001$, of the variable number of papers led by the author ("au.key"), led us to conclude that the author's ability to play a key role in publications was a significant boost in the quantity of their scientific contribution.

In contrast, the factor of overseas collaborations displayed a relatively small influence on scientific productivity with a coefficient of 0.052, which meant that for authors, an increment in international collaborators only led to a small growth of scientific output. The Pearson's correlation coefficient between these two factors $\rho_{(ttlitems,au.fr)} = 0.405$ ($p < 0.001$) also predicted a not very impressive association between them.

4. Discussion

Previous research on scientific collaborations [42,48] focused on understanding the scientific community in Vietnam as a whole, as well as the structure of collaborations in general. In contrast, this paper used a dataset with specific details regarding authors and articles. In analyzing such personalized data, we provided concrete, quantitative results showing how collaborations and a lack of single-authored publications impacted scientific output.

As we had previously noted, this dataset focused primarily on authors in the social sciences. The social sciences have been relatively new and are still in their developmental stage in Vietnam; as a result, the extant literature on their specificities remains scarce, despite the social sciences being especially crucial to transitioning societies. We aimed to contribute refined knowledge on the

current state of the Vietnamese social sciences through our in-depth analysis and specific conclusions below.

4.1. Are Two Heads Better than One? Collaboration and the Improvement of Scientific Output

As scientific research developed in Vietnam, collaboration has become more and more popular: as shown in our data, over 90% of scientists (379 out of 410) worked with other authors to publish. In this study, the role of collaborations in boosting scientific output was reflected not only by the number of collaboratively authored papers, but also by the number of collaborations, as well as the number of domestic/international co-authors.

According to our results, collaborations between scientists improved their performances. In fact, authors in Vietnam must have intuitively known this, considering how they were generally inclined towards collaborative work, so much so that co-authored papers accounted for a vast majority (83.7%) of publications by Vietnamese social scientists. This result was in line with earlier findings regarding the role of collaborations in boosting productivity [5,14,22,29,30], such as the positive correlation of the number of collaborators and scientific output with an estimate coefficient $\beta = 0.26$ ($p < 0.001$) [5]. Investigations also showed that the number of times an author collaborates was positively related to the number of publications, with a coefficient of correlation being 0.71 ($p < 0.001$). This not only meant that the scientist produced more when working with colleagues more often, but also demonstrated the reverse: Vietnamese authors who had a more ample body of works relied more on collaborators. Collaborative works are more associated with high output than single-authored papers, by significant proportions [55]. Such projects provide scientists with opportunities to share resources not only in expertise, but also in relation to their influence in the academic world [56,57]. The flow of exchange between collaborators also helps to diversify research questions and broaden the vision of each scientist, which was particularly significant in the transitional society of Vietnam. As the old proverb said, "Two heads are better than one": It was fairly understandable why collaborative works made up such a large portion of publications among Vietnamese social scientists.

Not only did the number of times an author collaborates count, the origins of collaborators mattered as well: domestic and international collaborations had, in fact, different degrees of impact on an author's production of scientific contents. While it should be noted that foreign collaborators only influenced scientific output to a relatively small extent ($\beta_{au.fr} = 0.052$, $p < 0.001$), Vietnamese scholars were still increasingly interested in collaborating with international colleagues: more than 65% of Vietnamese scholars had worked on an article with foreign colleagues at least once in their career. This was not paradoxical, as the factor of international collaboration still plays an important role in scientific careers. In fact, working with overseas authors not only boosted the quality of research and the volume of output, it also enhanced a scientist's reputation [24]. For many developing countries, such as Latin American nations, for example, domestic production has much lower impacts than the world average, which urges scientists to seek overseas collaborations [21]. Vietnam was not an exception from this logic. Additionally, Vietnamese social scientists had strong motivations for collaborations with foreign authors, as they expect to benefit from international collaborations [18].

Collaborations signify a fundamental change in the knowledge production process [40]. This tendency of change is manifested even more strongly in Vietnam's young scientific community, as shown through our review and results. While it was true that "no one is wise enough on his own" (*Nemo solus satis sapit*), the inclination to collaborate all of the time was not without its downsides, especially in the specific context of the Vietnamese society, where not all scientists had proven their individual scientific capacity outside of collaborative projects. We shall examine this in the following section.

4.2. Neither a "Lone Wolf" nor an "Alpha": Vietnam's Case of Low Scientific Output

First-authorship had a powerful influence on a scientist's number of publications, as shown in the coefficient of the number of papers in which the scholar assumed the role of corresponding

author (β_3 = 0.821). At the same time, our results showed that Vietnamese social scientists did not often lead research projects in which they partook: during an entire decade their career, the average author in social science in Vietnam led less than two collaborated articles. In addition, not only was it fairly rare for a scholar in Vietnam to be a key author in a scientific project, it was also shown in our data that the majority of Vietnamese scientists had never published single-authored papers (307 out of 410, which is about 75%). This was far behind even the low ratio of 15.9% research time spent working alone that had been reported by Lee and Bozeman [5].

At the beginning of our analyses, we reported a remarkable correlation between first-authorship and single-authorship. This was further supported by later analyses, which showed that the number of papers in which the author assumed a key role, and the number of papers published with the scholar as the single author, had the highest positive effects on the total publications count in respective models. Those authors who tend to be first or corresponding authors on multi-authored papers are more likely to publish single-authored papers than those who are not.

This finding should be interpreted with care, and in the context of Vietnamese academia, we provide our explanation as follows. Solo authors were obliged to come up with research ideas and designs, were singularly responsible for the quality of the final manuscript, and took care of correspondence with journal editors during the submission of the paper. Since first/corresponding authors had similar responsibilities, it could be deduced that they would need experiences as a solo author, or at least similar to that of a solo author, to be able to lead a research team. These experiences translated into publications, which were essentially scientific output. This constituted the triad of first-authorship, single-authorship, and high output.

In light of this, our results on the tendency to rely on collaborations in Vietnam meant that very few Vietnamese authors in the field of social sciences had acquired the above-mentioned skill sets. This troubling tendency to rely on the resources of collaborations, foreign or domestic, perhaps explained in part the modesty of Vietnam's current scientific production, especially in the field of social sciences.

4.3. Policy Implications

Our findings raised questions about the quality of Vietnamese academics, as well as their output, and consequently about the efficiency of the Vietnamese higher education system. Vietnam had only recently introduced the requirement of a minimum of two scientific publications indexed in Scopus or ISI/WOS for a doctoral student to validate their thesis [40]. Education had always figured among pressing matters in Vietnam, but public discussions have primarily focused on compulsory education rather than higher education, and much less on training in scientific research. Vietnamese society has held onto the mentality that the system should be fixed bottom–up (i.e., by reforming the primary and secondary educational programs), yet has failed to realize that without able scientists, especially in the social sciences, these reforms would only be inefficient at best, and destructive at worst.

In line with our results, we have several suggestions in the hopes of improving Vietnamese scientific capacity, especially concerning the field of social sciences.

On one hand, admitting the undeniable benefits of collaborations on scientific output, it was advisable that younger researchers be attached to research groups with evident research records to enrich both their experiences and their records. To support this, future centers of excellence at universities that aim to support quality research should consider promoting collaborative research operations, where senior and prolific researchers, as project leaders, would also serve as mentors and in-house reviewers to novice researchers [58–60].

On the other hand, in order to avoid dependence by some researchers on more acclaimed authors, single-authored papers should be encouraged through funding or promotion. This should be done in hopes of urging scholars to both enrich their expertise and acquire practical skills regarding the publication of a manuscript. It is advised that the government keeps a watch and closely measures scientific efficiency, particularly regarding the output of official institutions, as a

criterion for governmental scientific funding. This measurement should take into account various internationally acclaimed metrics other than the impact factor, as well as the value of research outputs other than publications (such as datasets) and qualitative impacts.

5. Conclusions

Collaborations have a certain positive impact on scientific output in Vietnam, which explains why Vietnamese scientists are inclined towards co-publishing. This is not without its downsides; for example, a large portion of Vietnamese scholars lack qualities that could hardly be forged without the experiences of producing articles as a single author. Simultaneously, not many Vietnamese authors have assumed the leading role in a scientific project. Both of these are linked to a modest body of scientific publications among Vietnamese social scientists. In light of these findings, suggestions to policy-makers have been made: namely, future research centers should support collaborations in which senior researchers lead and novices gain guidance, expertise, and experience; and single-authored papers should be encouraged to counter excess reliance on collaborations.

Finally, the current data set can also be transformed into categorical data for enriched conditional probabilities computations, employing the multinomial logistic regression framework for further policy implications, as exemplified by [61].

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