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Article *in* Economies · March 2022

DOI: 10.3390/economies10030058

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Drivers of Research Outcomes in Developing Countries: The Case of Lebanon

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Abstract: This paper uses a unique dataset from Lebanon, a developing country with unstable political conditions, to explore the drivers of research outcomes. We use the Negative Binomial model to empirically examine the determinants of the total number of publications and single and co-authored articles. The results indicate that males are more likely to publish co-authored papers than females. Moreover, our findings show a quadratic relationship between age and the number of published papers with a peak at the age of 40. After this turning point, the publication rate starts to decrease at an increasing rate. When we run the model by gender, we find that females in large departments tend to publish more co-authored papers. We also find that full professors tend to publish more papers in Q1 and Q2 journals, while associate professors have more papers in Q2 and Q3 journals.

Keywords: research productivity; publications; Lebanon

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Citation: Boutros, Pierre, and Ali Fakih. 2022. Drivers of Research Outcomes in Developing Countries: The Case of Lebanon. *Economies* 10: 58. https://doi.org/10.3390/economies10030058

Academic Editor: Franklin G. Mixon

Received: 13 January 2022
Accepted: 25 February 2022
Published: 4 March 2022

1. Introduction

Somerset Maugham once said, "We do not write because we want to; we write because we have to". Nowadays, academic research and publications are important for several reasons, including, but not limited to, advancing knowledge, gathering evidence based on empirical results to aid in policy making and assessment, shedding light on important issues that we are facing, and understanding how different variables affect one another to equip ourselves with the necessary tools to tackle obstacles that we are facing (Sultana 2019). What is captivating about academic research is the degree to which scholars build on each other's work to tackle the issue under study. This promotes a sense of community whereby the results obtained can be expanded upon, corrected in many instances, and even utilized in unexpected ways by scholars (Piccoli and Wagner 2003). Additionally, scientific research is one way to advise policymakers (Baverstock 2020). He adds that research is the new study norm by providing a wider approach to education than the conventional methods used to.

It is well known that a university's reputation is highly dependent on its excellence in scientific research.[1] That is why we are witnessing more universities engaging in research work.[2] In fact, according to the 2030 vision for Universities Without Walls[3], more universities will be ready to help curiosity-driven researchers, who develop and test new theories. The idea is to directly help them by supporting small publishing projects. Moreover, they will guarantee the formation of high-quality researchers.

In published work, one can find different types of authorship, with a major distinction between single-authored and co-authored publications. Over the past few decades, there has been a sharp decline in the number of publications issued by single-authors. Although this type of publication still exists and demands analytical attention, it is doomed to go extinct in the research literature (Kuld and O'Hagan 2018). The gradual growth of collaboration and networking has started to occur among researchers and has led to the

rise of co-authorships over the century (Al-Abbas and Saab 2020). It has been hypothesized that increased specialization, tighter deadlines, limited resources, longer delays, and the competitive research environment have motivated stakeholders to collaborate and work on larger projects (Card and DellaVigna 2013).

The direction of the research and the career path of researchers are highly influenced by the journal's rank. Hence, it has become increasingly difficult to publish in top journals as the competition for space has grown. Thus, the number of submissions has doubled, while the number of articles published in top journals has fallen, which decreases the acceptance rate from 15 percent to 6 percent (Card and DellaVigna 2013).

Research publication has been more prevalent in developed than developing countries. According to Amarante et al. (2021), less than one-sixth of the articles published in top journals were from researchers in developing countries, compared to about three-quarters of the articles published by researchers in developed countries. The remaining 11 percent were collaborations between researchers in both developed and developing countries. Interestingly, however, over the past four decades, countries in the Middle East and North Africa (MENA) have significantly increased the proportion of scholarly articles published (Brainard 2021). In 2019, 15 out of 19 countries in the MENA region had more citations than the global average, while in 2000, almost all of them had significantly a lower rate (Brainard 2021). Lebanon, which is the focus of our study, has one of the largest numbers of publications and resear chers per capita among countries in the MENA region (El Achi et al. 2020).

However, Lebanon has long been plagued by political instability (Al-Hajj et al. 2021). Throughout its history, Lebanon has faced several military conflicts and civil disorder, including the protracted civil war that lasted from 1975 to 1990, several Israeli attacks, the crisis in neighboring Syria, which has led to the massive migration of 1.5 million refugees, and the recent revolution of 17 October 2019, which has deepened the economic crisis (Jaspal et al. 2020). These successive armed events have resulted in chronic political instability, impairing public trust in both institutions and politics (Hazbun 2016). Unfortunately, since 2016, the Lebanese have been dealing with the worst political unrest and economic crisis in decades. According to Salem (2020), this economic and political turmoil has probably had the largest impact on researchers working in the country. Lebanon's consecutive crises have prompted many domestic researchers to scale back or cease their projects permanently, especially due to the severe shortage of US dollars (Salem 2020). Additionally, El Achi et al. (2020) point out that the lack of sustainable and sufficient funding for research is the main challenge facing researchers in Lebanon. Specifically, in times of catastrophes, ensuring adequate funding for research is much more difficult, and sometimes almost impossible.

Previously, papers that addressed this type of research question were mostly limited to data from bigger bibliometric databases such as the Web of Science. This is an issue in several fields, such as social sciences and arts and humanities, because the Web of Sciences does not index a sufficient list of relevant articles or books. Consequently, this might provide a skewed impression of research productivity (Hicks 2004). However, we can fully cover these two disciplines (i.e., social sciences and arts and humanities) in our paper. Moreover, the majority of previous studies have investigated scientists' publication output in a certain period of time. Thus, we add to the existing literature by capturing the drivers of research outcomes for our respondents considering all their research work across their careers. Moreover, this type of research is still scarce across developing countries. That is, this paper sheds light on the factors that have an impact on published papers in peer-reviewed journals using unique data from the Lebanese American University (LAU). LAU is a leading private and nonsectarian higher education institution operating in two campuses, Beirut and Byblos, Lebanon. It operates under the charter from the Board of Regents of the University of the State of New York and is accredited by the Commission on Institutions of Higher Education of the New England Association of Schools and Colleges. LAU is committed to academic excellence by providing all the needed resources for its students to ensure their future success. The university's mission is to be student-centered, promote

civic engagement and diversity from within the community, and uphold many values that it wishes to ingrain in its students including honesty, transparency, and excellence.[4] LAU is the ideal case to investigate due to the large publication volume relative to its faculty size, as well as the lack of any Ph.D. programs. Furthermore, LAU is considered a medium-sized institution with little to no overlap between faculty specialties according to their Ph.D. theses.[5]

2. Related Literature

In this section, we review the related literature and discuss the implications and the hypotheses of the explanatory variables.

2.1. Gender

Several studies examine the relationship between gender and research outcomes. Many authors from different countries and universities (Bentley 2012; Rørstad and Aksnes 2015) found that the number of publications of female researchers is generally lower than that of their male colleagues. However, Bentley (2012) also showed that the gap between male and female researchers is collapsing over time since the percentage of female publication productivity is increasing in a higher proportion than the percentage of male publication productivity. This could be explained through the increased participation of women in the academic field. According to Carrington and Pratt (2003), women account for more than 40 percent of all academics, while this contribution was only about 20 percent in 1985. Moreover, the decrease in the number of women with no or few publications plays a role in narrowing the gender gap (Bentley 2012). These gender differences can be explained through the hypothesis of Symonds et al. (2006) which states that men focus on quantity while women focus on the quality of the publications. Another explanation could be that women are more likely interested in teaching positions rather than research positions (White 2001). Specifically, among doctoral students, females are less likely to publish, collaborate, apply for funding, or present research at conferences (Dever et al. 2008). Moving to single-authored publications, both men and women tend to equally publish single-authored publications (Hussey et al. 2021). This result was also found in Ghosh and Liu's article (2020) among the top 20 schools only. However, Kwiek and Roszka (2021) found that single-authored publishing is more intense among women by 10 percentage points. Regarding co-authored publications, males who are in their early career during their Ph.D. studies are more likely to publish co-author publications than females (Asmar 1999, in Bentley 2012). However, Ghosh and Liu (2020) found that the gender gap has been decreasing over time. Moreover, Hussey et al. (2021) argued that females tend to co-author more with other females than males do even after controlling for other characteristics, and this co-authorship increases among females as the program is more competitive. Although they conclude that gender has a role in determining team composition, it has no role in the likelihood of working in a team in general. In addition, males are more likely to publish in top journals than females (Ghosh and Liu 2020), which is summarized in our first hypothesis.

Hypothesis 1 (H1). *Male researchers tend to publish more than females.*

2.2. Age

Another variable that might impact publications is the age of the publisher. Gingras et al. (2008) studied the impact of age on publication rate in different academic fields where they found that this rate increases as researchers grow in age until reaching its first turning point at the age of 40, where the increasing rate of productivity slows down, and then it reaches a peak at the age of 50, which is taken as the second turning point. Moreover, they showed that professors are less likely to publish first-authored papers, and their names tend to be at the end of the list of co-authored papers as they become older. Concerning single-authored publications, individuals aged 39 years or less are less likely to publish

than those aged within 40–54 years (Kwiek and Roszka 2021). However, Kuld and O'Hagan (2018) found that young scientists are more likely to publish single-authored research than other age groups. Moreover, differences by gender also exist among all age groups. In terms of publications, women aged 38 or more are less productive than men of the same age group (Larivière et al. 2011). We, therefore, hypothesize the following:

Hypothesis 2 (H2). *A positive correlation exists between age and research productivity.*

2.3. Tenured and Research Productivity

Academic tenure might affect research productivity. According to Hilmer and Hilmer (2012), and as cited in the Hussey et al. (2021) article, untenured young advisors are more likely to work and publish research papers as this may increase their probability of receiving tenure. Moreover, more established advisors also have many connections and networks that may positively affect their work as well as their students' work, which leads to more research productivity. In terms of publication output, a common perception exists in academia that states that the productivity of individuals tends to fall off among individuals after they receive a promotion. However, Scott et al. (2019) showed in a study conducted on a school of pharmacy that once faculty members become tenured, they become more motivated to work on research programs that increase research outcomes. According to Norwegian R&D statistics, Ph.D. students have, on average, 75 percent of their time to spend on research, while tenured employees have around 40 percent of their time to spend on research (Rørstad and Aksnes 2015). In addition, tenure status, for both men and women, is positively correlated with the number of single-authored publications (Hussey et al. 2021). Therefore, we summarize our hypothesis on the role of tenured faculty on research outcomes:

Hypothesis 3 (H3). *Tenured faculty members are more likely to publish.*

2.4. Department Size

In recent years, many started to believe that the larger the department is, the more effective and productive it is (Pontikakis et al. 2009). Moreover, Goedegebuure (2012) argued in his study that larger departments are more cost-effective. According to him, merging two small departments can save money (e.g., administrative expenditures). Another popular perception is that small research units usually suffer from low-quality outcomes (Velho 2004). A scarce number of studies have empirically reviewed the causal relationship between department size and publication productivity. When assessing the literature, Johnston (1994) established two decades ago that the size of the department is not linked with the number of publications. Subsequently, more recent evidence reached similar conclusions (Aksnes et al. 2018). However, these findings contradict the widely held belief that increasing the size of a department boosts research productivity. Not only that, but Bonaccorsi and Daraio (2005) found proof that opposes the latter theory. They suggest that small institutes were the most effective ones. Consequently, we hypothesize the following:

Hypothesis 4 (H4). *Faculty members in larger departments have a higher probability of publishing.*

2.5. Number of Citations

Tentatively to capture the impact of citations on publishing quantity, Stigler and Friedland (1975) looked at the number of citations of published papers in two economic subfields between 1950 and 1968 that were cited in doctorates in economics from six prominent US colleges. They discovered some evidence of modest but significant growing returns to quantity when they regressed the number of citations on the number of published papers. However, they did not control for age, gender, or team size in their paper. Trying to fill this gap in the literature, Bosquet and Combes (2013) more recently studied citation records and individual publications when controlling for age, gender, and co-authorship

patterns. They found similar results suggesting that more-cited individuals are more likely to publish an article. Specifically, they suggested that older individuals are more likely to be cited compared to their younger peers, meaning that they enjoy a higher probability of obtaining a publication. Moreover, while women usually write papers of high quality but at a slow rate, men are publishing lower-quality papers at a faster rate. These two effects cancel out, and hence no evidence was found when controlling for gender. When co-authorship patterns are taken into account, results suggest that the probability of being cited increases, and hence, the total number of publications also increases. We summarize these arguments in the following hypothesis:

Hypothesis 5 (H5). *Highly cited faculty are more likely to publish articles.*

2.6. Academic Position

Previous studies have demonstrated that faculty rank has an impact on publication rate, although the findings of the many studies are not always similar. First, Aksnes et al. (2011) found that professors are more likely to publish a paper, while faculty in lower positions publish fewer papers per year. They suggest that the rate of published papers grows as one moves up the academic ladder. According to Tien and Blackburn (1996), knowledge builds up over time. Hence, junior researchers have less experience than senior researchers, who are more likely to have improved their research and writing skills over the years. Furthermore, senior individuals usually work on multiple research projects simultaneously, resulting in more publications. Additionally, the pre-selection effect could be a way to explain the large number of publications that professors have. Universities frequently consider publishing activities as a primary criterion for promotion to a higher post. One should enjoy a long list of publications to be appointed as a professor or in another senior position (Tien and Blackburn 1996). We then hypothesize the following:

Hypothesis 6 (H6). *Faculty with a higher academic position tend to have better research outcomes.*

2.7. School

The publication rate may differ from one school to another at different universities. Aksnes et al. (2018) looked at the number of publications of different schools at Norwegian universities. They found that productivity in the medicine and natural sciences is lower than that in the humanities, social sciences, and technology. Specifically, productivity is higher in large departments in the school of humanities compared to small ones, while small departments have higher productivity in medical and health sciences. However, Puuska (2010) established that researchers at a Finnish university have high productivity in medical sciences when measuring journal articles only, but the productivity is low in other types of publications. Subsequently, the low proportion of non-publishers in the medical sciences (14.6 percent) could explain the higher productivity in this school. Besides, the author finds that scholars in social sciences and humanities have a higher probability of publishing articles in an edited book rather than journals. Regarding single-authored publications, a study conducted in a Polish university showed that more than 90 percent of the articles published are single-authored articles in the school of arts and humanities, while only 15 percent are single-authored publications in the school of chemistry (Kwiek and Roszka 2021). We summarize these arguments with the following hypothesis:

Hypothesis 7 (H7). *Research outcomes differ across faculties and schools.*

3. Research Methodology

3.1. Situating the Case Selection

The first question that arises here is the reason behind choosing LAU as the focus of our study. The main rationale behind the choice of our case study is that LAU does not offer any Ph.D. programs. Hence, its research output depends heavily on its faculty

members. Furthermore, LAU is considered a medium-sized institution with little to no overlap between faculty specialties according to their Ph.D. theses. Founded based on strong values and a deep-rooted sense of mission and accomplishment, LAU is a leading non-sectarian higher education institution. The university began in 1924 as a women's college, and its roots can be traced back to the first girls' school in the Ottoman Empire.[6] LAU has grown throughout the years to meet Lebanon's rising educational demands. Today, 65 different programs are offered at LAU in 60 different major fields through 7 schools: the School of Architecture and Design, the School of Arts and Sciences, the Adnan Kassar School of Business, the School of Engineering, the Gilbert and Rose-Marie Chagoury School of Medicine, the Alice Ramez Chagoury School of Nursing, and the School of Pharmacy.[7] LAU operates through two campuses, one located in Beirut and the other located in Byblos. In the fall of 2020, LAU had 8044 students and 758 faculty members.[8]

The university has substantially progressed in terms of research in the last few years. For instance, the School of Business is ranked first in the country by Times Higher Education Subject Rankings[9]. Interestingly, we observe that the vast majority of the published papers in the School of Business are either written by single authors or co-authored by only 2 people, as can be seen from Table A1 in the Appendix A. Observations are quite different in the Nursing, Medicine, and Pharmacy schools, where all published papers are co-authored by 3 or more researchers. When it comes to the Engineering and the Arts and Sciences schools, results are mixed. Hence, it cannot be inferred that there are more co-authored papers than single-authored papers.

One common observation across all schools is that none of them have papers in Q4 journals.[10] The School of Business and the School of Nursing share an equal and the highest number of papers published in Q1 journals. The School of Arts and Sciences and the School of Engineering fall in second place with 9 papers in their record, followed by the School of Pharmacy with 8 papers and the School of Medicine with 6 papers.

When it comes to Q2 journals, the School of Engineering takes the lead with 8 papers, followed by the Schools of Business, Pharmacy, Medicine, and Nursing with 5 papers. The school that has the least papers published in Q2 journals is the School of Arts and Sciences, with 4 papers. It is important to note that only a few schools have published their papers in Q3: the School of Medicine has published 4 papers, followed by the School of Pharmacy with 2 papers, and finally, the School of Arts and Sciences with only 1 paper. Moreover, only 2 schools have been published in journals with no official ranking with a limited number of 3 (2 in the school of engineering and 1 in the School of Arts and Sciences).

3.2. Data and Variables

Our paper investigates the determinants of research productivity in a developing country during political turmoil. We used a database covering the present case study, i.e., LAU. This database includes all types of scientific and scholarly publications, in all fields of research in this leading institution of higher education in Lebanon. Hence, the total number of published articles is 1974 as of fall 2021. Data were collected through a common exercise used by academic institutions, which is the documentation system. This resulted in complete, reliable, and well-structured data (Sivertsen 2010). Moreover, we made sure that all the publications were approved according to national criteria and guidelines.[11] Additionally, LAU regularly registers every publication outcome. Consequently, missing papers are not an issue in our analysis. We then combined this dataset with a second database that captures the socio-economic characteristics of faculty, department size, faculty rank, the total number of single and co-authored publications, and the different schools at LAU as of fall, 2021. After data cleaning, we were left with 270 observations.

We used several dependent variables that reflected the research productivity of faculty members. The number of publications was our first dependent variable, which counts for the total number of journal publications to date. Then, we created two dependent variables that account for two different types of authorships: the number of single-authored and the number of co-authored publications. In addition, we used four dependent variables

to capture the rank of the journals the research work was published in. The number of publications correspond to the quartiles of the journals in Q1, Q2, Q3, and Q4.

Moving into the independent variables, we included basic socio-economic variables, citations, faculty rank, department size, and schools in which the faculty member is hosted. Precisely, the variable gender is a dummy variable that takes the value one if the faculty member is male and zero otherwise. We also included a continuous variable that represents the age of the faculty member. To capture the possibility of the existence of a turning point throughout the age, we included the variable age squared. We also generated a continuous variable that represents the years of professional experience of the faculty members. Furthermore, the binary independent variable tenured takes the value one if the faculty member is tenured and zero otherwise. We also included a continuous variable, faculty size, which is defined as the total number of faculty members in the department. Then, a continuous variable is generated to capture the total number of citations to date. In order to account for faculty rank, we created three binary variables: professor, associate professor, and assistant professor (the reference group). Lastly, we controlled for the different schools across our models. The summary statistics of the variables are presented in Table 1.

Table 1. Descriptive Statistics.

Variable	Mean	Std. Dev.	Min.	Max.
Number of publications	20.549	24.188	0	181
Single-authored papers	1.859	3.425	0	31
Co-authored papers	9.304	15.234	0	160
Papers published in Q1	9.315	12.268	0	120
Papers published in Q2	4.658	5.853	0	34
Papers published in Q3	2.201	3.791	0	24
Papers published in Q4	0.641	1.475	0	14
Gender (=1 if male)	0.652	0.478	0	1
Age	46.804	9.495	29	78
Years of Experience	12.848	8.259	1	35.91
Tenured (=1 if tenured)	0.603	0.491	0	1
Faculty size	19.457	10.898	5	45
Number of citations	325.457	539.815	0	4951
Professor	0.163	3.704	0	1
Associate professor	0.5489	4.99	0	1
Assistant professor	0.288	0.454	0	1
Number of observations	270			

3.3. Modeling Approach

Following the steps of Gonzalez-Brambilia and Veloso (2007), we used the Negative Binomial fixed-effect model, as our dependent outcomes are count variables. This model was chosen over the Poisson model since the Poisson distribution imposes a constant variance. This is not applicable in our case, since the distribution of our dependent variables shows signs of overdispersion. The variance of the dependent variables far exceeds the mean in our dataset. Moreover, the Negative Binomial model drops the assumption made in the Poisson model, which is that the mean should be equal to the variance (Ver Hoef and Boveng 2007). This effectively allowed us to have more efficient estimates.

The model can be written as follows:

$$E(y_i|X_i) = \exp(\mu + \beta X_i + c_i)$$

With y_i as a negative binomial, i refers to faculty members; c_i is the unobserved effect that varies across faculty members; and X_i are the independent variables that vary across faculty members: gender, age, age squared, experience, tenure, faculty size, citations, faculty rank, and school.

4. Results and Discussion

4.1. Benchmark Results

Table 2 presents the estimated marginal effects of the benchmark results. Column one shows the effect of the independent variables on the likelihood to publish in peer-reviewed journals, while columns two and three capture their effect on single and co-author publications, respectively.

Table 2. Benchmark Results of the Negative Binomial model.

	(1) Publications	(2) Single-Author	(3) Co-Author
Gender (=1 if male)	0.116	0.369	0.355 **
	(0.099)	(0.258)	(0.155)
Age	0.133 **	0.321 *	0.143 *
	(0.055)	(0.165)	(0.086)
Age Squared	−0.002 ***	−0.003 **	−0.002 **
	(0.001)	(0.002)	(0.001)
Experience	0.027 ***	0.017	0.030 *
	(0.010)	(0.025)	(0.016)
Tenured (=1 if tenured)	0.105	0.537	−0.250
	(0.172)	(0.493)	(0.266)
Faculty Size	0.009	−0.086 ***	0.022 **
	(0.006)	(0.019)	(0.01)
Citations	0.001 ***	0.000	0.001 ***
	(0.000)	(0.000)	(0.000)
Professor	0.075 ***	0.139 **	0.120 ***
	(0.236)	(0.656)	(0.366)
Associate Professor	0.038 **	0.734	0.064 **
	(0.186)	(0.545)	(0.285)
School of Arts and Sciences	0.124 ***	0.067	0.185 ***
	(0.298)	(0.463)	(0.610)
School of Business	0.113 ***	−0.099 **	0.209 ***
	(0.293)	(0.454)	(0.602)
School of Engineering	0.139 ***	−0.090 ***	0.224 ***
	(0.298)	(0.494)	(0.609)
School of Medicine	0.168 ***	−0.182 ***	0.279 ***
	(0.350)	(0.935)	(0.665)
School of Nursing	0.157 ***	−0.032 ***	0.292 ***
	(0.404)	(0.118)	(0.735)
School of Pharmacy	0.117 ***	−0.398 ***	0.205 ***
	(0.365)	(0.103)	(0.683)
Observations	270	270	270
Pseudo R^2	0.136	0.112	0.119
Log Likelihood	−642.94	−288.251	−522.613

Notes: The reference groups are assistant professors for professors rank and the School of Architecture and Design for schools. Statistical Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are in parentheses.

The results suggest that being male increases the probability of publishing, being a single author, and co-authoring a paper. However, the result is only significant in the last column with the marginal effect being 35.5 percent. Therefore, we found no support to Hypothesis 1 in our regression stating that male researchers tend to publish more than females. This result is consistent with the findings of Asmar (1999), who suggested that males are more likely to publish co-author publications when compared to females. Moving to age, all coefficients are statistically significant, with age being positive and age squared negative across all columns. This suggests that the quadratic relationship between the researcher's age and the three dependent variables reaches its peak[12] at the age of 40 years for the total number of publications, 48 for single-authored publications, and 35 for co-authored publications. After these turning points, the rate starts to decrease at an increasing

rate. Therefore, Hypothesis 2, stating that a positive correlation exists between age and research productivity, is supported. Gonzalez-Brambilia and Veloso (2007) reached the same conclusion regarding the quadratic relation but find a different turning point for publications at the age of 53 in Mexico. Our results are also in line with those of Kuld and O'Hagan (2018), who found that young scientists are more likely to publish single-authored papers than are older age groups. That is, young researchers usually are more motivated and energetic to work on research projects.

When it comes to experience, we found unsurprising results. More-experienced researchers tend to publish more by 2.7 percent. Additionally, they are more likely to co-author a paper by 3 percent compared to their less experienced colleagues. These two results are statistically significant. However, there is no sign of significance when it comes to single-authored publications. This is consistent with the findings of Tien and Blackburn (1996), who suggested that knowledge builds up over time. They also argued that since senior researchers have more experience, they are more likely to have improved their research and writing skills, hence publishing more. When it comes to tenured faculty, we did not find significant results across three columns. Consequently, we did not find any support regarding Hypothesis 3, stating that tenured faculty members are more likely to publish. Moving to the faculty size, the results suggest that when the department increases in size, fewer single-authored papers are published, and more collaboration is present. Precisely, single-authored papers decrease by 8.6 percent while the probability of co-authorship increases by 2.2 percent. Nevertheless, these results contradict what has been found by Aksnes et al. (2018), who argued that department size does not affect the research productivity of faculty members. The results, however, are statistically insignificant when it comes to the number of publications. Again, we did not find any evidence that supports Hypothesis 4 stating that faculty members in larger departments have a higher probability to publish.

Citations of papers by others are found to have a positive effect across all specifications even though the magnitude of the estimator is small, but they are statistically significant, at the one percent significance level. This is in line with our Hypothesis 5, stating that highly cited faculty are more likely to publish articles, and is in line with the results reported by Bosquet and Combes (2013), who found that more-cited individuals are more likely to publish. When compared to assistant professors (the reference group), we show that professors are more likely to publish, write single-authored papers, and co-author a paper by 7.5, 13.9, and 12 percent, respectively. These results are statistically significant in all specifications. Similar results were obtained for associate professors. However, when compared to full professors, the coefficients are much lower in the first and last column, where results are statistically significant. This is also in line with the findings of Aksnes et al. (2011), suggesting that faculty at a lower rank publish fewer papers per year. Therefore, we found enough evidence to accept Hypothesis 6, stating that faculty with a higher academic position tend to have better research outcomes. Furthermore, the rate of published papers grows as one moves up the academic ladder. When it comes to different schools at LAU, the results suggest that all schools have a higher probability of publishing compared to the School of Architecture and Design (the reference group), with the School of Medicine enjoying the highest probability. All the coefficients are found to be statistically significant at a one percent significance level across all specifications. Our results are consistent with the findings of Puuska (2010), who suggested that researchers in the medical sciences field have higher productivity and tend to publish more than their peers. However, Aksnes et al. (2018) found contradicting results. Furthermore, when compared to our reference group, we found that professors from the Business, Engineering, Medicine, Nursing, and Pharmacy schools are less likely to publish single-authored papers. These results are statistically significant for all schools except for the School of Arts and Sciences. However, our findings indicate that researchers from all schools have a higher tendency to co-author a paper compared to those from the School of Architecture and Design. These findings lead us to fail to reject Hypothesis 7, stating that research outcome differs across different schools.

4.2. Results by Gender

Table 3 shows the marginal effects by gender. We obtain similar results for the variables age and age squared for male researchers where they are positive for age and negative for age squared, and the coefficients are statistically significant across all models. We also notice that female individuals have a higher tendency to publish single-authored papers, and they are less likely to publish co-authored papers. However, the results are statistically insignificant in all columns and contradict what has been stated by Hussey et al. (2021). Indeed, they find no difference between men and women in publishing single-authored papers. Concerning experience, female researchers with higher experience publish and co-author more papers by 4.8 and 8.5 percent when compared to males. All the remaining coefficients are found to be not statistically significant. Similar to the benchmark results, larger departments tend to publish fewer single-authored papers. Specifically, females publish more single-authored papers. When it comes to co-authorship, females also have higher probabilities to co-author compared to males by 4 percent. Nonetheless, the result is only significant for females. Moreover, and similar to our results, citations have been found to exhibit a positive effect on all of our dependent variables. When controlling for the faculty rank, and taking assistant professors as the reference group, we find that male full professors and associate professors have a higher tendency to publish and to work alone compared to female faculty. This might be explained by the work of White (2001) who claims that women are more inclined towards teaching positions rather than focusing on research work. Regarding co-authorship, results are only statistically significant for professors. We find that a male professor has a lower likelihood to co-author than a female professor. Regarding the school variables, male and female faculty have a higher tendency to publish in all schools compared to our reference group, with results being statistically significant except for females in the School of Pharmacy. Moreover, researchers, whether male or female, are less likely to publish a single-authored paper in comparison to the School of Architecture and Design. Nevertheless, results for male faculty are only significant for the Business, Engineering, and Pharmacy schools and only statistically significant for female faculty in the Nursing School. Lastly, the results for both males and females are positive and significant across all schools in the last two columns except for female researchers in the Arts and Sciences School. These findings are in line with our benchmark results.

Table 3. Results by gender.

	(1) Publications Male	(2) Publications Female	(3) Single-Author Male	(4) Single-Author Female	(5) Co-Author Male	(6) Co-Author Female
Age	0.207 ***	−0.027	0.329 *	0.406	0.195 *	0.100
	(0.066)	(0.113)	(0.190)	(0.349)	(0.102)	(0.181)
Age Squared	−0.002 ***	0.000	−0.004 **	−0.003	−0.002 **	−0.002
	(0.001)	(0.001)	(0.002)	(0.004)	(0.001)	(0.002)
Experience	0.018	0.048 ***	0.021	−0.041	0.009	0.085 ***
	(0.012)	(0.019)	(0.030)	(0.049)	(0.019)	(0.032)
Tenured (=1 if tenured)	0.137	0.172	0.262	1.309	−0.041	−0.717
	(0.200)	(0.347)	(0.559)	(1.025)	(0.306)	(0.542)
Faculty Size	0.004	0.008	−0.075 ***	−0.059 **	0.005	0.040 ***
	(0.009)	(0.009)	(0.024)	(0.029)	(0.015)	(0.014)
Citations	0.001 ***	0.001 ***	0.000 *	0.000	0.001 ***	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Professor	0.086 ***	0.044	0.259 ***	−0.127	0.104 *	0.161 **
	(0.029)	(0.046)	(0.081)	(0.144)	(0.046)	(0.069)
Associate Professor	0.042 *	0.018	0.141 **	−0.047	0.045	0.094
	(0.022)	(0.037)	(0.066)	(0.110)	(0.034)	(0.057)
School of Arts and Sciences	0.137 ***	0.119 **	0.277	0.320	0.253 ***	0.114
	(0.384)	(0.479)	(0.693)	(0.958)	(0.833)	(0.886)
School of Business	0.111 ***	0.121 ***	−0.145 **	−0.621	0.229 ***	0.207 **
	(0.375)	(0.455)	(0.702)	(0.831)	(0.827)	(0.853)
School of Engineering	0.148 ***	0.116 **	−0.136 *	−0.176	0.260 ***	0.205 **

Table 3. *Cont.*

	(1) Publications Male	(2) Publications Female	(3) Single-Author Male	(4) Single-Author Female	(5) Co-Author Male	(6) Co-Author Female
	(0.375)	(0.509)	(0.730)	(0.256)	(0.825)	(0.924)
School of Medicine	0.153 ***	0.156 ***	−0.144	−0.165	0.282 ***	0.262 ***
	(0.489)	(0.518)	(0.175)	(0.537)	(0.953)	(0.92)
School of Nursing	0.153 **	0.176 ***	−0.196	−0.276 *	0.298 **	0.321 ***
	(0.674)	(0.551)	(0.325)	(0.145)	(0.118)	(0.976)
School of Pharmacy	0.124 ***	0.981	−0.435 ***	−0.176	0.236 ***	0.175 *
	(0.457)	(0.598)	(0.328)	(0.284)	(0.909)	(0.009)
Observations	178	92	178	92	178	92
Pseudo R^2	0.140	0.149	0.118	0.180	0.118	0.156
Log Likelihood	−422.212	−214.921	−195.172	−83.662	−352.345	−162.165

Notes: The reference groups are assistant professors for professors rank and the School of Architecture and Design for schools. Statistical Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are in parentheses.

4.3. Results by Quartile of Journals Rank

Table 4 presents the marginal effects by journal rank according to CiteScore. We find that faculty males are publishing their work more in ranked journals compared to females. However, the results are statistically significant only in columns two and four, where males tend to publish more in Q2 and Q4 by 31.6 and 56.3 percent, respectively. These results could be explained by the work of Symonds et al. (2006), stating that males concentrate more on quantity rather than quality, while the opposite is true for females. Moving to the variable age, the findings are consistent with the benchmark results where a similar quadratic relationship is present. Moreover, we can notice that as individuals grow in age, the probability that they publish in a low-ranked journal increases. However, the results are significant only in columns two and four (for Q2 and Q4 journals). Again, concerning experience, we find identical results to the benchmark results where the relation between gaining experience and publishing is positive. Nevertheless, the coefficients are statistically significant only in the last two columns. Surprisingly, our findings indicate that the more experienced the researcher is, the more likely he/she is to publish in Q3 and Q4 journals. The intuition behind it is, regarding faculty size, we find a positive correlation between the department size and publishing in a top-ranked journal. That is, according to our benchmark results, bigger departments are more likely to co-author, which in turn improves the quality of the paper (Ductor 2015). Moreover, our results by journal rank match the benchmark results, revealing that more-cited individuals have a higher tendency to publish their work; however, they share an equal probability in all types of journals. Furthermore, findings reveal that professors publish more in Q1 and Q2 than do assistant professors (reference group) by 8.4 and 7 percent, respectively, where the coefficients are statistically significant. Lastly, when compared to assistant professors, associate professors enjoy a higher probability to publish in Q2 and Q3 journals. Precisely, they are more likely to publish in a Q2 journal by 5.3 percent and 7.2 percent in Q3. The findings reveal that all schools tend to publish more in Q1 and Q2 journals when compared to our reference group. All the results are statistically significant. When it comes to publishing in Q3 and Q4 journals, results are positive and only significant in the School of Medicine and the School of Nursing, respectively.

Table 4. Results by journal quartile.

	(1) Q1	(2) Q2	(3) Q3	(4) Q4
Gender (=1 if male)	0.005	0.316 **	0.098	0.563 *
	(0.105)	(0.138)	(0.202)	(0.307)
Age	0.056	0.184 **	0.141	0.448 **
	(0.060)	(0.081)	(0.120)	(0.216)
Age squared	−0.001	−0.002 **	−0.002	−0.005 **
	(0.001)	(0.001)	(0.001)	(0.002)
Experience	0.001	0.016	0.060 ***	0.073 **
	(0.011)	(0.014)	(0.020)	(0.029)
Tenured (=1 if tenured)	0.203	0.228	−0.314	0.401
	(0.187)	(0.230)	(0.360)	(0.545)
Faculty Size	0.019 ***	0.011	−0.001	−0.006
	(0.006)	(0.008)	(0.013)	(0.018)
Citations	0.001 ***	0.001 ***	0.001 ***	0.001 ***
	(0.000)	(0.000)	(0.000)	(0.000)
Professor	0.084 ***	0.070 **	0.077	0.010
	(0.025)	(0.033)	(0.050)	(0.077)
Associate Professor	0.033	0.053 **	0.072 *	−0.016
	(0.020)	(0.026)	(0.040)	(0.068)
School of Arts and Sciences	0.139 ***	0.176 ***	0.727	0.162
	(0.435)	(0.573)	(0.577)	(0.146)
School of Business	0.148 ***	0.168 ***	0.183	0.118
	(0.430)	(0.570)	(0.571)	(0.114)
School of Engineering	0.169 ***	0.163 ***	0.410	0.636
	(0.432)	(0.575)	(0.585)	(0.116)
School of Medicine	0.178 ***	0.257 ***	0.156 **	0.159
	(0.469)	(0.623)	(0.677)	(0.293)
School of Nursing	0.221 ***	0.256 ***	−0.364	0.228 *
	(0.507)	(0.659)	(0.902)	(0.370)
School of Pharmacy	0.182 ***	0.212 ***	−0.067	0.341
	(0.479)	(0.626)	(0.712)	(0.273)
Observations	270	270	270	270
Pseudo R^2	0.170	0.134	0.104	0.125
Log Likelihood	−501.219	−420.037	−320.616	−171.142

Notes: The reference groups are assistant professors for professors rank and the School of Architecture and Design for schools. Statistical Significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors are in parentheses.

5. Conclusions

In this paper, we explored the determinants of research outcomes in Lebanon, which is considered a politically unstable environment. The dataset provided by a leading university of higher education in the country allows us to study different factors that influence research productivity at this institution. The results suggest that being male positively affects the likelihood to co-author a published paper in peer-reviewed journals. When dividing by gender, we find that female faculty are more likely to write single-authored papers. This could be explained by the fact that females are more likely to be constrained with housework, hence limiting their ability to co-author papers and deal with deadlines.

Additionally, findings reveal that there is a curvilinear relationship between age and publication rate with a peak at the age of 40. Surprisingly, when accounting for journal rank, we notice that more-experienced individuals publish in low-ranked journals. It is argued that as researchers become older, they gain more experience, hence allowing them to be placed in higher administrative positions (e.g., Dean, Chairperson). Due to limited time available in these kinds of positions, researchers are more likely to co-author papers and publish them in low-quality journals (Neill 2008).

It is also found that larger departments are associated with more publications in top-ranked journals and more co-author publications in general, which is the case in LAU.

Furthermore, we show that as the number of citations of papers increases, researchers have a higher tendency to publish more, whether it is a single-authored paper or a co-authored paper. Moreover, results reveal that professors publish more in Q1 and Q2, and associate professors publish more in Q2 and Q3 compared to assistant professors when dividing by journal rank.

Administrators of higher education who plan to boost the research productivity of their faculty might benefit from the evidence offered in this paper in order to know what factors influence research outcomes. For instance, the negative effect of aging above 40 on publication productivity, and the negative effect of higher administrative positions on time availability to publish suggest that such positions would be granted to those over 40, leaving the space for those under 40 to focus on publishing research. Additionally, the positive effect of being a professor on publishing in top journals compared to assistant professors might suggest that assistant professors who co-author papers with full professors ensure that their research papers are published in top journals while obtaining the research experience needed to become tenured. Moreover, this paper sheds light on the existing gender gap in understanding factors that affect research productivity. The results clearly show the difference in the rate of publications between males and females. One way to address this gap is to grant females, especially married ones, flexible deadlines. Additionally, the gender gap in research is likely to increase due to the COVID-19 pandemic. According to a recent study, women are increasingly finding themselves with less time for research and are more anxious about their job stability and career chances than males.[13] Consequently, female researchers should receive greater support from their male colleagues by co-authoring more papers together.

Lastly, the independent variable funding was not included in our study as it was not available in our database. This could be regarded as a limitation in this paper since funding may increase the publication rate (Hussey et al. 2021). Therefore, as more data becomes available, researchers could include more independent variables. As for directions for future researchers, one could study the case of LAU during a longer period of time or even increase the sample size by obtaining data from other higher education institutions in Lebanon or the region.

Author Contributions: P.B. and A.F. contributed equally to this work. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable. The paper does not involve humans or animals.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this paper are not publicly available on request from the corresponding author. They include confidential information on the case selection used in the analysis.

Acknowledgments: The authors would like to thank three anonymous reviewers for valuable comments and suggestions. The authors are also thankful to Sara Kassab and Zeina Lizzaik for excellent research assistance.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Published papers in the School of Business per quartile, 2017–2021.

Articles	Q1	Q2	Q3	Q4
Abosedra et al. (2021)	-	x	-	-
Abdo Ahmad and Fakih (2021)	-	x	-	-
Syed and Bouri (2021)	-	x	-	-
Djoundourian (2021)	x	-	-	-
Karaki (2020)	x	-	-	-
Mansour-Ichrakieh and Zeaiter (2019)	-	x	-	-
Hilmi et al. (2021)	x	-	-	-
O'Connor and Assaker (2021)	x	-	-	-
Bandaly and Hassan (2020)	x	-	-	-
Fakih et al. (2020)	x	-	-	-
Ladki and Mazeh (2017)	x	-	-	-
Farah and Ramadan (2017)	x	-	-	-
Itani and Chaker (2021)	x	-	-	-
Fakih et al. (2021)	x	-	-	-
Farah (2020)	-	x	-	-

Table A2. Published papers in the School of Arts and Sciences per quartile, 2017–2021.

Articles	Q1	Q2	Q3	Q4
Hamdan and Houri (2021)	-	x	-	-
Assaf and Selim (2021).	x	-	-	-
Awad et al. (2018)	-	-	x	-
Nour and Zeidan (2021)	x	-	-	-
Khalil et al. (2021)	x	-	-	-
Mehanna et al. (2020)	x	-	-	-
Nsouli et al. (2018)	-	-	-	-
Doumit et al. (2017)	-	x	-	-
Jaafar et al. (2020)	x	-	-	-
Zeineddine et al. (2021)	x	-	-	-
Melki et al. (2021)	x	-	-	-
Nour and Takche (2020)	-	x	-	-
Romanos et al. (2019)	x	-	-	-
Saab et al. (2018)	-	x	-	-
Baaklini et al. (2021)	x	-	-	-

Table A3. Published papers in the School of Engineering per quartile, 2017–2021.

Articles	Q1	Q2	Q3	Q4
Baghdadi et al. (2020)	x	-	-	-
Skordaris et al. (2018)	x	-	-	-
Bejjani et al. (2021)	-	x	-	-
Candelino et al. (2020)	-	x	-	-
Cakir et al. (2021)	-	-	-	-
Antar et al. (2019)	-	x	-	-
Fakhoury et al. (2017)	-	-	-	-
Habchi and Vergne (2021)	x	-	-	-
Mansour and Haddad (2017)	x	-	-	-
Brassitos and Jalili (2020)	x	-	-	-
Antar and Elkhoury (2019)	x	-	-	-
Basma et al. (2022)	x	-	-	-
Zouein and Kattan (2021)	x	-	-	-
Liu et al. (2021)	x	-	-	-
Guan et al. (2021)	-	x	-	-

Table A4. Published papers in the School of Pharmacy per quartile, 2017–2021.

Articles	Q1	Q2	Q3	Q4
Guyenet et al. (2018)	x	-	-	-
Souza et al. (2018)	x	-	-	-
Griffin et al. (2018)	-	x	-	-
Iskandar et al. (2018)	x	-	-	-
Karaoui et al. (2018)	x	-	-	-
Matli et al. (2021)	x	-	-	-
Daaboul et al. (2017)	-	x	-	-
Abd El Razik et al. (2017)	-	x	-	-
Ramia et al. (2017)	-	x	-	-
Nasser et al. (2021)	x	-	-	-
Karaoui et al. (2017)	x	-	-	-
Hanna et al. (2021)	x	-	-	-
Dimassi et al. (2020)	-	x	-	-
El Khoury et al. (2019)	-	-	x	-
Zeenny et al. (2020)	-	-	x	-

Table A5. Published papers in the School of Medicine per quartile, 2017–2021.

Articles	Q1	Q2	Q3	Q4
El Jalbout et al. (2021)	-	x	-	-
Kaplan et al. (2019)	x	-	-	-
Moghnieh et al. (2019)	x	-	-	-
Zeitoun et al. (2019)	-	x	-	-
Obeid et al. (2018)	-	-	x	-
El-Hussein et al. (2020)	x	-	-	-
Saliba et al. (2021)	x	-	-	-
Deepthi et al. (2021)	-	x	-	-
Rizk et al. (2020)	-	x	-	-
Farra et al. (2018)	-	-	x	-
Dib et al. (2018)	-	-	x	-
Yazbeck-Karam et al. (2017)	x	-	-	-
Karam et al. (2017)	-	x	-	-
Aouad et al. (2019)	x	-	-	-
Eric et al. (2019)	-	-	x	-

Table A6. Published papers in the School of Nursing, 2017–2021.

Citations	Q1	Q2	Q3	Q4
Elias et al. (2019)	x	-	-	-
Daaboul et al. (2019)	-	x	-	-
El Zein et al. (2019)	-	x	-	-
Bar-Sela et al. (2019)	x	-	-	-
Doumit et al. (2019)	-	x	-	-
Clinton et al. (2018)	-	x	-	-
Davis et al. (2021)	x	-	-	-
Doumit et al. (2020)	x	-	-	-
Long et al. (2020)	x	-	-	-
Sukkarieh-Haraty et al. (2018)	x	-	-	-
Sukkarieh-Haraty et al. (2018)	x	-	-	-
Mehanna et al. (2021)	x	-	-	-
Elias et al. (2021)	-	x	-	-
Alameddine et al. (2021)	x	-	-	-
Nabulsi et al. (2021)	x	-	-	-

Notes

1 https://www.insidehighered.com/views/2012/03/30/essay-research-universities-must-pay-more-attention-student-learning (accessed on 1 January 2022).

2 https://www.timeshighereducation.com/blog/academics-must-become-more-engaged-open-access-struggle (accessed on 1 January 2022).

3 https://eua.eu/downloads/publications/universities%20without%20walls%20%20a%20vision%20for%202030.pdf (accessed on 5 January 2022).

4 https://dira.lau.edu.lb/images/Factbook%202017-2018%20-General%20Information.pdf (accessed on 5 January 2022).

5 https://www.lau.edu.lb/files/lau-int-rep-self-study-short.pdf (accessed on 5 January 2022).

6 https://www.lau.edu.lb/about/history/ (accessed on 5 January 2022).

7 https://dira.lau.edu.lb/documents/03%20General%20Information.pdf (accessed on 6 January 2022).

8 https://www.lau.edu.lb/about/facts.php (accessed on 6 January 2022).

9 https://sb.lau.edu.lb/news/general/2021/aksobs-business-and-economics-pr-1.php (accessed on 6 January 2022).

10 The number of publications according to CiteScore Journal Rank indicator based on the quartiles of the journal in Q1, Q2, Q3, and Q4 refers to the total number of papers published in Q1, Q2, Q3, and Q4 journals respectively.

11 Only book publishers and journals with peer review systems are approved.

12 *Turning point* $= \frac{\beta_1}{2\beta_2}$ (See Principles of econometrics, 4th edition, chapter 6) (Hill et al. 2018).

13 https://oecdsciencesurveys.github.io/2020flashsciencecovid/ (accessed on 8 January 2022).

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