



Publication and collaboration anomalies in academic papers originating from a paper mill: Evidence from a Russia-based paper mill

Anna Abalkina 



Anna Abalkina

Institute for East European Studies, Freie Universität
Berlin, Berlin, Germany

ORCID: [0000-0003-1469-4907](https://orcid.org/0000-0003-1469-4907)

E-mail: anna.abalkina@fu-berlin.de

Abstract: This study attempts to detect papers originating from the Russia-based paper mill 'International Publisher' LLC. A total of 1,063 offers to purchase co-authorship on a fraudulent papers published from 2019 to mid-2022 on the 123mi.ru website were analysed. This study identifies at least 451 papers that are potentially linked to the paper mill, including one preprint, a duplication paper and 16 republications of papers erroneously published in hijacked journals. Evidence of suspicious provenance from the paper mill is provided: matches in title, number of co-authorship slots, year of publication, country of the journal, country of a co-authors and similarities of abstracts. These problematic papers are co-authored by scholars from at least 39 countries and are submitted to both predatory and reputable journals. This study also demonstrates collaboration anomalies in questionable papers and examines indicators of the Russia-based paper mill. The value of co-authorship slots offered by 'International Publisher' LLC from 2019 to 2021 is estimated at \$6.5 million. Since this study only analysed a single paper mill, it is likely that the number of papers with forged authorship is much higher.

Keywords: academic misconduct, co-authorship for sale, ghostwriting, hijacked journals, journals, paper mills, suspicious collaboration

INTRODUCTION

Paper mills are commercial companies that organize on-demand writing of fraudulent academic manuscripts and offer co-authorship of these papers for sale. The purchase of an entire paper or a co-authorship slot by scholars is illegitimate and constitutes authorship fraud. Paper mills also provide additional services, such as searches for co-authors, submission of manuscripts, revision and control of publications, and indexation of the paper in international databases.

Very often, fraudulent entities selling co-authorship slots or entire academic papers mimic companies offering legitimate text-editing services or translation services (COPE & STM, 2022; Hvistendahl, 2013). However, paper mills promise scholars that papers will be published, whereas legitimate entities make no such promises (COPE & STM, 2022). Moreover, the cost of such paper mill production significantly exceeds the cost of real editing services.

The frequency of paper mill papers appearing in the academic literature is unknown. Recent investigations by research

integrity experts and sleuths have demonstrated the infiltration of paper mill productions into the academic literature (Bik, 2020; Schneider, 2020). One publisher detected that almost a quarter of its journals are subject to risk of submission from paper mills (COPE & STM, 2022). Since 2020, journals have initiated mass retractions of papers that originated from paper mills (Candal-Pedreira et al., 2022). In January 2021, the Royal Society of Chemistry announced a series of retractions by its journals. *RSC Advances* retracted 68 papers due to the 'systemic production of falsified research', and *Food and Function* and *RSC Medicinal Chemistry* retracted one paper each (Royal Society of Chemistry, 2021). All of these papers were submitted by authors affiliated with Chinese hospitals, had common structures and templates, and were assumed to be productions of paper mills (Else & Van Noorden, 2021). In December 2021, SAGE retracted 122 papers because of submission or peer-review manipulations associated with production by a paper mill (Oransky, 2021). In February 2022, IOP Publishing retracted 350 papers at once from two conference proceedings due to lack of peer review, citation manipulations, the presence of 'tortured phrases' discovered by Cabanac et al. (2021), and text similarities (Oransky, 2022).

According to the Retraction Watch database, since 2020, massive retractions of papers originating from paper mills have occurred (Fig. 1). As of December 2021, 3,450 fraudulent manufactured papers have been identified.¹ However, this discovery could be just the tip of the iceberg because paper mills act on an anonymous basis, and their production cannot be easily detected.

To date, paper mills have been detected due to suspicious submission processes or anomalies in the papers, falsification/fabrication in images and data, and similarities between texts. Manipulation during the submission process includes falsification of peer-review processes (COPE Council, 2021; Day, 2022; Grove, 2021), numerous submissions to a journal with the same patterns (geographical region, the same email linked to different accounts), and requests for authorship changes after acceptance of the manuscript (COPE Council, 2021).

Streamlined production of dishonest papers is also associated with the usage of common templates on submissions despite them not sharing co-authors; for example, similar paper structure and section titles (Byrne & Christopher, 2020; Cabanac et al., 2021; Else & Van Noorden, 2021; Heck et al., 2021; Royal Society of Chemistry, 2021), similar formatting (Byrne & Christopher, 2020; Byrne & Labbé, 2017), similar colours and types of diagrams (Cabanac et al., 2021; COPE & STM, 2022), and identical fonts in figures (Byrne & Labbé, 2017; COPE & STM, 2022). Articles from paper mills may demonstrate other discrepancies that could potentially draw suspicion of non-authentic authorship. Evidence also suggests suspicious authorship in papers of questionable provenance, such as rare individual authorship (McCook, 2016), lack of previous publications on the topic of the paper (McCook, 2016), unlikely collaborations between co-authors from different universities (RAS, 2020), and

Key points

- There is a rising threat to the scientific community and academic publishing from paper mills.
- A total of 451 suspicious papers that are potentially linked to the Russia-based paper mill 'International Publisher' LLC were identified in this study.
- Problematic papers potentially originating from 'International Publisher' LLC are characterized by collaboration anomalies; that is, diversity of affiliations in each paper, mismatch between the specialization of the authors and the topic of the manuscript, and so forth.
- Current systems for paper mill detection should be regularly monitored and improved.

suspicious affiliations, for example, a university that is unlikely to support certain types of experiments or research (Schneider, 2021).

Paper mill production demonstrates a systematic violation of academic ethics (Christopher, 2018), for example, fabrication and falsification of data (Else & Van Noorden, 2021), fabrication of images and western blots (Christopher, 2018; van der Heyden, 2021), plagiarism (McCook, 2016), and citation manipulations (Christopher, 2021).

The majority of known paper mills are located in China (Hu & Wu, 2013; Hvistendahl, 2013; Liu & Chen, 2018; Schneider, 2020; Schneider, 2021; Zou et al., 2019). There is documented evidence of paper mills based in other countries, namely, Iran, India, Peru, Latvia, and Russia (Abalkina, 2020b; Christopher, 2021; COPE & STM, 2022; Else & Van Noorden, 2021; Mayta-Tristán & Borja-García, 2022; Stone, 2016). However, few formal studies have been conducted about their activities: strategies to attract potential authors, submission strategies or even collusion with editors or journals. The goal of this study is to shed light on the activity of paper mills using the example of one based in Russia to attempt to identify the fraudulent papers originating from these mills and to define a set of indicators of fraudulent papers.

'INTERNATIONAL PUBLISHER' LLC

There are dozens of advertisements on the internet that offer Russian scholars the opportunity to purchase co-authorship in a paper that will be submitted to a journal indexed in Scopus or Web of Science. 'International Publisher' LLC is one such entity, with an address that places it in one of the modern skyscrapers in the Moscow International Business Center (Moscow-City). 'International Publisher' LLC claims on its website that it has helped approximately 20,000 scholars publish 4,000 papers in journals indexed in Scopus or Web of Science. Offers to purchase co-authorship are openly listed on

¹<https://docs.google.com/spreadsheets/d/1zKxfaqug4ZhwHyGzslF38pFyC8xtU8lzmOFMGYITDI/edit#gid=0>

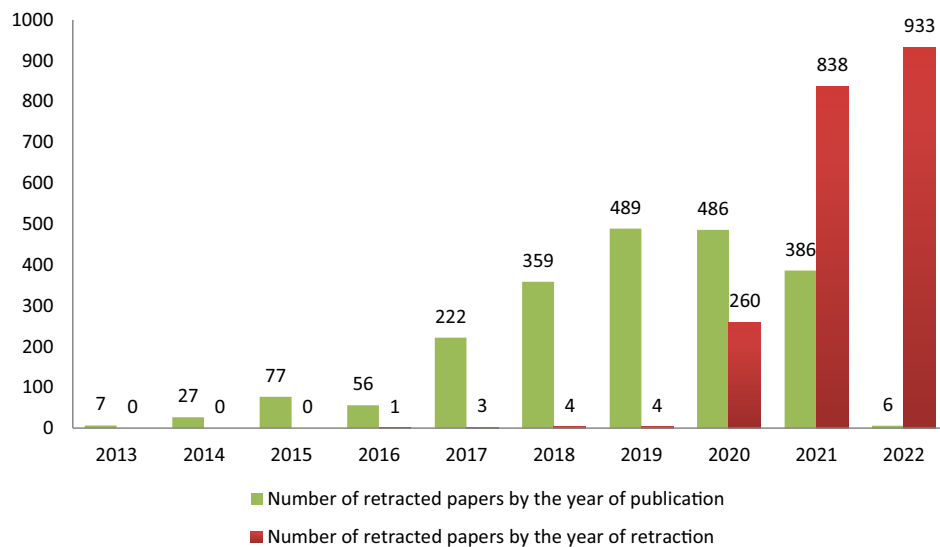


FIGURE 1 Number of retractions of paper mill papers. Source: Retraction Watch. URL: <http://retractiondatabase.org/>.

the 123mi.ru website (in Russian, English, and Chinese) or on the website with a much clearer name: <http://buy-sell-article.com/coauthorship.php#banner>.

One can choose the topic of the paper, the position in the list of authors, the quartile ranking of the journal, the date of publication, and the database where the journal will be indexed. As of mid-March 2022, the website listed 2,376 papers with between one and five authorship slots to purchase; 2,320 papers for sale would be indexed in Scopus, 480 papers in Web of Science, and 37 on Russian lists of journals compiled by the Higher Attestation Commission (VAK list).

The papers offered for sale cover several disciplines, such as economics, law, education, linguistics, medicine, engineering, and agriculture. These areas (excluding linguistics) may already be problematic as Dissernet, a network of scientists and journalists who detect plagiarism in PhD theses and academic papers in Russia, asserts that these disciplines represent 83% of detected theses with massive plagiarism in Russia (Dissernet, 2018).

According to the website of the paper mill, an author should not worry about anything; 'International Publisher' LLC will take care of the entire process of publishing and indexing the manuscript in the client's name. The author only needs to pay the requisite fees. The price range for co-authorship varied from €180 to €5,000 in 2019–2021, depending on the position of the co-author—1st co-authorship costs the most—and the impact factor and reputation of the journal. For example, according to one offer, the highest price (€5,000) is charged by 'International Publisher' LLC for 1st co-authorship on a paper that will be submitted to a special issue of a journal published by Frontiers Media.

The total value of co-authorship slots offered by 'International Publisher' LLC with publication dates from 2019 to 2021 is estimated at \$2.6 million. To obtain this number, the prices of the co-authorship slots mentioned in the contracts available on

the 123mi.ru website were summed. The price of the approximately 2,000 papers offered over nearly 3 years reaches \$6.5 million.

It is difficult to confirm that all of these sales of co-authorship have occurred. These offers could be fraud to collect money from scholars and do not guarantee publication of the paper. However, a correspondent for the Russian online media *The Insider* documented a test purchase from 'International Publisher' LLC—co-authorship in a paper that was supposed to be published in 2019 (Litoy, 2019). The paper, entitled 'Project-Based Learning as a Tool for the Formation and Development of the Entrepreneurial Skills of Students', was indeed published in the *Journal of Entrepreneurship Education*, together with several co-authors. The paper was devoted to surveying students in Omsk, Russia, but none of the co-authors live or work in the Omsk region. Moreover, none of the co-authors on the paper specialized in education studies; instead, the co-authors are a journalist and scholars specializing in chemistry, history, and engineering. Some of the co-authors confirmed that they had purchased a co-authorship slot at 'International Publisher' LLC (Litoy, 2019).

Unlike many paper mills that offer co-authorship for sale and collect payments after the acceptance of a manuscript (COPE & STM, 2022), 'International Publisher' LLC signs a contract with its clients and guarantees the publication of a manuscript despite the usual uncertainty of acceptance due to peer review. 'International Publisher' LLC uses a cost-effective strategy, and manuscripts are written only after some co-authorship slots are sold. There is also evidence that calls to write papers have been posted on various job search websites in Ukraine (Perron et al., 2021). It is plausible in individual cases that some new co-authors are added after the acceptance of the manuscript (Chawla, 2022), but this is probably because not all co-authorship slots were sold before the submission of a paper.

The guarantee of getting published by 'International Publisher' LLC can be explained in several ways. First, according to the offers, in 2019, 'International Publisher' LLC submitted manuscripts to journals with low impact factors (presumably predatory journals), where the probability of acceptance is high. Second, 'International Publisher' LLC claims that it collaborates with journals and their editors and agrees upon the dates of publication. The offers on the website confirm these statements because some offers include the editor of the journal as a co-author, which is clearly stated in the offer. Third, according to the information on its website, 'International Publisher' LLC also owns international journals, ensuring risk-free publication of the auctioned manuscripts (Litoy, 2019). Fourth, 'International Publisher' LLC approaches legitimate authors to buy co-authorship slots in their manuscripts. It claims the following on its website:

We also work with foreign authors who publish their articles in good Q1-Q2 journals. The process looks like this: an author with a high Hirsch index writes an article to submit to a quality journal; one place is assigned to him; the remaining 2-3 places in the article are for sale. The payment is divided among the journal, the author, and us. Such schemes cannot be traced since there are only two sides, and each of them is interested in continuing cooperation.

Like many other broker companies, 'International Publisher' LLC's contracts mimic legitimate services providing 'publishing services', for example, 'scientific journal selection' and assistance in the 'publication of research' in journals.²

Because both 'International Publisher' LLC and users who purchase co-authorship demonstrate unethical behaviour, they attempt to maintain confidentiality. The titles of the journal and co-authors are available to potential clients only after payment.

There is also a special condition in the contract:

Each Party undertakes to maintain complete confidentiality of financial, commercial and other information received from the other Party. Such information could be transferred to Third Party only under the written consent of the both Parties, as well as in cases provided by law.

'International Publisher' LLC uses aggressive marketing to attract potential clients. In addition to the website through which the company offers to sell co-authorship slots, it also uses other insidious strategies. According to the website information, the company has contracts with various universities, and it organizes seminars on publication strategies for international journals for university faculty. There is evidence of aggressive mail spamming

²See the archived example of the contract in Russian and English: <https://web.archive.org/web/20220223120141/http://123mi.ru/1/contract.php?n=14&m=1>

with offers. The more that the company expands abroad, especially into the markets of ex-Soviet countries, the Middle East and China, the more it establishes local offices. More than 10% of published papers potentially originating from 'International Publisher' LLC are associated with China, Saudi Arabia, and the United Arab Emirates.

The unethical activity of 'International Publisher' LLC has received attention in the media and blogs at both the national and international levels (Abalkina, 2021b; Chawla, 2020, 2022; Clarivate, 2019; Litoy, 2019; Marcus, 2019). However, its activity and consequences have not yet been investigated by scholars or by academic officials in Russia. In December 2021, Retraction Watch published the report by Perron et al. (2021) on the activity of 'International Publisher' LLC. It focused on communication with authors, journals and publishers concerning problematic papers from the paper mill. This current study is an independent study that sheds light on the long-standing activity of the Russia-based paper mill 'International Publisher' LLC and identifies collaboration anomalies and a set of indicators to identify fraudulent papers.

METHOD

Data

Data were obtained from two main sources. Initially, since 2019, I saved the offers of 'International Publisher' LLC published on the 123mi.ru/1 website. Additionally, the titles of papers were also provided in the contracts that 'International Publisher' LLC signs with the co-author. The text of the contracts was also available online. The text of nearly every offer on the website 123mi.ru/1 comprises the topic or approximate title of the paper, the number of co-authorships for sale, the price of a co-authorship, information about the target journal (indexation in international scientometric database, quartile, country or region, scientific area), the deadline for submission and the approximate date of publication. 'International Publisher' LLC does not openly disclose the title of the journal; the title is available only after payment. Some offers also included the abstract of the paper. After a co-authorship slot was sold, the offer sometimes provided information on the co-author's country to give information to potential clients about future co-authors.

'International Publisher' LLC started to promote offers of co-authorship for sale in mid-December 2018. Since then, more than 2,000 offers of papers with co-authorship for sale have been created, and approximately 1,000 papers, according to my estimation, had a publication deadline before the end of June 2022. The website claims that as of 16 March 2022, 5,961 co-authorship slots had been sold.

Identification of the papers

A total of 1,063 co-authorship offers with a publication deadline before the end of June 2022 were examined to detect auctioned

papers that had been published in journals. The offers contain details that can facilitate recognition of the published papers. The unique topic (title) of the article can in some cases provide sufficient information to identify the paper because many of them were published with identical or very similar titles. Each offer title was manually searched in Google, Google Scholar or Scopus. Some of the titles were found in Russian, so they were translated with Google Translate before the search. Additionally, the final result can be confirmed by the year of publication, country/region of the journal and the number of co-authorship slots. For some offers, the identification result was also confirmed by matches in abstracts and a co-author's country of origin.

Please see Fig. 2 as an example of the identification of a paper.

This example illustrates the matches between the titles of the offer and the published paper, the publication year, the

journal's country, the number of co-authorship slots, the abstract, and the affiliation country of the third co-author. The identified paper has been retracted due to 'peer review manipulation' and 'authorship manipulation' (Sabyrzhay et al., 2022).

RESULTS

The number of papers retrieved

As of July 2022, 451 published papers that potentially originated from the paper mill were identified. Among these 451 papers, there is one preprint, one duplication paper and 16 republications of papers erroneously published in hijacked journals (for details on hijacked journals, please, refer to Section 4.3.3). The list of these papers can be accessed via <https://docs.google.com/spreadsheets/>

Offer details:

- #721
- Набор в журнал до 30-12-2020
- 221400 руб
- 3 чел. (авторов) в этой статье
- Coauthors: 1-й, 2-й, 3-й
- Рубли: \$6100, 75850, 59450
- № 721.1, № 721.2, № 721.3
- Договор, Договор
- Название журнала доступно только клиентам, которые оплатили
- Netherlands
- Scopus Q3 Q4, Percentile = 30-50
- !!!95!!!
- Специализация журнала: Law Management, Monitoring, Policy and Law

Identified paper details:

- RETRACTED ARTICLE: Economic and legal regulation of the use and development of renewable energy sources**
- Ali Sabyrzhay, Gulnara Balgimbekova & Viktor Shestak
- International Environmental Agreements: Politics, Law and Economics 21, 595-610 (2021)
- Abstract: The study, through the prism of comparing various government practices, critically examines the problems of Russian legislation and policies in the field of renewable energy sources, such as problems of fragmentation, obsolescence and lack of legislation. The article examines the current legislation, which establishes incentives for the development of renewable energy. The research question consists in assessing the applicability of current international practices in the field of regulation of the use of renewable energy sources in the context of the modern Russian legal system.
- Scimago
- International Environmental Agreements: Politics, Law and Economics
- Netherlands

Connections:

- Offer title: "Legal regulation for use and development of renewable energy sources" matches the identified paper title.
- Offer abstract: "Правовое регулирование использования и развития возобновляемых источников энергии" matches the identified paper abstract.
- Offer co-author: "Третьим автором является: только экологическое право" matches the identified paper's third co-author affiliation.

FIGURE 2 Example of the identification of an offer.

[d/1vzjtRPX7kd2KcZdtKONEpRZb2F-4lj5Sd9jL6DfbiBk/edit?usp=sharing](https://doi.org/10.1002/leap.1574). This list will be updated as soon as new papers potentially originating from this paper mill are identified. I included on the list only those problematic papers for which I have sound evidence of suspicious origin. The list does not include dozens of cases that were submitted with the intermediation of 'International Publisher' LLC but that were not offered through their 123mi.ru/1 website³ or papers published in Russian journals. It also does not include problematic cases in which I doubted whether they came from 'International Publisher' LLC. In this list, there is also a column of retraction or correction notices. As of July 2022, more than 30 papers from the list have already been retracted.

In some cases, proving suspicious provenance was challenging. This was especially true for papers with very common topics or more or less identical titles. I illustrate this difficulty with an identification and demonstration example (see Table 1).

I provide further evidence that these papers could be associated with the paper mill (see Fig. 2). For every paper, there is information about the deadline for publication and the number of co-authorship slots. The majority of offers on the website contain information about the region or country of the journal indexed in Scopus or Web of Science. Approximately 44% of identified papers have matches in these four parameters (the same title, year, number of co-authorship slots, and country/region of a journal), 41% had matches in three parameters and 15% had matches in two. Approximately 84% of papers with three matches or fewer can be confirmed by one of two additional parameters (the coincidences of abstracts or the country of a co-author), which could provide sound evidence of a questionable provenance of these papers. Only one paper on the list has one match, but it is included due to additional evidence of the author's affiliation country and their co-authorship in another identified questionable paper.

The mismatch of the number of co-authorship slots, date of publication or country of the journal can be explained in several ways. Fluctuations in the number of co-authors occur because not all co-authorship slots were sold or because it is possible to purchase an entire paper, for example, all co-authorship slots, adding more co-authors to the paper or remaining a solo co-author. Mismatches in the year of publication are rather uncommon (only 43 papers) and are mainly associated with earlier publication than was advertised. In 34% of cases, the country/region of the journal does not correspond to the offer due to deindexation of the journal from Scopus or rejection of an article. I also suspect that, in some cases, 'International Publisher' LLC was attracted by special offers from other journals and changed the target journal, as in the case of multiple submissions to a hijacked journal, for example.

³Except one title of the paper without an available offer. The title represented a republication of a paper published in a hijacked journal (see explanation below).

Collaboration abnormalities

Suspicious collaborations

The majority of papers potentially originating from the paper mill 'International Publisher' LLC are characterized by suspicious collaboration patterns. The patterns of such collaboration can be observed in the variety of affiliations among the authors of the article. Moreover, in many cases, the 'authors' of an individual manuscript specialize in different disciplines that do not correspond to each other and/or to the topic of the paper. In other words, the phenomenon of suspicious collaboration supposes a collaboration of scholars who (1) might not be familiar with each other; (2) do not have common research interests; (3) are affiliated with various universities; (4) specialize in different disciplines; and (5) might not specialize in the topic of the paper. A striking example of such collaboration is a paper written by scholars from an economic University A and a medical University B in one ex-Soviet country on the topic of chemical engineering. Such a collaboration pattern is not misconduct in and of itself but can serve as an indicator of a violation of academic ethics and of suspicious origin from a paper mill.

Suspicious collaborations can also be observed at the university level. Suspicious co-authorship includes collaborations in which the co-authors are affiliated with different organizations that might not engage in joint scientific cooperation. These cases can be detected by the comparison of collaboration in Russian and international journals. For example, according to the Russian scientometric database e-Library, which also indexes Russian journals, the abovementioned medical University B is outside the top 100 collaboration organizations of economic University A. In contrast, according to Scopus data, medical University B reached the sixth rank among the top collaboration organizations of economic University A. These data and such a mismatch suggest that such cooperation most likely represents artificial collaboration for the purpose of publication in international journals to inflate the publication record.

Another pattern that can be observed in the collaborations linked to the paper mill is the presence of the first authorship associated with China. Based on the detected papers, it has been observed that more than 85% of Chinese co-authors prefer the position of first co-author. Moreover, more than 10% of problematic papers from the list have Chinese scholars as the first co-author. This finding is likely related to the system of financial rewards in China, where the first author receives all benefits from publication (Liu & Chen, 2018).

Collaboration anomalies observed in the detected papers can be explained by country-specific patterns. The new system of requirements for publications and effective contracts introduced in Russian universities has required more research output. This policy led to the destruction of scientific collaboration and its replacement by groups interested in publication in international journals (Guba, 2022). Moreover, such artificial collaborations appear to share the financial costs of

TABLE 1 Identification of papers.

	Offer	Title found	Title found
Title	Supply chain and supply logistics as new areas of study in higher education	Supply chain and supply logistics as new area of study in higher education	Supply chain and logistics as new areas of study in higher education
Region/country of a journal	Europe	Germany	Venezuela
Number of co-authorship slots	4	4	7
Year of publication	2020	2020	2020
Decision		Confirm	Reject

Note: This is a demonstration. The titles are imaginary (the key words were changed to other terms) to avoid involving possible legitimate papers in this discussion.

publication. This phenomenon was also observed in Ukraine (Mryglod et al., 2021).

Co-authorship-specific patterns

The average number of affiliations within problematic papers that potentially originated from the paper mill 'International Publisher' LLC is 3.2, while the average number of co-authors is 3.9 per article. This co-authorship practice does not correspond to normal practice in science. Matveeva et al. (2021) examined the trend of collaboration patterns in publications with fewer than 10 co-authors and demonstrated that the average number of affiliations per publication by 21 universities of the Russian University Excellence Initiative (Project 5-100) increased from 2.2 in 2012 to 2.6 in 2016. These data do not suggest increased collaboration between authors but rather anomalies in the diversity of affiliations, which in all likelihood was the result of the acquisition of co-authorship by independent scholars.

Another significant aspect of authorship patterns is the share of single-authored papers. In our sample of suspicious papers originating from the paper mill, there are only eight single-authored papers (~2%). In contrast, according to Web of Science data, in 1993–2019, the share of solo papers by Russian scholars reached 16% (Chankseliani et al., 2021). Of course, co-authorship patterns are highly dependent on the relevant discipline. The largest share of single-authored publications can be found in the humanities. According to the Russian Science Citation Index, among the 100 most successful authors in terms of the number of publications in relevant disciplines, the share of single-authored papers in the majority of social and human sciences exceeded 50%. In economics and psychology, it is more than 40%, and the smallest share is registered in astronomy, physics, and chemistry because these disciplines are characterized by large teams and even mega-collaborations (Akoiev, 2021). Such discrepancies between the share of solo-papers from the paper mill and the practice in science suggest an artificial authorship practice. According to the evidence of the 'International Publisher' LLC offers, single authorship in papers in international journals can be explained by the fact that either no one purchased the remaining co-authorship slots or a single author purchased the entire paper.

Alphabetical order

Out of 443 papers, 392, or 88.5% (I excluded the papers with one author), did not follow the rule of alphabetical order. There are different norms regarding how to order the co-authors of papers in different disciplines. Many disciplines apply contribution-based approaches or seniority rules (Fernandes & Cortez, 2020). Some disciplines, such as economics, mathematics, and high energy physics, mainly use an alphabetical order in scientific publishing (Fernandes & Cortez, 2020; Frandsen & Nicolaisen, 2010; Waltman, 2012; Weber, 2018). The lack of alphabetical order in these problematic papers is a consequence of the slot-order principle and could serve as an indicator of problematic papers together with other suspicious patterns.

Summary of collaboration abnormalities

Each individual paper might seem legitimate until I analyse the whole sample and identify some anomalies that could predict fraudulent papers. To conclude, the results of Section 4.2 'Collaboration abnormalities' of the paper, I provide the following peculiar features and indicators of the Russian paper mill:

- Suspicious collaborations:
 - Specialization of the universities not corresponding with each other (economic universities with medical universities if the subject of the paper is not the economics of health care, for example).
 - Specialization of the authors does not correspond to the topic of the manuscript.
 - Affiliations of the authors do not correspond to the topic of the manuscript.
 - Diversity of affiliations per paper.
- Lack of alphabetical order in the author list is observed in the papers belonging to certain disciplines such as economics, where the rule of alphabetical order is typically applied.
- Similar structure of the papers. Normally, the traditional IMRAD structure is used, in which M is frequently entitled 'Materials and Methods' even in papers where the research did not require any materials (e.g., in social sciences and humanities).

- The majority of clients of paper mills are affiliated with universities but not with research institutes, which are numerous in Russia.
- The majority of suspicious papers are associated with Russia, Kazakhstan, China, Ukraine, and the United Arab Emirates or a combination of these countries (see Figure A1). Authors associated with China normally have the first co-authorship.
- The use of commercial email is *not a sign* of a paper mill, as in many Chinese paper mills (Seifert, 2021). Many legitimate scholars in Russia use their personal email addresses for submissions (Shen et al., 2018).

Journals

Problematic papers potentially originating from the paper mill were identified in a total of 159 authentic journals and three hijacked journals (for hijacked journals see Section 4.3.3.). According to the data obtained, 104 legitimate journals have published just one article from the paper mill (Fig. 3). This means that individually tailored articles were submitted separately to one journal, which makes it very difficult for a journal to recognize a submission from the paper mill due to the lack of multiple submissions and similar patterns. The data of Fig. 3 should be interpreted with caution because not all the offers were identified.

Initially, 'International Publisher' LLC focused on publishing in a limited number of low quality and predatory journals, such as *Opcion* and *Espacios* (RAS, 2020). Later, these journals were deindexed from Scopus. According to the website of 'International Publisher' LLC, in 2020, the company changed its strategy and invited legitimate scholars for collaboration to sell already-written texts or co-authorship slots. There is evidence that legitimate scholars received such dishonest offers (Hyndman, 2020). This policy change can be explained by the instability of publications in predatory journals, which can be quickly excluded from international scientometric databases. Indeed, since the fall of

2020 and 2021, priority has been reoriented towards legitimate journals of reputable publishers (Elsevier, Springer Nature, Emerald, Wiley, Taylor & Francis, etc.). In addition, there was a significant increase in the number of journals in which papers from the paper mill were published.

Analysis of the offers allowed me to conclude that 'International Publisher' LLC is very careful not to submit numerous papers to legitimate journals of reputable publishers, limiting submissions to one or a few papers per year, making it impossible for an individual journal to detect a problematic paper because a single paper in isolation can appear absolutely legitimate.

Special issues

'International Publisher' LLC used special issues as a route for the publication of auctioned papers, a common practice among other paper mills (COPE & STM, 2022). In summer 2020, 'International Publisher' LLC posted an offer:

Special issue

Note: this special issue will also contain papers #1081, #1082, #1083, #1084, #1085, #1086, #1087, #1088, #1089, #1090 on our website. A single author is free to purchase not more than 2 papers from this special issue tops. This is one of journals requirements.

All 10 papers were planned to be published in a journal indexed in Scopus, Emerging Sources Citation Index, and EI Compendex. I detected nine of 10 papers published in the same issue (2021, Vol. 16, #2) of the *International Journal of Emerging Technologies in Learning*, matching all of the journal characteristics in the offer. The same type of special issue offer with 10 papers was planned for the *International Journal of Interactive Mobile Technologies*, which belongs to the same publisher, the International

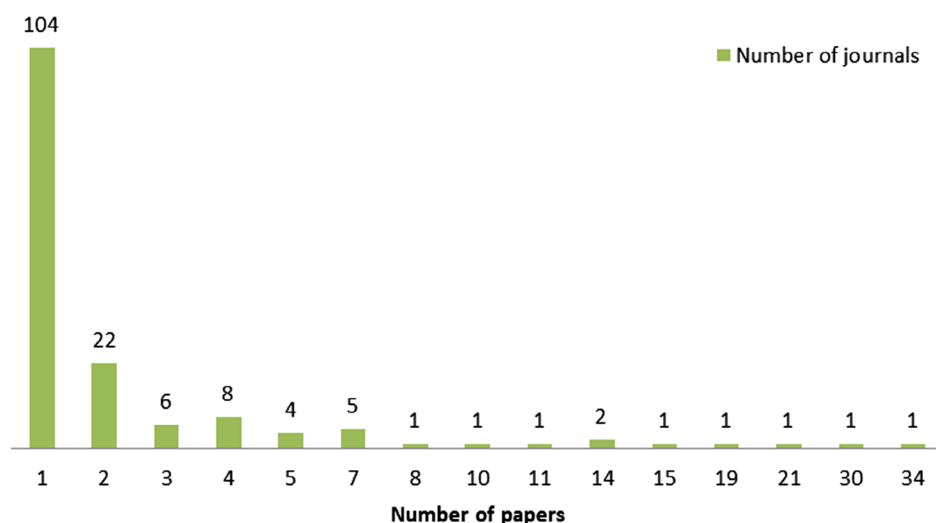


FIGURE 3 Number of papers per individual journal.

Association of Online Engineering, as the previous one. Five of 10 papers were detected in the issue (2020, Vol. 14, #21). The issue itself included only 10 papers ‘written’ mostly by Russian scholars that perfectly matched the number of offers. However, I do not have sufficient supportive evidence to match the remaining five offers. The *International Journal of Emerging Technologies in Learning* has already retracted 30 papers from the paper mill after the report by Perron et al. (2021) and the investigation by the journal (Kincaid, 2022).

Editorial collaboration example

Analysis of offers and papers potentially originating from the paper mill allowed me to identify at least one episode of questionable collaboration between editors of MDPI journals and ‘International Publisher’ LLC. Twenty of 21 identified papers published in MDPI journals had a specific feature: they were co-authored by scholars associated with one Eastern European country; 18 of them were affiliated with University C, and two had an affiliation with University D in this Eastern European country. One might suggest that these co-authors dishonestly purchased a co-authorship slot, but I suspect that the relationship is of a different nature. Some of these Eastern European co-authors were editors of several MDPI journals or guest editors of special issues. One could suggest that it is a coincidence, but

some of the offers on the 123mi.ru website explicitly mentioned that one co-authorship slot of the paper was reserved for the editor of the journal or the editor of the journal from this particular country. This co-authorship pattern in MDPI journals served as a good indicator of other dishonest papers.

Four MPDI journals (*Sustainability [Switzerland]*, *Journal of Theoretical and Applied Electronic Commerce Research*, *Energies*, *Mathematics*) were involved in this kind of suspicious collaboration patterns (see Fig. 4).

At least eight papers potentially originating from the paper mill were co-authored by three editors of MDPI journals. All of them were affiliated with University C. Two editors were academic editors on one paper, likely purchased on the shadow market of academic papers. All three editors mentioned in Fig. 4 were also guest editors of special issues of *Energies* and *Sustainability (Switzerland)*, in which several papers of suspicious provenance were published. At least 10 other scholars from University C co-authored problematic papers that were published in MPDI journals. As of July 2022, ‘International Publisher’ LLC continues to publish offers reserving a slot for an editor from this Eastern European country.

Hijacked journals

Twenty-two papers of questionable provenance were published in hijacked journals. Hijacked journals are cyber-criminal

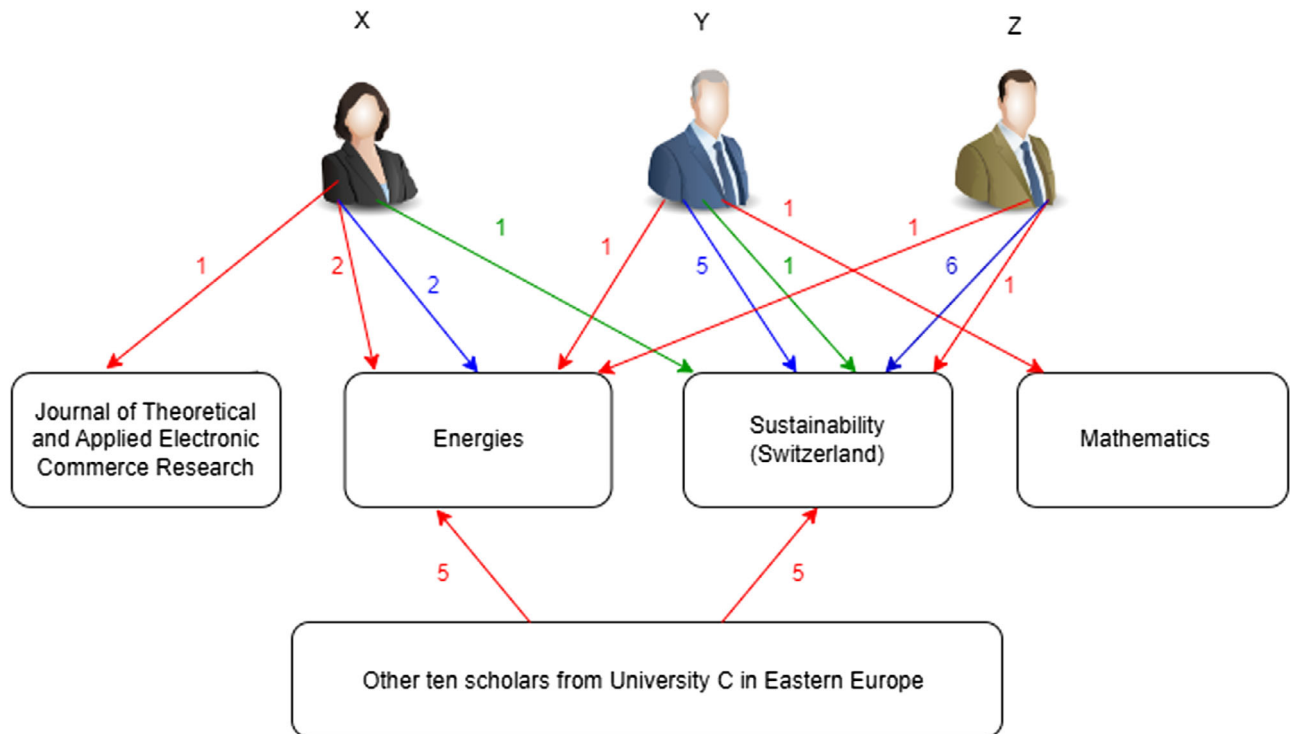


FIGURE 4 Suspicious collaboration patterns of MDPI journal editors. Red arrow and number—number of co-authorships in papers potentially originating from the paper mill. Blue arrow and number—guest editor of a special issue of the journal and number of special issues. Green arrow and number—academic editor of a paper potentially originating from the paper mill and number of papers. Editors X, Y, and Z are affiliated with University C.

publishers; in most cases, they create a clone website of legitimate journals, steal their identity (title, ISSN) and fraudulently collect fees for rapid publication without providing peer review (Abalkina, 2021a; Jalalian & Dadkhah, 2015; Moussa, 2021). I detected papers of questionable provenance in three hijacked journals: *Journal of Talent Development and Excellence* (Abalkina, 2020a), *Journal of Southwest Jiaotong University*, and *International Journal of Disaster Recovery and Business Continuity*.⁴

Such collaboration between this paper mill and fraudulent publishers provides further evidence for how both paper mills and hijacked journals work. Hijacked journals can publish thousands of papers over several months. Such numerous submissions are collected not only by aggressive marketing and spam emails but also by collaboration with national broker companies and paper mills that have their own databases and clientele and accumulate papers for publication. Broker companies and paper mills are attracted by the possibility of providing fast and guaranteed publication. However, paper mills themselves can be cheated by hijacked journals, as the case of 'International Publisher' LLC shows. This conclusion is drawn from the detection of several republications of papers in hijacked journals with the same set of co-authors and on similar topics but with slightly different texts. A possible explanation for this republication might be that 'International Publisher' LLC guarantees the indexation of the published papers in Scopus or Web of Science, which is problematic in the case of hijacked journals. All nonlegitimate content from the *Journal of Talent Development and Excellence* was withdrawn by Scopus, and there is no evidence of indexation of papers submitted by 'International Publisher' LLC from the *Journal of Southwest Jiaotong University*⁵ or *International Journal of Disaster Recovery and Business Continuity*. Therefore, contractual obligations forced the republication of similar papers in legitimate journals, in most cases without advertising a respective offer on their website. Sixteen republications of papers with a similar topic and set of co-authors provide further evidence of possible provenance from the paper mill.

DISCUSSION: THE SIZE OF THE PROBLEM

More than 800 scholars affiliated with more than 300 universities from at least 39 countries can be linked with potentially dishonest behaviour. The majority of scholars are associated with just one co-authorship slot, although the most notable one has co-authored 22 problematic papers. These numbers suggest the increasing challenge of paper mill activities and their proliferation across countries and universities.

⁴Journals published at the website <http://sersc.org/> are most likely hijacked journals. However, original journals could not be identified.

⁵There is evidence of unauthorized content indexation from a hijacked version of the *Journal of Southwest Jiaotong University*. However, there have been no identified papers originating from 'International Publisher' LLC found among the indexed content.

Since I analysed only one paper mill, 'International Publisher' LLC, there remains evidence of other paper mills in Russia and other ex-Soviet countries (Marcus, 2021). It is likely that the real number of paper mill productions is much higher and that this is only the tip of the iceberg. These fraudulent papers contaminate academic literature due to plagiarism and fabrication, which were found in some papers from the paper mill. One of the most notable examples of fabrication and plagiarism is a paper by a scholar affiliated with New York University on the analysis of the leaf fall of American elm and American ash in Detroit (US), which potentially originates from a paper mill. The scientific results and numbers were found to be identical to those in a Russian-language paper on elm and European ash in Orenburg (Russia).

Papers from the paper mill become more visible due to citations. Approximately half of the detected papers were cited at least once, and one problematic article was cited as many as 77 times as of July 2022. Cross-citations were found in the sample, but it does not appear to be a trend for manipulating citations. However, some citations look suspicious as they are received from numerous papers within the same journal issue. This pattern can be observed across different papers in the sample, suggesting inflation of citations.

Such outputs of a Russia-based paper mill is difficult to detect due to individually tailored papers being submitted to more than 100 different international journals. Journals themselves have no opportunity to notice irregularities according to the current COPE guidelines that recommend tracing similarity patterns between manuscripts or during the submission process (COPE Council, 2021). Noticing irregularities may require publishers and COPE to regularly upgrade fraudulent paper detection systems. All suspicious collaborations should be examined closely. Suspicious collaboration is not misconduct in and of itself, but it can attract attention to a problematic manuscript. This study sheds light on the patterns of the paper mill 'International Publisher' LLC, which could help journals identify suspicious papers.

Despite numerous publications about the paper mill 'International Publisher' LLC both in Russia and worldwide, it is still operational. To defend its operations, the paper mill appears to have introduced several new techniques. In fall 2021, this paper mill published approximately 10,000 fake offers using the abstracts of *already published*, legitimate papers by legitimate authors. It is likely that the only reason to include such fake offers was to mislead the investigation. Later, in March 2022, 'International Publisher' LLC introduced an archive for 2018–2021 on its website. This archive included approximately 100,000 entries that represent fake offers with abstracts of papers that have been already published by legitimate authors, generally associated with Russia. The intention of such an archive, in my opinion, is also to mislead the detection of fraudulent papers. However, the archive has much more serious consequences because these fake offers implicate innocent authors. In several cases, anonymous users of PubPeer left comments asking legitimate authors to explain their possible connection with the paper mill. Moreover, the paper mill completely changed the design of the website and deleted several pages with valuable information that helped to detect

fraudulent papers. Unfortunately, these examples show that paper mills adapt but do not stop their operations.

The orientation towards publication in journals indexed by Scopus and Web of Science has become a trap in the system of research output evaluation in Russia. The nationwide criteria require increasing publications from universities, and universities in turn motivate faculty to publish more to increase funding. Unfortunately, such a strategy, aside from its advantages, becomes a win-win strategy when faculty members with high workloads who are unable to produce high-quality papers can receive financial benefits through dishonest behaviour, while universities receive budget funding due to increased publication records. Many Russian and Chinese universities introduced financial rewards for publications (Guba, 2022; Liu & Chen, 2018). However, in early 2020, China's science and education ministries issued a notice instructing research institutions to discontinue the practice of offering cash bonuses for papers (Mallapaty, 2020). An increased effect resulted where researchers affiliated with Chinese or Russian institutions, having received a grant, bought co-authorship in a paper mill to demonstrate their output capabilities. Unfortunately, the difficulties in detecting fraudulent papers and the lack of sanctions for violations of academic ethics in some countries, such as Russia, only contribute to the proliferation of dishonesty.

CONCLUSIONS

This study attempts to identify papers with forged co-authorship originating from the Russian paper mill 'International Publisher' LLC by searching the paper titles from 1,063 offers of co-authorship for sale and confirming the results by analysing the country of the journal, year of issue, and number of co-authorship slots.

The major contributions of this paper are as follows.

1. The current study allowed me to identify 451 suspicious papers that are most likely associated with the Russian paper mill 'International Publisher' LLC. Among these papers, there are at least 16 republications of papers previously published in hijacked journals. Unfortunately, I was not able to identify more papers with forged authorship that have infiltrated the academic literature.
2. The Russian paper mill has become very successful due to its diversified strategies of collaboration with journals: (a) the one paper--one journal principle, such as submission of only one problematic manuscript per legitimate journal, hinders the identification of patterns or suspect similarities; (b) submission to predatory journals where the rate of acceptance is high; (c) special issues; and (d) suspicious cooperation with editors of journals.
3. The prevalence of dishonest papers from 'International Publisher' LLC varies across journals: the majority of papers are published in predatory journals or in journals with special issues. More than 100 papers were published in journals of reputable publishers where mainly individual submissions were

made. The evidence of the year 2021 shows a redirection of submissions to the journals of reputable publishers.

4. The activity of 'International Publisher' LLC has an international scope. The majority of papers potentially originating from this paper mill are associated with Russia but also with Kazakhstan, China, Ukraine, and the United Arab Emirates. More than 800 scholars affiliated with more than 300 universities from at least 39 countries have potentially purchased co-authorship slots in Russia-based paper mills.
5. The analysis showed irregularities between the sample and the common practices of the scientific community in Russia, providing further evidence of the questionable provenance of the sample papers: (a) diversity of affiliations per paper; (b) topics of papers not corresponding to the specialization of the co-authors and their previous work; and (c) the average number of co-authors in the sample being larger than is typical in Russia, and vice versa, the number of solo papers being significantly smaller.
6. This study provided a set of indicators of 'International Publisher' LLC, including suspicious collaboration patterns; lack of alphabetical order in the author list in certain disciplines, such as economics; similar structure among different papers; and suspicious associations with Russia, Kazakhstan, China, Ukraine, and the United Arab Emirates or a combination of these countries.
7. The present study provides further evidence of hijacked journal activity. This study demonstrates the strategies of hijacked journals in attracting potential authors through the intermediation of broker companies.
8. The current system of paper mill detection should be regularly monitored and improved.

AUTHOR CONTRIBUTIONS

Anna Abalkina conceptualized the project, developed the methodology, collected data from online resources, identified papers potentially originating from paper mills, performed the analysis, created tables and figures, wrote the initial draft of the paper, and addressed the feedback provided by the reviewers.

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CONFLICT OF INTEREST STATEMENT

Anna Abalkina creates the Retraction Watch Hijacked Journal Checker in partnership with Retraction Watch.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Figshare at <https://doi.org/10.6084/m9.figshare.22046783>

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APPENDIX

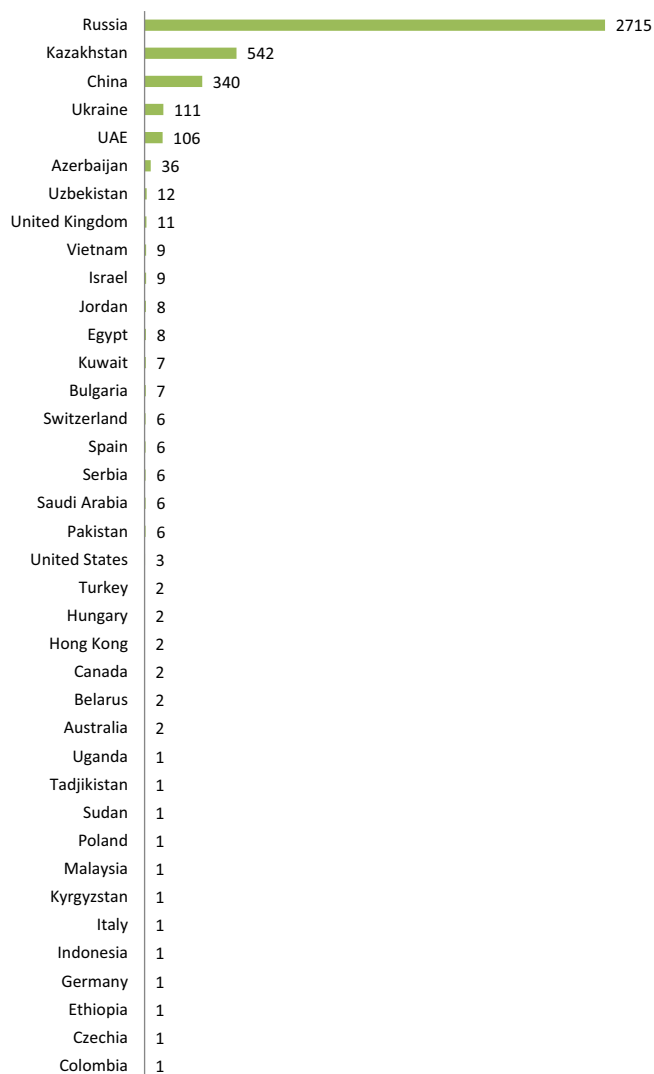


FIGURE A1 Number of purchased co-authorship slots by country (as of 16 March 2022).

Source: 123mi.ru website (<https://web.archive.org/web/20220318084750/http://123mi.ru/contracts.php>).