

# Knowledge about Sino-Swiss International Scientific Collaboration: An Analysis of Twenty Years Co-authorship in Two Databases

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Xiaona Wang

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## **Abstract**

Within the broader context of Sino-European relations, China and Switzerland have maintained continuous bilateral relations and historical ties since 1950. Despite these longstanding connections, the knowledge patterns of scientific collaboration between the two nations, remain largely unexplored. This research contributes to the global science discourse by focusing on the previously unexplored collaborative relationship between China and Switzerland and offers a deeper understanding of scientific knowledge in international collaborations by incorporating and examining data from a domestic Chinese database. Addressing the unevenness between global and local, this study utilizes publication counts, corresponding authorships and disciplinary classifications as indicators to identify patterns, similarities, and

differences in disciplinary knowledge pertaining to international collaborations, as presented in the science knowledge databases. Data from Weipu (VIP), a domestic Chinese scientific database and Web of Science (WoS), an international database, spanning the years 2001-2021, serve as the basis for this analysis. Key findings highlight significant divergence in the number of collaborative papers indexed across various databases, suggesting potential marginalization of specific collaborations. Additionally, China emerges as the predominant contributor, represented by the corresponding author, in collaborative endeavors with Switzerland. Lastly, evidence of marginalized knowledge is manifested within the disciplinary field, suggesting the presence of certain disciplinary biases. Collaborations in specific fields such as Agricultural, Veterinary and Food Sciences, and Built Environment and Design, tend to be published more in Chinese database, thereby garnering greater recognition locally. Conversely, physics publications are comparatively less prevalent in Chinese databases and markedly rare in the context of Sino-Swiss collaborative research.

**Keywords:** Knowledge about science; International scientific collaboration; Co-authorship; Languages; Disciplines

## Introduction

In an increasingly interconnected world, international scientific collaboration emerges as more than just a trend; it is a strategic imperative. The geopolitical conflicts, however, have added a new layer of complexity, stoking competition particularly around vital resources such as talent, and fields such as science and technology (S&T) (Wu, 2019). Amid these developments, the importance of understanding the evolving landscape of international scientific collaborations becomes paramount (Chen, Zhang and Fu, 2019).

Global connections and collaborations play a pivotal role in the production of scientific knowledge, as evidenced by the prevalence of internationally co-authored papers (Glänzel and Schubert, 2005; Wilsdon, 2011). Such collaborations form a cornerstone for significant technological and economic advancements (Shin, Kim and Kogler, 2022). Consequently, the primary goal of academic endeavors is to generate high-quality research, primarily disseminated through scholarly publications. This goal is particularly pronounced in the realm of international collaborations, which are characterized by a clear and growing trend in co-authored publications (Lee and Haupt, 2021).

Furthermore, meta-research on international science collaboration frequently presupposes English publications as the default for analysis, with few exceptions (Horta and Shen, 2020; Shu et al., 2019, etc.), there is still a need to extend this focus to STEM fields that publish in their own languages. As such publications can reflect a country-specific network and collaborations within that particular linguistic context (Leydesdorff et al., 2013), which are often overlooked. The prevailing emphasis on language in humanities and social sciences underscores the disparity and highlights the importance of examining how linguistic preferences shape STEM research outcomes and collaborations within national boundaries (Larivière, Gingras and Archambault, 2006).

Examining co-authored papers through databases such as Web of Science or Scopus offers extensive insights into current trends in scientific collaboration. However, it is crucial to acknowledge that relying exclusively on single-language databases underscores the dominance of English in scientific

communication (Marginson, 2022). This dominance not only highlights linguistic preferences but also mirrors broader power dynamics within the scientific community. Therefore, to enhance the understanding of the scientific knowledge landscape, particularly in terms of power dynamics, it is essential to acknowledge the unequal knowledge distribution and incorporate marginalized knowledge. This inclusion can be facilitated by integrating local databases into the research framework. Additionally, adopting various analytical perspectives, such as examining authorship and disciplinary differences, will yield deeper insights into the patterns of international scientific collaboration between countries.

## **China and Switzerland**

China-Europe relations have become an important focal point in the changing landscape of global politics and economics (Goulard, 2020). These relationships are characterized by a complex interplay of collaboration and contention (Geeraerts, 2019), encompassing areas such as trade relations (e.g., Karkanis, 2018; Garcia-Herrero, 2020), technological cooperation (e.g., Assimakopoulos and Chen, 2013), and geopolitical concerns (e.g., Scott, 2007; Maher, 2016; Yu, 2018).

Switzerland is a unique country among its European peers, distinguished by above-average growth and a high average citation impact for a small nation (Adam, 2013). Two particularly notable factors contribute to Switzerland's distinctiveness: its strategic 'geographical position' and its robust 'economic trade', both of which serve as pillars of the country's success (Salis, 1971: 73). Its policy of permanent neutrality supports foreign relations that are friendly and welcoming, positioning Switzerland as a mediator in global disputes. This is evidenced by the numerous international organizations headquartered there. In the scientific arena, the influence of Switzerland's political stance is undeniable, as exemplified by CERN, the world's largest international particle physics laboratory. Despite not joining the European Economic Area (EEA) and European Union (EU), Switzerland maintains close economic ties with Europe, evidenced by a treaty of association with it (Wildblood, 1990: 109). This illustrates Switzerland's ambition to forge its path in progress and development,

which is also reflected in its scientific policies. Moreover, what sets Switzerland apart from other European nations is its social order, which is not defined by ethnic or linguistic lines but by the logic of historical discourse (Wimmer, 2011: 727). Switzerland combines patriotic movements with the construction of its cultural identity.

Additionally, Switzerland has cultivated a unique relationship with China, distinct from the typical EU-China dynamics. The long historical connections between Switzerland and China have been solidified through consistent bilateral relations since 1950. A significant milestone was reached on February 24, 1989, when the Swiss Federal Council and the Chinese government signed '*a bilateral agreement on technical and scientific cooperation*' 《中瑞科技合作协定》 (Embassy of the People's Republic of China in Switzerland, 2020; State Secretariat for Education and Research, 2008). This agreement marked a crucial development in S&T collaboration, building on the foundations of their initial diplomatic relations established in 1950. As strategic and economic partners, the two countries are keen to enhance their collaborative efforts in S&T, though the specific knowledge patterns of their research collaboration remain less explored.

Despite global uncertainties, the trend of international scientific collaboration, particularly in publications, has persisted, even amid the COVID-19 pandemic (Lee and Haupt, 2021). However, the geopolitical tensions highlighted earlier have deepened these uncertainties, especially as reflected in the shift of U.S. policy from 'decoupling' to 'small yard, high fence', which targets scientific collaboration strategies with China (Du and Walsh, 2021). Amidst these diplomatic tensions between China and the U.S., China has proactively sought to establish scientific collaborations with scientifically advanced nations that maintain neutral political stances (Freeman and Huang, 2015). Consequently, Switzerland represents a vital strategic partner for China, not only because of their long-standing historical connections but also as a crucial gateway and anchor in maintaining collaborative relationships with European countries.

Therefore, analyzing the bilateral collaborative relationships between China and Switzerland can provide new insights into the underexplored patterns of



collaborative scientific knowledge. Additionally, such analysis can reveal how smaller, non-EU European nations manage and sustain productive relationships with major global players in the scientific community.

## **Conceptual framework**

### ***The unequal distribution of scientific knowledge***

International collaboration, as a complex socio-productive activity that transcends borders, tightly intertwines its produced knowledge with social life. The generation of scientific knowledge within this context is a complex activity involving numerous facets. Jasanoff stated in *States of knowledge (2004): The co-production of science and social order* that

‘Scientific knowledge, in particular, is not a transcendent mirror of reality. It both embeds and is embedded in social practices, identities, norms, conventions, discourses, instruments and institutions – in short, in all the building blocks of what we term the social. The same can be said even more forcefully of technology.’  
(p.3)

Additionally, Wallerstein's World Systems Theory categorizes the global economic structure into a stratified hierarchy of nation types: core, semi-periphery, and periphery. This stratification is known to perpetuate inequality, with the concentration of wealth occurring predominantly in core nations (Wallerstein, 1974,1980,1989) . Notwithstanding the fact that the disparity he delineates is based on economic rather than scientific parameters, his theory continues to provide meaningful insight and relevance in elucidating the relationships between various actors within the context of scientific collaboration. Numerous empirical studies pertaining to international scientific collaboration have drawn upon this theoretical framework as a reference (e.g., Schubert and Sooryamoorthy, 2010; Gui, Liu and Du, 2019) .

Intrinsic to the World Systems Theory is a discourse centering on the Anglo-American academic dominance (Jöns and Hoyler, 2013; Berg,2004; Harding, 2011), which incorporates geographical location and uneven distribution of

scientific information into the discussion regarding science knowledge production (Livingstone, 2003: 12) . Considering international collaboration, the collaboration between China and Switzerland can be conceptualized as an alliance between a developing nation and a developed nation, an emergent scientific powerhouse and a long-established knowledge epicenter. In this imbalanced world system, certain knowledge domains have been disregarded or are yet to become integral to the mainstream dialogue, particularly in the context of collaboration.

### ***Power in science and marginalised knowledge***

All above mentioned underlying concepts reflect the power dynamics inherent in scientific knowledge, which is socially constructed. As global science mirrors the world's core and periphery structure, with core countries dominating knowledge exchanges and setting academic standards. These countries shape research priorities and draw talented scientists from less central regions (Olechnicka, Ploszaj, and Celinska-Janowicz 2019:102). The production of knowledge, its formats, and its recognition to some extent, could possibly mirror these power relations, particularly in the context of international collaboration as manifested through co-authorship patterns.

In academic discourse, marginality is often linked to a lack of scientific opportunities, which can manifest as limited access to funding, diminished reputation, or fewer networking opportunities (Schubert and Sooryamoorthy, 2010). Internationally published work often serves as a global knowledge pool utilized by local researchers. However, this utilization may sometimes reflect a strategic alignment where researchers conform to global knowledge trends at the expense of incorporating 'indigenous knowledge' (Horta and Shen, 2020). Given this, marginality can also be present in internationally collaborative research, suggesting that even global efforts are not immune to the challenges of exclusion and oversight.

Therefore, this study aims to further deconstruct power dynamics in science by incorporating local databases. Marginalized knowledge, as housed in databases that utilize local languages, will be analyzed through the lenses of authorship and disciplines. This analysis will be compared with internationally

circulated work to identify distinct patterns across different knowledge pools. The goal is to elucidate a broader understanding of scientific knowledge by integrating insights from domestic sources. This approach seeks to highlight the value and impact of incorporating domestic knowledge into global scientific discussions.

To enhance comprehension and foster interpretative understanding, this research constructs a conceptual framework, as shown in Figure 1. This framework comprises three main components that will be meticulously examined: languages, authorship, and disciplines. The rationale behind selecting these three facets to represent marginalised knowledge in this research is that they are closely aligned with the research question that this study intends to explore.

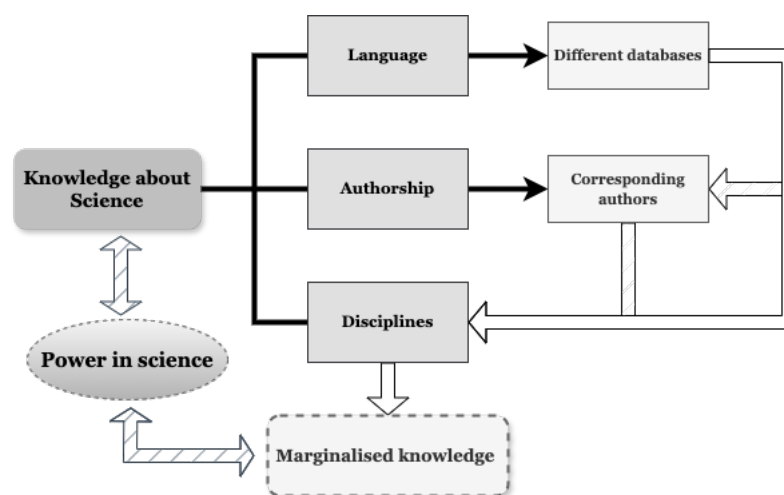


Figure 1 Conceptual framework

## Languages

The role of national languages in scientific knowledge production is critical, as they serve as crucial repositories for indigenous knowledge. However, the prevailing dominance of English in scientific evaluations and knowledge production tends to sideline this indigenous knowledge, potentially augmenting global disparities in the scientific field (Marginson and Xu, 2021). This marginalization of knowledge is made apparent in Xie and Freeman's (2019) study which highlighted that a mere 329 Chinese-language STEM papers were indexed in Scopus, in comparison to the 4,216 noted within the China National Knowledge Infrastructure (CNKI) in 2017. This trend is not confined to Scopus,

with similar patterns observed in other researches (e.g., Shu et al., 2019; Guan and He, 2005; Zhou and Leydesdorff, 2007). Consequently, these studies intimate that database such as the Web of Science may not adequately encapsulate the holistic nature and complexity of Chinese research activities, due to their possibly limited coverage of literature. It's clear that Chinese-language papers and their respective citations are underrepresented, thereby creating a gap in the evaluation of China's contributions to the scientific community.

The literature reveals that policy incentive structures also wield substantial influence over the scientific publication landscape in China (Quan, Chen and Fu, 2017; Xin, Oancea and Rose, 2021) . More specifically, the focus on Chinese-language papers is integrally tied to the nation's research evaluation reforms. In 2020, significant measures were undertaken by the Chinese Ministry of Science and Technology and the Ministry of Education. These included developing a China Science Citation Index (CSCI) and endorsing the publication of funded papers in national journals, thereby accentuating the importance of national dissemination. This policy shift is consequently sparking conversations about the integration of national and global knowledge systems within China (Shu et al., 2019). Nevertheless, further research is imperative to enable effective utilization of both domestic and international databases in Chinese research (Moed, 2002; Ren and Rousseau, 2002) . This ties back to the broader narrative of marginalized knowledge.

## **Authorships**

The unevenness is further evidenced by empirical studies focusing on different nations' roles within the global scientific system. These studies have revealed that 'most international collaborations are asymmetrical, and that the research system remains structured around a few dominant nations'. (Chinchilla-Rodríguez, Sugimoto and Larivière, 2019)

The concept of authorship has undergone significant evolution within academic landscapes, particularly concerning the roles of individual contributors in a collective endeavor. According to the International Committee of Medical Journal Editors (ICJME, 2023), the corresponding author takes on the

responsibility of liaising with the journal and often serves as the primary contact for administrative tasks required by the journal. Moreover, they are also entrusted with upholding ethical obligations in the publication of the work. While the positioning of the corresponding author in the byline of a paper may suggest varying levels of workload and contributions made, the act of designating someone as the corresponding author is generally perceived as an augmentation of that author's contribution to the article (Bhandari et al., 2004).

This evolution is apparent whether we examine the achievements of Nobel laureates, who represent the apex of the scientific pyramid, or conduct a survey of the broader scientific community and the journals in which they publish. Similarly, it holds true whether we are studying the early twentieth century or exploring the most recent scientific activities. The vital role of the author in an article, or their placement in the byline, remains crucial to their scientific contribution (Zuckerman, 1968; Sauermann and Haeussler, 2017). In alignment with this, Grácio et al. (2020) associate the role of corresponding author with scientific leadership, a viewpoint supported by studies analyzing the scientific roles of nations or institutions involved in international collaboration (Chinchilla-Rodríguez et al., 2018).

Similarly, the corresponding author holds significance for scientific productivity, having the potential to generate considerable impact with their contributions (De Moya-Anegón et al., 2013, 2018). Hence, it is reasonable to view the role of the corresponding author as a viable proxy for scientific collaboration, particularly when considering the marginalisation of knowledge, and the paper aims to evaluate their significance and differences at the national level.

## **Disciplines**

Differences in the scope and nature of various disciplines can translate into disparities in their respective roles in knowledge production, specifically within the realm of scientific collaboration. Certain scientific fields, such as astronomy, oceanography, and atmospheric and space science, exhibit a higher propensity for international collaboration in comparison to others (Luukkonen et al., 1992; Trowler, 2001) offers insights into these disciplinary variances, highlighting distinctions in research objectives, behavioural norms, interaction methods,

publishing regulations, and values, all of which can potentially influence the dynamics of scientific collaboration.

Within the sphere of experimental science, chemical engineering has been found to foster a comparatively less open climate – considering factors such as training environments, domain-specific characteristics, gender distribution, scientific norms, and historical collaboration patterns – in contrast to life sciences (Louis et al., 2007). The intrinsically multidisciplinary nature of biotechnology and its need for diverse resources lend it to being a highly collaborative discipline, a trait integral to its development and sustainability (Oliver, 2004). As it pertains to pure science, prior research suggests that informal interactions significantly influence collaborative knowledge production in the field of mathematics (Franceschet and Costantini, 2010; Schott, 1987). Additionally, a pronounced Anglophone centrism can be identified in certain disciplines, such as mathematics and physics with a high frequency of co-authorships (Crane, 1971; Sheil, 2010; Jöns, 2007; Ackers, 2005). In light of the aforementioned, this study utilizes academic disciplines as a means to investigate the potential discrepancies between two databases, thereby exploring the prospect of marginalized knowledge across disciplinary lines.

This paper aims to shed light on the factors determining the dynamics behind two international science powers by answering the main research question: What are the patterns, similarities and differences in disciplinary knowledge pertaining to international collaborations as presented in the science knowledge databases?

Therefore, to analyse the collaborative knowledge, the paper lies in identifying the research collaboration and dynamics of scientific knowledge production between China and Switzerland over the past 20 years (2001-2021) by comparing a domestic Chinese scientific database and an international SCI database. In this paper, research collaboration is analyzed based on the joint publications of researchers affiliated in China and Switzerland. The study contributed to the study of global science by focusing on a particular dyad of relationships: China and Switzerland. This is the first attempt to establish a collaborative scientific relationship between the two countries. Moreover, it

allows for a better understanding of the knowledge patterns and power dynamics within international collaborations by incorporating and researching a Chinese domestic database, which gives a new perspective to international scientific collaborations.

## **Data and Methods**

This study employs bibliometric methods to investigate the disciplinary and corresponding sources of published collaborative papers between China and Switzerland. The research only considers data exclusively pertaining to Sino-Swiss collaboration, thus excluding publications involving multi-collaborative relationships. The data concerning the disciplines of published collaborative research were sourced from both the Web of Science (WoS) and Chinese Weipu/维普(VIP) databases.

In addition, a comparative method is applied, when the data from the two databases are juxtaposed. This comparison allows for the elucidation of differences in knowledge structure, personnel composition, and content, thereby showcasing variations in knowledge systems. The selection of these two databases is premised on their representativeness within the realms of English and Chinese scientific research literature (Shu et al, 2019).

Corresponding and disciplinary information was derived from the classifications of each article within the respective databases. The dataset includes all publication records from 2001 to 2021. For this research, the focus was narrowed to publications that are exclusively categorised in Social Sciences, Arts, and Humanities. It should be noted that some publications were counted more than once in the dataset. The dataset consists of a count of publications by different disciplines, the publication's corresponding author's country of affiliation, and the year of publication.

The nationality of the institution to which the corresponding author belongs is determined in the WoS based on the 'Reprint Addresses'. For articles in the VIP database, this is determined by the 'author information'(作者简介) in the document information or whether there is an asterisk or similar sign after the

author's name. This information is extracted from the original text of the article. In the author's introduction, only those leaving a contact email are classified as corresponding authors; the rest are treated as not having a corresponding author.

However, it's worth noting that for some Chinese articles, where the original manuscript was inaccessible or when there were multiple authors or no designated corresponding author, or when no email or other contact method could be located in the author information section, this data was treated as missing (accounting for 22%). In the case of the Web of Science data, duplicates were manually removed. For data in the VIP database, a single corresponding author was counted at most twice in the statistics, once as a Chinese scholar and once as a scholar from Switzerland or another institution. If an article had more than one corresponding author, it was counted in this manner. In a single instance, a single author was counted at most twice.

Moreover, this article only focuses on bilateral collaborations between China and Switzerland, so articles that included multi-variable relationships were also deleted. It is worth noting that in the Chinese database, this step could only be manually executed. After excluding duplicates, a total of 228 and 4,646 documents were returned in Veipu and WoS respectively. The overlap between the two databases is relatively small (0.04%), indicating significant differences in the coverage of co-authorships between the two databases.

To facilitate a deeper understanding of the differences between the two databases, particularly with respect to disciplines, it is imperative to first establish a unified standard. The following section will provide a detailed explanation of how the data was processed.

### ***Publication disciplinary category***

The WoS database categorizes disciplines into 254 classes, while the research areas classification divides 154 of these classes into five major categories, namely Arts and Humanities, Life Sciences and Biomedicine, Physical Sciences, Social Sciences, and Technology. The Chinese VIP database



employs the Chinese Library Classification (4th edition) (CLC), dividing disciplines into five major categories and 22 fundamental categories.

To facilitate a comparison between the two databases, this study intends to pinpoint the corresponding WoS research areas that align with the 254 disciplines, classified under the CLC categories, in the VIP database. For standardizing the disciplines, this research will also incorporate the Australian and New Zealand Standard Research Classification (ANZSRC, 2020) as an intermediary tool to aid in the classification process. This strategy will support the effective integration of both databases. The meticulous steps for aligning the Chinese discipline types in VIP publications with those in WoS are visually represented in Figure 2.

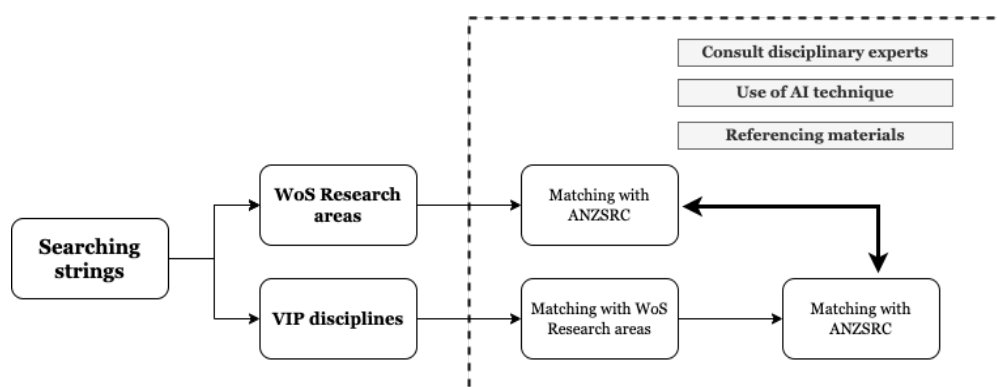


Figure 2 Process of matching scientific disciplines between VIP and WoS databases

## Comparison

Initially, the CLC codes for the disciplines cited in the 259 Chinese articles are collated and associated with their corresponding Chinese discipline names. This is followed by identifying the relevant research categories within WoS. The procedure for matching these research categories begins with an initial alignment based on the definitions and content of the CLC codes for the disciplines. This is further supported by incorporating the ANZSRC classification into the process. Subsequent stages of this alignment are expedited through consultations with experts across a variety of fields such as engineering, mathematics, statistics, medical science, chemistry, and computer

science. Furthermore, AI technology, under the guidance of these subject matter experts, was leveraged to augment the matching process.

Although this process aims to compare the disciplines between the two databases, it is inherently challenging. First, the Web of Science's classification of subject categories warrants further examination. In this study, this choice is made solely for the convenience of data analysis; however, whether disciplines can be accurately classified through this method requires further investigation.

The division of categories into five major research areas is already subject to debate. According to the WoS classifications, 154 research areas are divided into five broad research areas (Arts and Humanities, Life Sciences and Biomedicine, Physical Sciences, Social Sciences, and Technology), while in the research by Shu et al. (2019), the disciplines draw from WoS categories was then divided only into three main domains, namely Arts and Humanities, Natural Science and Social Science. This research follows with WoS five broad research areas classification, while without in-detailed classification illustration, it is hard to classified some of the disciplines to a specific category.

Secondly, regarding the classification of Chinese disciplines, the CLC has released its fifth edition, but VIP uses the classification standards of the fourth edition. Furthermore, although the CLC system provides a detailed and hierarchical classification of disciplinary knowledge and research fields, it is noticeable that this hierarchical classification sometimes results in disciplinary overlap. Therefore, during the matching process, researchers need to occasionally return to the higher-level concepts of the classification system to identify the most suitable corresponding WoS category. Which means there are also disputes related to upper and lower-level concepts related to a same topic. Since WoS does not provide more detailed explanations for its subject classifications, understanding the terms may lead to cognitive differences. For example, the Chinese category R373.2 ‘肠道病毒与肝炎病毒’ can correspond to both ‘Virology’ and ‘Gastroenterology and Hepatology’, but the latter is a lower-level concept of the former. When classifying, the upper-level concept is primarily chosen as the main corresponding standard.

Furthermore, the experts consulted in this study are all doctoral or post-doctoral research fellows in STEM disciplines with disciplinary education backgrounds in both Chinese and English. Their expertise is emphasized to demonstrate their in-depth understanding of the disciplinary knowledge and culture in both Eastern and Western academic contexts. However, during the classification process, it becomes evident that they sometimes cannot find a perfect match between the two disciplinary systems. That is, the CLC code for a specific field may not have a corresponding WoS English name. This discrepancy is not due to language differences, but rather to the distinct underlying logic in the classification of disciplinary knowledge.

### **Robustness check**

The process of conducting bibliometric analysis, despite the manifold challenges that arise during classifications, follows four rigorously executed steps, which can be summarized as below:

1. The search process: The composition of the search terms was inclusive of all potential literature pertaining to the research content. The search terms were vetted by peers familiar with both Chinese and English research contexts, thus ensuring comprehensive coverage of the literature without omission.
2. The classification process: A uniform standard was established. This was reflected in two ways. First, all the articles downloaded from the Chinese and English databases were categorized and organized for analysis. Second, the discipline classifications in the two databases were sorted and summarized according to a standardized system.
3. Translation process: As the Chinese and English databases involved language translation, this study consulted experts from various disciplines during the translation of the search terms and the comparison of Chinese and English disciplines, thereby ensuring the rigor of the process.
4. Verification process: This study employed several tests, such as examining CERN-related publications in the Chinese database and

comparing physics discipline searches in both databases. This cross-validation ensured the rigor of the research findings and highlighted the uniqueness of the data presented in the Chinese database.

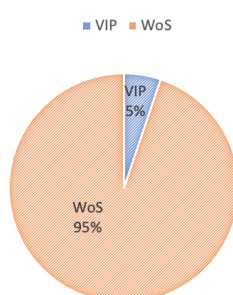
The above mentioned four steps not only lay the groundwork for the findings of this research but also ensure the rigor and reliability of the results. Following, the research findings will be presented.

## Findings

### *Discrepancies in publication volume*

Considering total publication volume, both databases have been scrutinized using identical search strategies, with the aim to aggregate Sino-Swiss collaborative research outputs within the same timeframe. Despite this uniform approach, a marked discrepancy is discernible in the quantity of content within the two databases, echoing findings of Shu et al.(2019)'s research. Moreover, this study's particular emphasis on STEM articles, which represent a relatively smaller fraction of the research, further highlights this discrepancy.

This study specifically targets publications stemming from Sino-Swiss collaboration, which notably yield fewer results in Chinese, as illustrated in Figure 3. This relative scarcity suggests a predominance of English-language journals as the main venues for publishing Sino-Swiss collaborative research, thereby implying a preference for English as the predominant language for scholarly communication and publication.



*Figure 3 Number of co-authored publications*

The following figure 4 illustrates the trend of Sino-Swiss collaborative publications from 2001 to 2021 in the two databases, and in the consolidated database combining both. The right and left vertical axes in this figure apply different statistical criteria for the total quantity due to the significant disparity in the data volume between the VIP and WoS databases.

The annual publication volume timeline demonstrates that the majority of publications are from the WoS database. Moreover, between 2001 and 2021, the overall trend of international collaborative publications between China and Switzerland has shown an upward trajectory. This upward trend becomes particularly pronounced after 2017.

As for the VIP database, its publication volume shows fluctuations over time. However, since the total number of articles is relatively small, these fluctuations appear more significant than they are. Consequently, numerous random factors are at play, and this study will not conduct a more detailed analysis.

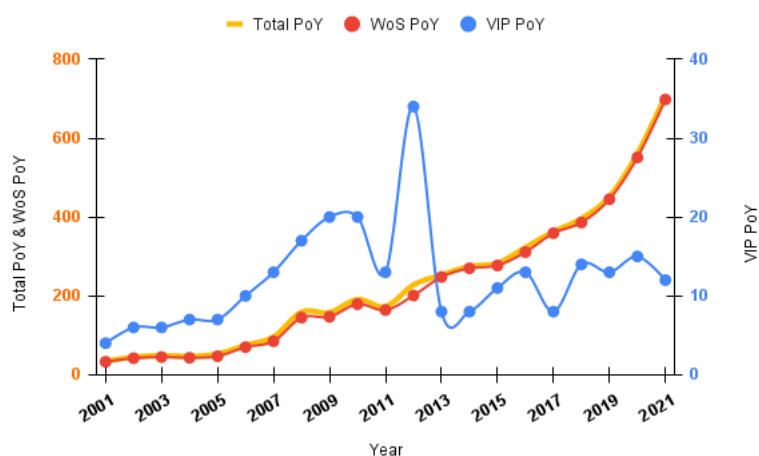


Figure 4 Comparison between publication of the year

Broadly speaking, the number of published articles did not show a significant fluctuation from 2001 to 2005. Nevertheless, post-2005, there was a marked surge in publication volume. This pattern mirrors the stages of international research collaboration delineated by Chen et al. (2019), moving from a 'fermentation phase' to a 'take-off phase' after 2005. It's worth noting, however, that their analysis is based on the Web of Science's Social Sciences Citation

Index (SSCI), whereas this study differs in its use of the Science Citation Index (SCI).

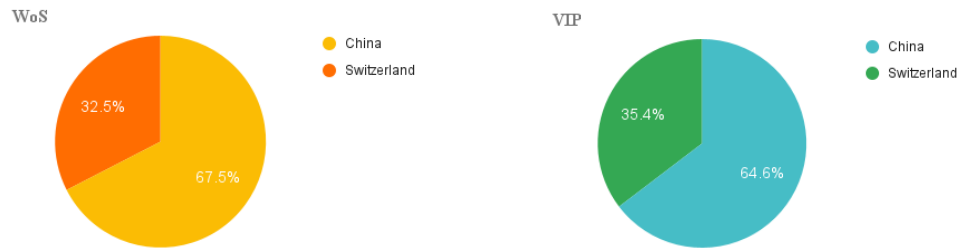
***Deciphering leadership in co-authorships: the role of corresponding authors***

Firstly, the data analysis reveals a consistent trend across two vastly different databases (shown in Table 1 and Figure 5). Even with the considerable variation in their overall data volumes, both databases show that Chinese researchers dominate the position of the corresponding author when the data is considered in relative terms. The similar ratios observed in both Chinese and English databases attest to China's substantial role in spearheading the Sino-Swiss research collaborations. This observation implies that the Chinese research community is proactive and leading in both initiating collaborations with Swiss counterparts and in steering the subsequent publication of the joint research findings.

The proportion of Chinese corresponding authors significantly outnumbers their Swiss counterparts suggests a possible directions in these collaborations, indicating that they are predominantly initiated by Chinese researchers. Such directionality is not uncommon in international research collaborations and can be influenced by numerous factors including, but not limited to, funding availability, research infrastructure, academic networks, and global standing of the research communities.

*Table 1 Corresponding author country of affiliation*

Attributes	Databases			
	WoS		VIP	
Author country of affiliation	China	Switzerland	China	Switzerland
Publications	3661	1766	128	70
%	67.5%	32.5%	64.6%	35.4%



*Figure 5 WoS and VIP corresponding author country distribution*

The concept of reciprocity, often discussed in studies of relational dynamics, underscores that such collaborations have a clear directionality. In the case of Sino-Swiss research collaborations, the data seems to suggest a trend where collaborations are mainly initiated and driven by China. This provides an important perspective on the nature of these collaborations, suggesting a certain inclination or strategic alignment in China's approach to international collaborations, particularly with Switzerland. This observation warrants further investigation to fully understand the underlying factors driving this trend.

Building upon this, a more in-depth examination is needed, especially focusing on the disciplines in which the two countries collaborated in co-authorships. Specifically, are there any discrepancies in disciplines between the two different databases? Can these differences further elucidate the unique aspects of the collaborative endeavors between China and Switzerland?

### ***Discrepancies in discipline representation***

By conducting a comparative analysis of these two databases, some interesting results can be observed (shown in Figure 6 and 7). Firstly, integrating the two databases appears to be a viable approach. The top three disciplines (Engineering, Chemical Sciences, Biomedical and Clinical Sciences) do not display significant disparities, suggesting that these areas are primary domains of knowledge production for international collaboration, regardless of whether this production occurs domestically or internationally.

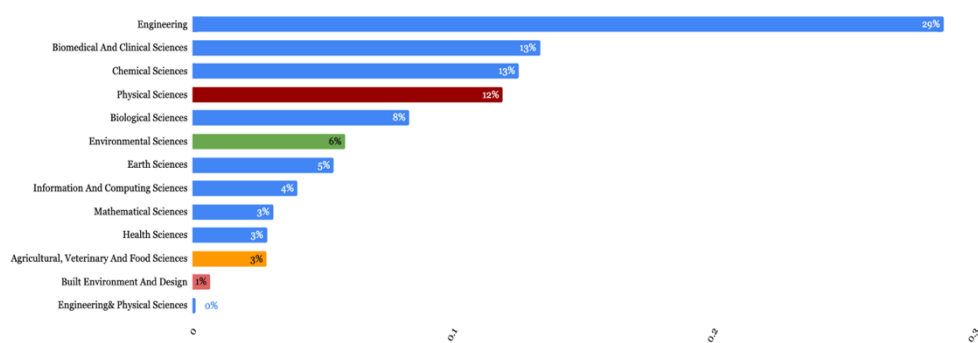


Figure 7 % of VIP STEM Disciplines

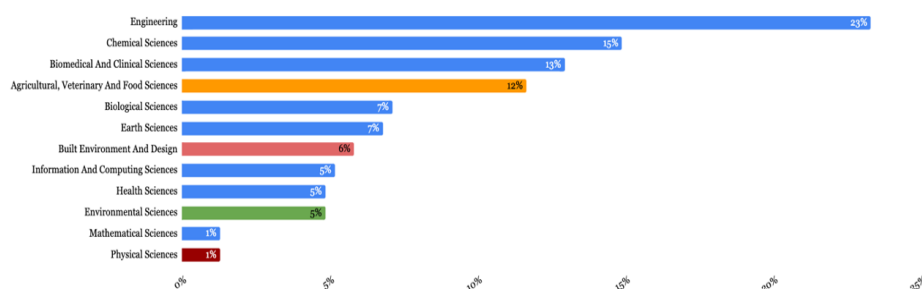


Figure 7 % of WOS STEM Disciplines

However, collaborations in specific fields such as Agricultural, Veterinary and Food Sciences, and Built Environment and Design, tend to be published more in Chinese database, thereby garnering greater recognition. Intriguingly, domestic journals serve as principal platforms for disseminating research, even for papers resulting from international collaborations. In contrast, disciplines such as Physical Science and Environmental Sciences tend to have a higher number of publications in international databases. The marked disparity in the representation of these fields between the two databases highlights a notable academic anomaly. This observation has prompted further investigation into the underlying factors responsible for these discrepancies.

One way to validate this phenomenon is by examining the discipline data in the VIP database for the period 2010-2021 and discerning if physics displays notable discipline deviations. For the purpose of this study, the research randomly chose the year 2020 for retrieval in both databases. Subsequently,



undertook a statistical evaluation of the WoS research areas and VIP discipline data.

The data analysis revealed that physics ranked significantly lower in the VIP database than in the WoS, where it was among the top four. This preliminary observation warrants a more detailed, discipline-specific analysis. Nonetheless, this initial finding supports the assertion that physics publications are comparatively less prevalent in Chinese databases and markedly rare in the context of Sino-Swiss collaborative research. Consider the case of CERN, a large-scale international cooperative project and an integral entity in China-Switzerland collaboration. This study found that among all collaborative publications, only one paper was co-authored with CERN. This discovery reinforces the peripheral role of Chinese databases in the international dissemination of physics research.

## **Limitation**

Admittedly, there are some limitations within this research that need to be addressed. When discussing the issue of marginalised knowledge within the Chinese databases due to the dominance of English in global science presents a significant challenge. This is because much of the marginalized Chinese scientific knowledge is not produced through international collaborations. Consequently, such marginalization may not be readily apparent within a dataset comprised solely of collaborative papers. To effectively explore this aspect within the data, a precise approach to identifying signs of marginalization is necessary. Thus, it is important to acknowledge that this dataset might not encompass all the dimensions of power dynamics at play. Also, the dataset of internationally collaborated papers in the Chinese database is limited in scope and smaller in scale compared to the comprehensive WoS database, highlighting a deficiency in the data itself. This limitation could restrict the intriguing potential of the findings. Future research could enhance the interest and validity of the results by either extending the timeframe of the study or by including a broader range of countries in the comparison.

## Discussion and conclusion

In conclusion, this research offers a pragmatic approach in comparing the two databases, WoS and VIP, and captures a comparative view of knowledge generated from international collaboration. WoS provides valuable insights from a global perspective, while the inclusion of the VIP database enriches the landscape with diverse local knowledge. Comparing these two databases showcases a wide spectrum of academic publications and knowledge communities, thereby fostering a more inclusive understanding of collaborative scholarly efforts.

In the context of Sino-Swiss scientific collaborations, this study explores the international collaborated knowledge and power in knowledge across three dimensions. The first dimension relates to the divergence in the number of co-authored papers indexed across the two databases. Secondly, a significant variation is evident in terms of the nation leading Sino-Swiss co-authorship. China emerges as the predominant contributor, represented by the corresponding author, in collaborative endeavors with Switzerland. This finding highlights the disparities in participation and recognition at the national level. Lastly, evidence of marginalized knowledge is manifested within the disciplinary field, suggesting the presence of certain disciplinary biases.

It was found that the volume of data in the VIP database is considerably smaller compared to the WoS database. Such disparity could stem from the prestige linked to academic publishing, often viewed as a means of accruing 'recognition' (Merton, 1973: 419-438). In the field of STEM, English-language journals typically hold higher prestige and grant broader access to an international audience (Ramírez-Castañeda, 2020). This dominance exemplifies a facet of marginalized knowledge, where content from non-English journals may fail to receive the recognition it deserves. This facet aligns with the observations showing a striking difference in the volume of physics-related publications across Chinese and English databases, revealing a discrepancy in knowledge preferences between the repositories. The scarcity of physics papers in Chinese databases may indicate a reduced inclination among scientists to publish in these outlets. This scenario suggests a prevalent

Anglophone centrism in certain disciplines. Physics, in particular, has been described as the epicentre of international scientific research collaboration networks, exhibiting a high rate of co-authorships (Crane, 1971). Unlike their peers in philosophy and history, physicists and chemists exhibit 'less place-specific motivation' (Jöns, 2007), reinforcing Ackers' (2005, p. 102) concept of 'high convertibility' of knowledge. This trend might be due to the discipline of physics heavily relying on team collaboration (Thagard, 1997), thereby fostering a unique disciplinary culture. This culture could influence international publications to the extent that scholarly dialogues are more prevalent in Western-oriented databases compared to their Chinese counterparts.

Although the international scientific collaboration dataset in the VIP database is limited, it remains crucial to understand the actors and trends within China's domestic scientific fields. While codified scientific knowledge in published papers is often associated with international publications in English (Marginson, 2022), gaining insight into the research published in Chinese is essential for comprehending the landscape of international collaborations within the Chinese academic context. A comprehensive analysis of these publications can reveal unique features, challenges, and opportunities inherent in collaborative research in China. Such an examination would enrich the broader discourse on how international collaborations are influenced by regional and cultural factors.

In the research analysis of Chinese S&T publications from the early 21st century, Jin et al. (2002) posited that a distinct language preference existed, with the majority of Chinese scholars opting to publish their S&T papers in Chinese journals, and only a minority in international journals. However, this study's findings suggest that this trend has since reversed, with the majority of S&T papers now being published in English within internationalized journals, indicating a rapid advancement in Chinese academic development over the past twenty years. The temporal trend of international collaboration between China and Switzerland also aligns with previous research pertaining to Sino-European collaboration in the field of nano science. As delineated by Chen et al., (2013), the collaboration between China and Nordic countries in the realm of nano science was relatively sparse from 1980s to 1995. However, with the progressive amplification of 'geopolitical relationships' and 'trade linkages', the

collaborative ties between China and other European nations have gradually intensified.

Following the discussions, several areas for future studies can be identified. Firstly, future studies could build on these findings by integrating both datasets, providing a more comprehensive view of the collaborative dynamics of knowledge. Also, incorporating case studies from additional countries could provide valuable insights into differences across academic disciplines within the context of international collaboration. To enhance the existing research, conducting interviews with scientists from the disciplines identified in the databases would be enlightening. Moreover, exploring discipline-specific case studies can offer significant insights and deepen the understanding of particular fields. The structure of knowledge varies not only across disciplines but also within them (Horta and Shen, 2020). This variability extends to the methods of producing collaborative knowledge and the attitudes and actions of researchers within these fields. By focusing on specific disciplines or comparing across different disciplines, future case studies could reveal a wealth of nuanced information about how collaboration shapes and is shaped by the disciplinary context.

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