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INTERNATIONAL JOURNAL OF
CHINESE EDUCATION 9 (2020) 219–242

INTERNATIONAL JOURNAL OF CHINESE EDUCATION

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Studying Abroad, Social Capital, and Sino-Swiss Scientific Research Collaboration: A Study of Chinese Scholars Studying in Switzerland

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Abstract

This study explores the relationship between studying abroad, social capital, and Sino-Swiss scientific research cooperation. Evidence from in-depth interviews involving 16 Chinese doctoral students, postdoctoral researchers, and visiting doctoral students in Switzerland informs the findings and conclusions drawn from this study. Social capital plays a vital role in the establishment of scientific research relations between China and Switzerland, especially in the initial stages of cooperation. Specifically, Chinese scholars use strong and weak ties to obtain information about studying in Switzerland. Findings show that in the initial stage of cooperative relationship establishment, structural holes play an essential role, and the relationship between trust and international research collaboration is differentiated between three types of academic mobility. Under the trend of antiglobalization, international scientific research cooperation is facing new challenges. How to build a trust relationship to maintain effective international cooperation deserves further research.

Keywords

Switzerland – studying abroad – scientific collaboration – social capital – trust

1 Introduction

With global economic integration, international scientific research cooperation has become one of the main features of internationalization. Since the reform and opening up in 1978, with the national/global synergy strategy (Marginson, 2018), China has gradually integrated into the world scientific research system and become one of the important players in international scientific research cooperation. The total number of internationally coauthored papers in China saw an upward trend from 2000 to 2018, increasing from 7,038 to 97,400 and accounting for 27% of the Science Citation Index (SCI) publications worldwide (Research Group on Statistics and Analysis of Chinese Scientific Papers, 2000–2018). At the same time, R&D expenditure in China, as a proportion of the GDP, rose by 2.19% (China Statistics Press, 2018). Total expenditure increased to 444,755 million US dollars (OECD, 2018), ranking China second in the world after the United States (UNESCO Institute for Statistics, 2019). China's main scientific research partners are the United States and the United Kingdom (US National Science Board, 2018). Moreover, the country has an unwavering belief that strong connections can be made with the outside world through scientific development (Wu, 2019). In addition, cooperation with the international community through the circulation of top talents and exchange of ideas can explain the rise of China (Freeman and Huang, 2015a).

International scientific research cooperation has attracted the attention of scholars in science and technology policy, higher education research, sociology of science, and bibliometrics. However, the existing research has gaps. First, with rare exceptions (e.g., Ynalvez and Shrum, 2009; Murakami, 2014; Jiang and Shen, 2019), most studies on international scientific research cooperation emphasize the perspective of science and technology policy without paying adequate attention to the education system and educational mobility. Second, when explaining the relationship between academic mobility and international scientific research cooperation, most studies either highlight the role of scientific internationalism (Shen, 2018) or the differences in scientific research training systems (mentor guidance styles and modes of study) to explain whether international cooperation can be maintained (Ynalvez and Shrum, 2009). According to Ynalvez and Shrum (2009), when Filipino scholars return to their home country after completing their postgraduate training in the United States, Australia, or Japan, they are more likely to cooperate with Japanese scholars owing to more frequent interactions with Japanese supervisors than with American or Australian supervisors during their graduate studies. These differences are caused by the scientific research and training

systems. However, this framework cannot explain the differences in international cooperation among scholars trained in the same higher education system. Therefore, a comprehensive theoretical perspective is necessary to explain the differences in international scientific research cooperation in specific higher education systems. Third, previous research focuses on cooperation between China and the United States, Britain, Germany, Australia, and other major Western countries but neglects cooperation between China and countries with small populations.

Notably, cooperation with small countries may be less affected by international competition factors (Schøtt, 1987), and in recent years, China attached considerable importance to scientific research links with small European countries. However, very little is known about the pattern of scientific research cooperation between China and those small countries. Moreover, significant differences could exist in the cooperation models between China and small countries. Compared with China's 9.6 million km2 land area and nearly 1.3 billion people, Switzerland has only approximately 8.6 million people inhabiting less than 50,000 km2 of land (World Meters, 2019). Although Switzerland has a small population, it is a leader in innovation in Europe and one of the most innovative countries in the world. According to *Nature* (2012), Swiss scientists' degree of internationalization is exceptionally high. The proportion of foreign scientists in Switzerland is 57%, among which the proportion of young postdoctoral fellows and professors is 74% and 52% (Nature, 2012), respectively, thereby ranking the nation first in the world (Noorden and Richard, 2012). As the world's leading country in the field of natural sciences, Switzerland has unique features in its knowledge production. Moreover, Switzerland's neutral political status and diplomatic strategies with numerous international organizations define its unique geopolitical existence. Research on this cooperation could potentially integrate significant parts of the world regarding their views on international higher education.

Existing research generally focuses on a specific type of academic mobility, such as that of international doctoral students (Ynalvez and Shrum 2009), visiting doctoral students (Shen, 2018), postdoctoral researchers (Melin, 2004), and visiting faculty members (Patrício et al., 2018). However, little is known about the possible differences in social capital among scholars involved in different types of academic mobility. Doctoral students, postdoctoral researchers, and visiting doctoral students are the three most common types of Chinese mobility students abroad. By comparing and analyzing the three selected types of researchers and how they build trust with Switzerland, we can gain an in-depth understanding of scientific research interaction between large and small countries in the context of higher education, which can also contribute to

policymaking. Considering the aforementioned gaps, we interview 16 Chinese scholars studying in Switzerland for this research. Through the interviews, we analyze how scientific research cooperation between large and small countries is established and maintained, focusing on social capital.

The following section will discuss social capital and its relational and structural characteristics and understand trust in the context of Chinese culture and the impact of trust on scientific research cooperation. Afterwards, we empirically establish the influence of social capital and trust on the process of establishing and maintaining Sino-Swiss international scientific research cooperation.

2 Literature Review

2.1 *Social Capital, Strength of Ties, and Structure of Ties*

Social capital is a topic of debate, with divergent explanations and perspectives, in the field of social science (Lin, 1999). Bourdieu (1986) conceptualized social capital as the aggregate of actual or potential resources in line with the possession of a durable network of institutionalized relationships of mutual acquaintance and recognition. Portes (1995) emphasized the "embeddedness" of individuals in a network or broad social structure to obtain scarce resources. Putnam (2000) applied the concept of social capital to political science. In his view, social capital refers to social organization characteristics, such as trust, norms, and networks, which can increase the efficiency of society by promoting cooperative behavior. Similarly, Coleman (1994) viewed social capital as an individual asset (Lin, 1999) and devoted his attention to its collective nature in emphasizing norms, authority, and trust as forms of social capital.

However, Lin (2005) paid considerable attention to relationship-based social capital and proposed the idea that social capital is individual behaviors embedded in a network. In his view, social capital is a personal item dependent on the initiative of individual agents. In addition, the rich information contained in social capital can reflect an individual's ability and identity, and promoting the flow of information can help people obtain related resources. By summarizing previous theories, Lin (1999) argued that social capital can be viewed from two distinct perspectives, that is, the use of social capital by "individuals" or at the "group level." Thus, embedded resources in social relations and structure constitute social capital (Lin, 2005). The present research focuses mainly on social capital from the perspective of individual-level relationships, that is, social capital from the ties and structure of ties of individuals (Burt, 2000).

However, the strength of individual ties is affected by various factors. The strength of ties refers to the familiarity of parties in a relationship (Moran, 2005). Strong and weak ties are the two leading indicators in the strength measurement of ties. Weak ties are considered useful for obtaining diversified information, whereas strong ties are the opposite, referring to reciprocal relationships with high interaction frequency and strong emotional linkages (Granovetter, 1983). The former promotes the flow of information, whereas the latter embodies the closed structure of social networks. Some studies analyzed the strong and weak ties of social capital from the structural level. Owing to the asymmetric nature of social capital networks, individuals are located differently, specifically, some are at the center, interacting closely with other internal members, whereas others have little or no connections. Individuals located in structural holes have affluent information resources and connect others who are unable to establish contact with one another (Burt, 1995). In addition to structural holes, closed-network features make generating trust for individuals inside easy (Burt, 2000). While weak ties are advantageous for acquiring abundant information (Burt, 1995), strong ties are more valuable in the transmission of complex information, as parties with such ties are more willing to spare time to exchange and explain information (Podolny, 1993). Despite the attributes of strong and weak ties, the strength of ties is affected by different factors, such as the length, depth, and closeness of relationships; degree of reciprocity; privacy; closeness; interactions; and homogeneity between two parties (Alba and Kadushin, 1976; Lin, Ensel and Vaughn, 1981; Marsden and Campbell, 1984; Granovetter, 1995). Chen (2020) concluded that the strength of ties is determined by the history of the ties, interaction frequencies, the natural attributes of the relationship, and the use of the relationship.

Focusing on research on international scientific cooperation among scholars, the current study is mainly in the field of bibliometrics. Compared with short-term interactive activities, such as attending academic conferences or forums, collaborative networks, especially coauthorships, are strong ties (Newman, 2001). Existing studies also revealed a positive correlation between scholars' academic output and cooperation frequency (Pravdić and Oluić-Vuković, 1986). Research on the establishment and development of academic cooperation networks can be summarized from the perspective of ego-network and the overall network (Yang, Guo and Liu, 2015; Chen, 2020). The former takes important scholars as the central node. In addition, it extends the network to scholars they have cooperative relationships with, paying attention to the impact of the network structure on scholars' academic output (Sosa, 2011). The strength of ties and locations have a considerable impact on the accumulation of academic social capital (Cannella and McFadyen, 2016). The latter

involves selecting the cooperative relationship of scholars in a certain field or discipline to build a network to comb the development context or predict the development of a specific discipline (Friedkin, 1980; Granovetter, 1983; Frank and Yasumoto, 1998; Watts and Strogatz, 1998; Watts, 1999; Newman, 2001; Moody and White, 2003). However, the present research focuses on the characteristics of the individual network structure. Yang et al. (2015) used Chinese "Thousand Talents Plan" returnees as their main research object to build an individual network and discussed the process of social capital transfer through a network structure similar to structural hole theory proposed by Burt (2004). In Yang et al. (2015)'s research, bridges connect academic circles in different countries, disciplines, or circles formed by different star scholars. Moreover, he pointed out that "bridges" exist extensively in the initial network establishment and play a role in collecting information and building connections (Yang et al., 2015).

2.2 *Trust and Social Capital in the Chinese Context*

Trust is an essential component of social capital (Worms, 2002). Associability, trust, and attention are the three most essential factors for measuring social capital (Offe and Fuchs, 2002) and prerequisites for the generation of social capital (Fuller, 2014). Therefore, trust is at the core of cooperation promotion among members in terms of shared values. Hence, analysis of social capital is inseparable from the concept of trust. However, what is the definition of trust, and how is trust established and maintained in international scientific cooperation?

The establishment and maintenance of cooperative relations cannot be separated from the establishment of trust, and this process is generally fraught with uncertainties. In previous studies, the construction of trust categories is based mostly on the paradigm of a dichotomous construct. Applying the concept of strength of ties (strong and weak ties) to reexamine interaction-based trust, we found a correlation between them. Strong ties are the primary sources of interaction-based trust owing to high-frequency interactions, long-term acquaintances, intimate conversations, and emotional reciprocity (Granvetter, 1973; Marsden and Campbell, 1984). Intimacy and emotions are established from strong ties, which increase people's likelihood of expressing kindness toward one another, interacting, and increasing trust, thereby indicating that trust behavior is a result of interpersonal relationships. Interaction-based trust is likely in line with particularized trust. Personal assets accumulated through a closed group serving its own interests (Patulny and Svendsen, 2007) reflect a type of trust that occurs among acquaintances, which is formed through a small range of face-to-face communication (Delhey, Newton and Welzel, 2011;

Huhe, 2014). Meanwhile, institution-based trust, which is similar to generalized trust, occurs among strangers and is closely related to one's basic values, such as norms of civility (Newton, 2001; Delhey et al., 2011; Huhe, 2014). The relationship between generalized trust, particularized trust, and social capital is well investigated. Uslaner (2002) concluded that generalized and particularized trust are similar to the "bonding" and "bridging" of social capital, respectively.

Chinese students, as the initiators in Sino-Swiss collaborations, are naturally affected by their culture in building cooperative relationships. Therefore, the discussion of trust should include the Chinese cultural background. Studies on trust in Chinese culture are based mostly on Confucianism (Fukuyama, 1995; Delhey et al., 2011; Liu and Shen, 2020) and have specific manifestations, such as differential patterns, which are a type of trust based on blood and geographical ties (Fei, 1998). Unlike in Western traditions, the closeness of relationships in Confucian culture may cause individuals with kinship or living in the same village to trust one another despite the trust possibly leading to irrational decisions (Pye, 1999; Huhe, 2014). Moreover, some of the characteristics, values, and norms externalized in Confucianism are considered to exert a substantial impact on the establishment of trust relationships, such as respect for teachers, hierarchy acceptance, filial piety, and self-cultivation (Rankin, 1993; Fukuyama, 1995; Pye, 1999; Liu and Shen, 2020). Specifically, the supervisor-student relationship is noteworthy. "Day as a teacher, life for the father" is an old Chinese saying that can partly demonstrate the particularity of strong ties without blood relationships. Therefore, in investigating the establishment of trust, we must pay considerable attention to the supervisor-student relationship in the Chinese context.

Empirical studies on weak and strong ties are abundant. Weak ties are important for acquiring resources beyond individuals' social status and promoting resource-based interactions (Granovetter, 1983; Wegener, 1991; Montgomery, 1992; Bian and Ang, 1997; Lin, 2005). Meanwhile, strong ties play an essential role in the acquisition of resources from specific organizations or cultural contexts (Lin and Dumin, 1986; Bian, 1997; Portes, 1998; Völker and Flap, 1999; Lin, 2000). These studies enhanced our knowledge of social capital and the strength of ties; however, they have significant limitations. The first limitation is the scope of the research. Previous discussions on the relationship between strong and weak ties focused mainly on the job-seeking process, specifically, labor markets with different distribution systems (Bian, 1997; Völker and Flap, 1999). Although doctoral students and postdoctoral researchers studying in Switzerland can be regarded as being at the initial stage of their academic careers, their mobility and behaviors can be understood through transnational

academic mobility and belong to the academic labor market. The academic labor market differs from the general labor market given that the relationship established by transnational scientific research activities is affected by not only individual resources and national distribution systems but also higher education institutions.

In addition to focusing on the relational dimension of social capital, this research incorporates structural dimensions in analyzing the strength of ties, thereby highlighting the role of individuals in structural holes in the acquisition of resources. Combining relational and structural dimensions is helpful in analyzing the process of individuals obtaining social capital in international scientific cooperation. Finally, previous studies on the strength of ties mostly used large-scale questionnaires to present the characteristics of certain classes or countries' relationship networks (Granovetter, 1983; Bian, 1997) but lacked in-depth qualitative research to enhance understanding on the strength of ties and how they are used to establish and maintain international scientific activities. Therefore, in the field of higher education, the influence of social capital and strength of ties on international scientific research cooperation is worthy of further investigation through qualitative methods.

Considering the aforementioned gaps, this research aims to explore the strength and structural characteristics of ties in social capital from the perspective of individuals. This focus leads to the examination of the following research questions. (1) How does trust influence the establishment of international cooperative relations between China and Switzerland through social capital, specifically, the strength and structure of ties? (2) What are the differences between academic mobility types (for doctoral students, visiting doctoral students, and postdocs) in terms of establishing trust? (3) How does trust affect the maintenance and development of Sino-Swiss international cooperation?

3 Data, Method, and Research Design

This study adopted a longitudinal qualitative research method. Data were collected from documents, CVs, and in-depth interviews. A longitudinal qualitative research method was applied to "study the development" of collaboration (Hermanowicz, 2013). In choosing this method, this research aimed to follow the academic life course of scientists to observe changes in their mobility identity. Therefore, interviews were conducted at every identity transformation point (from doctoral students to postdoctoral researchers, from postdoctoral

researchers to assistant researchers, or at the end of a program for visiting doctoral students) to determine whether it influenced the scholars' trust in scientific collaboration.

The first round of interviews was conducted with 16 scholars between October 2018 and June 2019. In March 2020, the second round of interviews was conducted with five scholars who experienced academic career identity transformation. The interviewees were approached in 2018 at the Chinese Association of Science and Technology annual conference based on the recommendations of the previous interviewees. Moreover, the interviewees from the China Scholarship Council (CSC) sponsor list were recruited via email.

The following information was also collected:

1. Interviewees' academic CV and publications on websites and Scopus
2. Interviewees' laboratory background information on their laboratory website

The duration of an interview ranged from 40 minutes to 90 minutes. The interviews were semistructured and conducted in Mandarin, recorded after the interviewees gave their consent, transcribed in Chinese, and analyzed using NVivo12. To protect the interviewees' privacy, pseudonyms were used based on their academic status in Switzerland. In the coding system, D represented a doctoral student, DE represented a visiting doctoral student, and PD denoted a postdoc. The letter F represented female, and M represented male. Table 1 presents the coding method used in this research. First, open coding was used to identify the basic approaches for establishing international scientific cooperation. Next, this process was coded according to the strength and structure of ties. By synthesizing the codes, we observed that trust played a crucial role in the establishment of Sino-Swiss international scientific research cooperation. The coding schema is shown in Figure 1. The cooperative relationship established by the three types of scholars through different channels reflected the characteristics of social capital and level of trust.

4 Findings

4.1 *Social Capital, Trust, and Approaches for Studying in Switzerland*

Switzerland is lesser known compared with the United States, the United Kingdom, and Australia, which are typical destinations for Chinese students studying abroad (UNESCO, 2020). Therefore, information matters most in Chinese students' decision to study in Switzerland. This process can also be regarded as the initial establishment of a cooperative relationship. The 16

TABLE 1 Interviewees' information (first and second round of interviews)

Code	Major	Identity in Switzerland[a]	Current identity[b]	Contact channel	Time of first-round interview	Time of second-round interview
DE-M1	Particle physics	Visiting doctoral student	End of visit, last year of PhD	Conference	Oct 2018	Mar 2020
DE-M2	Materials science	Visiting doctoral student	Doctoral student	Conference	Oct 2018	—
D-F1	Environmental science	Doctoral student	Last year of PhD	Conference	Oct 2018	Mar 2020
D-M3	Electronic engineering	Doctoral student	Doctoral student	Conference	Oct 2018	—
D-M4	Atmospheric chemistry	Doctoral student	Last year of PhD	Conference	Oct 2018	Mar 2020
D-M5	Bioengineering	Doctoral student	Doctoral student	Recommendation	Jun 2019	—
D-M6	Materials science	Doctoral student	Professor	CSC list	Jun 2019	—
D-M7	Geophysics	Doctoral student	Professor	CSC list	Jun 2019	—
D-M8	Geophysics	Doctoral student	Professor	Recommendation	Jun 2019	—
D-M9	Geophysics	Doctoral student	Assistant professor	Recommendation	Jun 2019	—
D-M10	Nuclear materials	Doctoral student	Professor	Conference	Oct 2018	—
PD-M1	Oncology	Postdoctoral researcher	Postdoctoral researcher	Conference	Oct 2018	-
PD-M2	Neurosciences	Postdoctoral researcher	Postdoctoral researcher	Conference	Oct 2018	Mar 2020
PD-F1	Immunology	Postdoctoral researcher	Professor	Conference	Oct 2018	—
PD-M3	Chemical engineering	Postdoctoral researcher	Employee in an enterprise	CSC list	Jun 2019	—
PD-M4	Radiation protection	Postdoctoral researcher	First year of return to China	Conference	Oct 2018	Mar 2020

a Identity when the scholars first studied in Switzerland.
b The statistical deadline was on April 20, 2020.

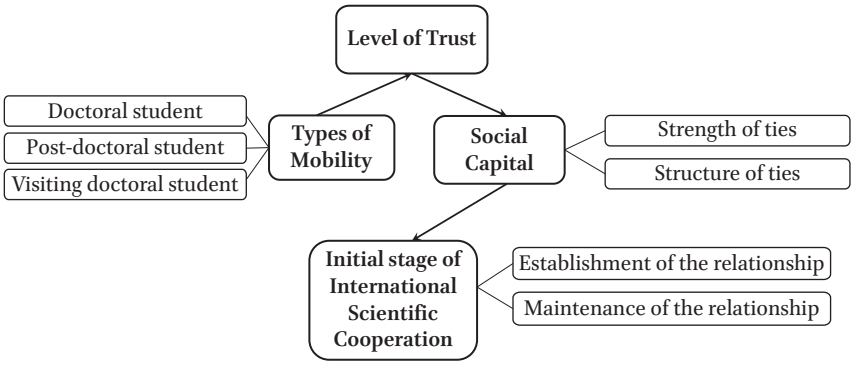

FIGURE 1 Coding schema

interviewees used several approaches for gathering information, including referrals from common friends, supervisors, or fellow students, which is known as "*Shimen*" in Chinese, and connections established through international meetings or historical linkages. These approaches can be categorized according to the structure of ties and distinguished based on the attributes of the cooperating parties, that is, whether the connection is established people to people or organization to organization (Table 2).

TABLE 2 Social capital, trust, and the initial establishment of cooperative relationships

Structure of ties		**Approaches**	**Strength of ties**	**Level of trust**
People—People	Structural hole	Acquaintance	Weak ties	Low
		Supervisor / Fellow students (*Shimen*)	Strong ties	High
	Individuals' direct connections	Writing emails	Weak ties	High / Low
		International conferences	Weak ties	High
Organization—Organization	Closed network	Joint projects	Strong ties	High

4.1.1 People-to-People Connections

In a people-to-people network, the key point is whether the relationship is built through individuals' interactions or through structural holes. Supervisors, fellow students, and acquaintances are the structural holes, as they provide the individuals with information regarding studying in Switzerland.

4.1.1.1 *Structural Holes*

As a result of learning and cooperating in the same laboratory for several years, a supervisor and his/her students have an in-depth understanding of one another's research interests and abilities and thus have a profound relationship of trust. In Confucianism, supervisor-student relations are subject to moral constraints. A supervisor must not only impart knowledge but also have an intimate impact on his/her students' daily lives, especially in disciplines that require teamwork, daily communication, and frequent interactions. In addition, owing to the similarity and relative closeness of circles, particularized trust is high. The above factors can influence students' trust on the information provided by their supervisors and peers, thereby considerably influencing their inclination toward the study destination.

> I know about this university only because of my master's supervisor; otherwise, I would not have known there was such a university. (D-M9)

From D-M9's narrative, we can see that his graduate supervisor was the key in his decision to study in Switzerland, who provided him with information and raised his awareness of another choice. Moreover, his choice of studying in Switzerland reflects the strong ties and high particularized trust between him and his supervisor.

Compared with a network formed through strong ties and high particularized trust, an acquaintance who is the "bridge" providing information to an individual is coincidental and relies on timing.

> When I was a graduate student, there was a young teacher in my office who met her fellow student during a meeting in Europe, and they just happened to talk about one of their classmates who now are visiting ETH. The message was therefore passed on to me when she returned. (D-M8)

In this interview, we learn that D-M8 worked only for a short period of time with the young teacher, and they were not familiar with each other. However, this teacher, as an intermediary, obtained the information coincidentally by

attending a meeting and passed it to D-M8, thereby completing the information loop. As they are connected through weak ties and low particularized trust, D-M8 obtained the information only from this young teacher. Subsequently, he employed direct connections by writing to his prospective supervisor in Switzerland.

4.1.1.2 *Individuals' Direct Connections*

After obtaining information from an intermediary source, regardless of whether it is from strong or weak ties, individuals have to build a direct connection with their potential supervisor in Switzerland independently. Several approaches (e.g., sending emails or attending international conferences) can be used by Chinese students to cultivate an initial cooperative relationship.

Sending emails is the most common approach used by students to directly establish an initial cooperative relationship with an unfamiliar supervisor. The strength of ties between a student and an intermediary will have an impact on their subsequent cooperative relations. D-M9 and D-M8 can be categorized under one scenario, in which the presence of a structural hole can provide students with information and future supervisors with an opportunity to learn about the students, thereby contributing to the initial establishment of trust. Another situation, distinguished by the absence of an intermediary, necessitating students to write letters through various methods to foster connections. DE-M2 states the following:

> Because my university is not a top university in China, and materials science is not a strong field in the university, we don't have much international cooperation … there is no one to make introductions or recommendations … you must contact and find all necessary information online by yourself … I tried to find professors who publish high-quality articles and send them an email on address they have left … the process of finding a supervisor abroad is challenging. (DE-M2)

Owing to resource limitations, DE-M2 had no way to establish contacts with Switzerland except through publicly available information and emails. This "spray and pray" strategy often requires a certain amount of luck, because most of the time, individuals who establish connections with potential supervisors using this technique are often from small and lesser-known laboratories. The social networks that individual scholars tap into may not be able to provide the wide range of international cooperation they expect. In addition, in most cases, scholars will only receive a response by taking the initiative and building extensive contacts.

Attending international conferences and lectures provide excellent opportunities to scholars without an established network to form contacts on the Swiss side. International conferences enable academic communities to exchange ideas and communicate and can provide opportunities to scholars to meet individuals within the same research field and promote themselves in a short period of time.

> This connection is a bit of a coincidence. At that time, when I was about to apply to be his student, he happened to have organized a lecture at our Shanghai Research Institute. I spoke to him during the lecture. Afterwards, he invited me to visit the laboratory for what turned out to be an interview. I performed well, and he agreed to my request. I didn't need to contact other schools, I decided to come here directly. (PD-M4)

PD-M4's narrative shows that there is no substitute for face-to-face communication, as it allows for many subtle emotional connections that are difficult to express virtually (Urry, 2002). As a result, outstanding young scholars who demonstrate their research interests, research methods, and research abilities can attract potential supervisors and successfully obtain an offer. Cooperative relationships with prospective supervisors established through international conferences are relationships formed between two unacquainted people. Therefore, the strength of this tie is weak, but trust can be established on a higher level based on the common belief of the academic community.

4.1.2 Organization-to-Organization Connections

The above discussion addresses individual-level relationship establishment, whereas organization-level linkages can also initiate cooperation and facilitate the academic mobility. As Chinese students and their potential supervisors belong to specific organizations (a university, faculty, or association), historical connections between organizations are the focus of this section. Cooperative relations formed through organizations' historical linkages are based mostly on joint training projects, especially when they include visiting scholars. Withstanding the test of time, cooperative relationships are highly institutionalized and based on common values or interests. Meanwhile, trust is based on long-term interactions and common values centered on a cooperative model and institutionalized norms.

In this study, the collaboration between the institutes where DE-M1 originated from and visited began in the 1980s. Over time, the institutes created a well-established system for sending students from China to The European

Organization for Nuclear Research (CERN). Nearly every professor in the Chinese institute experienced studying in Switzerland. This cooperative relationship was formed over the course of years; hence, DE-M1's choice of studying in Switzerland is a decision as expected.

> A group was sent out (to CERN) in the late 70s and early 80s, who later became the mainstay of our institute. Afterwards, the leaders of the institute began to encourage young scholars to cooperate more and spend time abroad. For example, in the early 1990s, my supervisor participated in the L3 experiment (in Switzerland), initiating what became a long-term partnership. (DE-M1)

4.2 *Types of Mobility, Trust, and International Scientific Research Collaboration*

When students arrive in Switzerland, they must maintain their relationship, which is the initial stage of the cooperative relationship establishment. From the process of maintaining their relationship, we can observe the differences between the scholars with different types of mobility. Visiting doctoral students, postdocs, and doctoral students are the three most common types of Chinese scholars studying in Switzerland, which we discuss below.

4.2.1 Visiting Doctoral Students

Unlike doctoral students and postdoctoral researchers, visiting doctoral students stay in Switzerland for a relatively short period of time, generally between 6 and 18 months. Their relationship with their host supervisor is relatively loose at the institutional level and rarely subject to formal contracts. Unlike the relationship between doctoral students and their supervisor, which is funded by the Swiss government or a scientific research institute, visiting doctoral students are funded through different channels. Moreover, they are affiliated with different institutes; therefore, potential conflicts, including the attribution of intellectual property rights and sequence of authorship, may arise between visiting doctoral students and their host supervisor owing to a lack of trust arising partly from the absence of institutionalized contracts.

In this study, DE-M1 and DE-M2 are visiting doctoral students who have been in a Swiss laboratory setting for 18 and 11 months, respectively, but experienced different degrees of difficulty in establishing and maintaining important relationships. Although DE-M2 has been in Switzerland for nearly a year, his coauthors are all from his domestic institute, which partly reflects his low level of participation in the Swiss laboratory.

> Now I am doing this on the Swiss Federal Laboratories for Materials Science and Technology (EMPA) side, although this idea comes from China. The copyright issue is a big problem. My supervisor (domestic) may have better ideas, but EMPA has better equipment and more staff. If they conduct the work here, they will be the first to produce results and publish ahead of us. If they are interested in this idea, they will possess a considerable advantage in reaching it before we do, which will be detrimental to my domestic research institute. In many ways, it is equivalent to a competitive relationship. (DE-M2)

In DE-ME's view, the main obstacle in maintaining the relationship is that his host supervisor belongs to a different institute, which means that potential conflicts could arise in the attribution of intellectual property rights. Moreover, he worries about "preemptive publication behavior" between the two institutes for priority competition. In a highly competitive discipline, without institutionalized contracts or guarantees, trust formed through individual interactions over a short period of time is inadequate.

In contrast to DE-M2, DE-M1, who is majoring in particle physics, is affiliated with a domestic institute that has collaborated with CERN on long-term cooperative joint projects since the 1980s. This arrangement includes a set of default institutionalized norms that cover the selection of visiting scholars, duration of stay, and ways of collaboration. Moreover, among the 26 scholars in his Swiss laboratory, nine are Chinese. Based on the history of the collaboration and the relatively high percentage of Chinese researchers, DE-M1 successfully established trust in the laboratory environment and collaborated effectively in Switzerland, thereby showing that he can participate in the publication of laboratory scientific collaboration papers, with 60% of his papers coauthored with his host supervisor.

> These articles belong to the whole cooperative group. In fact, the actual work related to the individual may not be that much, because the history of our collaboration is so long, everything belongs to the cooperative group. Whether the article is directly related to any one individual is not important. (DE-M1; second round of interviews)

Although DE-M1 published three papers with the Swiss research group, he does not feel that he contributed much to these group papers. He considers the two remaining papers, in which he has a relatively high sequence, as his main achievement. These papers are also written in cooperation with his domestic supervisors. Although he has strong ties with the Swiss side, if we

use publications as the main measure of output of his international scientific cooperation (Newman, 2001), the problem remains that DE-M1 feels that he did not meaningfully participate in the cooperation let alone establish trust with his host supervisor. Trust remained at the organization level, whereas at the individual level, his true cooperative relationship is with his domestic mentor rather than with his Swiss supervisor.

For visiting doctoral students, establishing a close relationship with a Swiss supervisor at the individual level is extremely difficult owing to the short duration of their visit. Other reasons include the informal supervisor-student relationship and the overly closed relationship between institutes in addition to potential conflicts in the ownership of intellectual property rights and competition for the priority of discovery (Merton, 1957). However, the interview with DE-M1 demonstrates that in the presence of a long-term stable cooperative connection between two institutes, a high degree of trust will be established, as it relates to international cooperation.

4.2.2 Doctoral Students and Postdocs

For doctoral students and postdocs, length of stay is a significant advantage in building trust and maintaining cooperative relationships. Moreover, in contrast to visiting doctoral students, doctoral students and postdocs naturally have more formal and clearly-defined supervisor-student relationships. Owing to the increased investment in a formal relationship, the accumulation of social capital also builds strong bonds of trust.

For doctoral students, daily interactions with their supervisor are highly focused on the completion of their doctoral dissertation. Doctoral students are laboratory learners and handle various technical tasks that are not overly challenging under the guidance of postdoctoral fellows and other researchers.

> I live in Zurich, but our research institute is not in Zurich. So, if they (senior students) encounter any emergencies, I will go to maintain the equipment. (P-M4; second round of interviews)

Compared with doctoral students, postdocs' daily communication and interaction with their supervisor are more frequent. The number of postdocs' international publications in collaboration with foreign supervisors is also higher than that of doctoral students. Combined with their daily work, they are more than merely laboratory learners. With this change in identity, they gradually become collaborators. Apart from "publishing papers" (PD-M1), their daily work also combines "supervising doctoral students and researchers" (PD-M2) with their own research projects. Throughout this process, their relationship

with their supervisor changes from the previous supervisor-supervisee relationship to a "more equal" (PD-F1) relationship.

6 Conclusion and Discussion

This study focuses on three types of mobility and explores the links between trust, social capital, and international scientific cooperation. The conclusion indicates that Sino-Swiss international cooperation is affected by different levels of individual trust as well as the strength and structure of ties and amount of accumulated social capital. Regarding the establishment and maintenance of Sino-Swiss international cooperation relationships, trust between doctoral students, postdoctoral researchers, and visiting doctoral students and their supervisor in Switzerland presents different degrees of difficulty, with varying characteristics.

This research confirms the findings of previous studies on potential conflicts that may arise during international scientific research collaboration in terms of intellectual property ownership, sequence of authorship, and scientific discovery priority (Floyd, Schroeder and Finn, 1994; Katz and Martin, 1997; Shen, 2018). When parties do not belong to the same organization, conflicts in knowledge production caused by a lack of trust are likely to occur. Besides, strong ties and a high degree of trust at the organization level may also lead to a lack of trust at the individual level, especially for visiting students, who have relatively less time to establish trust relationships with their Swiss supervisor. The findings of this study illustrate that not all overseas connections can be successfully transformed into international cooperative relationships, with trust as a prerequisite. The same is true at the macro level, which can interrupt cooperation between countries, that is, cooperation among sensitive disciplines, such as national defense or genetic biology.

In terms of differences in the trust relationships of doctoral students and postdocs, existing studies explain that the process from being a doctoral student to a postdoctoral researcher involves identity transformation and socialization (Guo, Zhang and Hong, 2020). From the perspective of the academic community, the growth of researchers involves stages, from apprentices, colleagues, and masters to elite members (Laudel and Glaser, 2008). As their identity changes, their perception of knowledge production and adopted methods to establish and maintain trust relationships also change. This concept explains to a certain extent why doctoral students and postdoctoral researchers are differentiated in specific strategies for maintaining international cooperative

relations. This finding also concurs with life course theory stating that trust will change over time (Wu, 2020).

This study finds that the establishment of a cooperative relationship sometimes requires structural holes, which echoes Wegener (1991). Structural holes are crucial, because Swiss and Chinese universities have historically few connections, with Switzerland not well known to Chinese students. Furthermore, people in structural holes have relatively abundant information. Meanwhile, this type of network has a hierarchical structure. Thus, students are unable to contact people at the top of the hierarchy easily, such as their prospective supervisor, except through structure holes, mainly, their domestic supervisor, who also belongs to the same network but has high prestige and can easily help build connections with potential supervisors (Podolny, 1993).

This study explores the accumulation of social capital through the prism of three types of transnational academic mobility. However, some gaps remain. For example, the discussion of social relations using only strong and weak ties could be viewed as simplifying the problem (Wegener, 1991). Chen (2020) created the new concept of "*zhongduguanxi*" (moderate ties) in exploring Chinese people's preference for social relations formed during the job search process. This moderate tie is a relationship between strong and weak ties and results from gambling between the labor market and redistribution (Chen, 2020). Ethnicity is also an essential factor in cooperation. Freeman and Huang (2015b) revealed that homophily in ethnicity is likely to generate cooperative relations. In this research, D-M10 is a Chinese professor in The Paul Scherrer Institute (PSI) who is highly likely to hire Chinese students in his laboratory, which shows a high level of particularized trust between Chinese supervisors and Chinese students when they are in Switzerland. Therefore, trust and international scientific cooperation within similar ethnicities deserve further exploration, especially for the Chinese. Furthermore, though publications can reflect trust to a certain extent, they cannot fully represent the overall process of international scientific collaboration (Hong and Zhao, 2016). Moreover, different academic identities (doctoral visiting students, doctoral students, and postdoctoral researchers) and career development stages (doctoral students, postdoctoral researchers, lecturers, and professors) are differentiated in terms of perception and international collaboration behavior. These issues deserve further exploration. Finally, we find that the trust established by visiting doctoral students with their host supervisor is fragile and can be affected by conflicts. However, the number of interviewees was small. Additional quantitative research and in-depth interview analyses are needed to enrich our understanding.

Acknowledgements

This research is supported by the Beijing Social Science Fund Project, "Doctoral Students' International Experiences and their Benefits" (18JYC024). We would also like to thank the editor and anonymous reviewers for their insightful feedback.

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