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How do alumni faculty behave in research collaboration? An analysis of Chang Jiang Scholars in China

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ABSTRACT

Recruiting overseas alumni as faculty within their Chinese alma mater has become a common phenomenon in Chinese universities. This paper studies how the alumni linkage, the connection between alumni faculty members and their alma mater, influences the individual collaborative behaviour of returnee scholars. The results show that alumni faculty are inclined to conduct less intra-institutional collaboration than non-alumni faculty, and the impact of alumni linkage on a scholar's propensity towards international collaboration is not significant. Both results are inconsistent with expectations. The importance of local networking and other factors in Chinese research culture may cause returnee scholars to exhibit such unexpected behaviours in collaborative propensities. Another central finding is that alumni faculty members tend to publish in journals with an average greater impact factor than non-alumni faculty. We therefore argue that alumni linkage has played an important role in bringing about the prosocial behaviour of alumni faculty by strengthening their motivation to pursue quality research, and that the strength of a returnee scholar's local academic network also has a great impact on their tendency towards high impact research.

1. Introduction

As the country sending the most students abroad in the world, China has suffered a large outflow of top talent in recent years. Between 1978 and the end of 2012, China sent over 2.64 million students abroad, but only 41.2% of them returned after graduating (Wang and Miao, 2013). In order to reverse this "brain drain", the Chinese government has, since the early 1990s, introduced a series of policies aimed at attracting overseas academics (Zweig and Wang, 2013). The most well-known policy initiatives are the "Distinguished Young Scholars Program" introduced by the National Natural Science Foundation of China in 1994, the "Chang Jiang Scholars Program" co-founded by the Li Ka Shing Foundation and the Chinese Ministry of Education in 1998, and the "100 Talents Program" of the Chinese Academy of Sciences of 1999. More recently, the government has unveiled the country's *National Medium and Long-term Talent Development Plan* (2010–2020). The plan outlines 12 major programmes for recruiting top talent at home and abroad, including the "Recruitment Program of Global Experts" (the 1000 Talent Plan), which has been widely publicised as of late (Xinhua, 2011).

It has been claimed that returnee scholars may have "added value", or accumulate "some kind of transnational capital" during study and employment abroad (Zweig et al., 2004). Furthermore, many studies have shown that overseas experience increases both the "human capital" and "social capital" of returnees (Jonkers and Tijssen, 2008; Woolley et al., 2008). The return of overseas scholars to domestic institutions may benefit such institutions in two main ways. Firstly, the skills and knowledge obtained abroad may help improve the quality and broaden the areas of research at the institutions; secondly, returnees may provide an institution with access to international academic networks and resources (Velema, 2012). Ultimately, returnee scholars will help receiving institutions achieve their goals of research excellence. Considering the potential advantages overseas scholars can bring, most Chinese universities prefer recruiting faculty with overseas experience to those without. Moreover, the number of overseas scholars a university has brought back and the percentage of faculty members holding foreign PhD degrees have become important measures of a university's overall faculty strength and capacity. Overseas talent has become a critical academic resource for Chinese universities seeking to reach world-class standards.

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Great efforts have been made by Chinese universities to attract talent. On the one hand, Chinese universities have had huge financial support from both state and local government in bringing back global talent (Cao, 2008). On the other hand, universities themselves are implementing various institutional policies and strategies in order to obtain and retain overseas talent. Playing the "alumni card" appears to be one of the widely used strategies. Based on our observations, most Chinese universities, especially those in the top tier, have taken great care to maintain relationships with overseas alumni. The connections between overseas alumni and their Chinese alma maters are strengthened through joint research projects, student exchange programmes, and similar initiatives. These motivate alumni to come back and work as full-time faculty at their Chinese alma maters (Cai, 2012). In this paper, alumni faculty refers precisely to those returnee faculty members who work for the Chinese universities from which they received their undergraduate education, and non-alumni faculty refers to other returnee faculty members not working at their Chinese alma maters. Although the recruitment of alumni faculty has become commonplace in Chinese universities, no one has asked what advantages alumni faculty may offer in comparison to non-alumni faculty, and whether they behave differently in terms of teaching and research. This paper tries to answer these questions by exploring the differences in behaviour between alumni faculty and non-alumni faculty in research collaboration.

A variety of studies have addressed the topic of individual-level research collaboration. Katz and Martin (1997) have discussed the basic nature of research collaboration, including the concepts, motivations, measurements, benefits and costs of collaborative activity. Melin (2000) has investigated the unstructured factors that foster research collaboration at the individual level through surveys and interviews. Most recently, Bozeman et al. (2013) have reviewed literature on the attributes of research collaboration, and presented several areas requiring research. They argue that current studies mostly focus on either the individual researchers or collaborating organisations, while ignoring the organisational contexts and individual dynamics that may shape the collaborative behaviour of individual researchers and organisations. In other words, previous studies fail to reveal the impact of relationships between individual researchers and their affiliated organisations on the outcomes of research collaboration (Kislov et al., 2011), while treating individual and organisational collaborations independently. This paper aims to fill this gap by focussing on the collaborative behaviour of Chinese returnee scholars recruited by the "Chang Jiang Scholars Program", the so-called "Chang Jiang Scholars". More specifically, through an analysis of alumni faculty and non-alumni faculty in the group of Chang Jiang Scholars, we try to investigate the impacts of alumni linkage on the returnee scholars' collaborative propensities, and find empirical evidence to support the contention that the connection between researchers and institutions can also influence individual research collaboration.

The remainder of this paper is organised as follows: in Section 2, we review the literature and form several hypotheses; Section 3 provides an overview of the Chang Jiang Scholars Programme and introduces measures and research methods; Section 4 presents our results and findings; the discussion and policy implications are given in Sections 5 and 6 respectively.

2. Literature and hypotheses

2.1. Research collaboration in the Chinese context

According to an annual report released by *the Institute of Scientific and Technical Information of China* (ISTIC), China has achieved a threefold increase in research publication in international peer-reviewed journals over the past 10 years (2002–2012), and roughly one-fourth of the papers published in 2012 covered by the *Science Citation Index* (SCI) feature international collaboration (ISTIC, 2013). As internationally co-authored papers have boomed, the bibliometric characteristics of international research collaboration in China have been heavily studied in recent years by both foreign and native scholars (Fu et al., 2011; Tyfield et al., 2009; Wang et al., 2013; Zheng et al., 2012; Zhou and Glänzel, 2010). Earlier studies have shown five basic principles for understanding international collaboration in the Chinese context. Firstly, the number of internationally co-authored publications has increased tremendously along with total publications, but this increase does not match that of China's total publications in international peer-reviewed journals (Zhou and Glänzel, 2010), which indicates that the publication of local-collaboration papers has increased rapidly (as solo-authored papers have decreased year by year). Secondly, internationally co-authored publications normally outscore other publications in citation impact, which helps raise the overall impact of China's publications in international peer-reviewed journals (Fu et al., 2011; Tyfield et al., 2009; Zhou and Glänzel, 2010). Thirdly, China's major partners in collaboration are the USA, Japan and the European Union (He, 2009; Zhou and Glänzel, 2010). Although collaboration between China and other Asian countries has become more frequent, there is no evidence to suggest that intra-Asian scientific collaboration will change the structure of China's collaborative network (Haustein et al., 2011). Fourthly, differences between disciplines have been found in international collaboration. Biology and medical sciences appear to be more active in international collaboration than physics, chemistry, mathematics and engineering (ISTIC, 2013; Zhou and Glänzel, 2010). Finally, most scholars believe that the rapid development of China's international collaboration is mutually beneficial for both China and its partners (Adams, 2012; Jonkers, 2009).

Compared to the abundant study of international collaboration, literature on Chinese intra-institutional and inter-institutional collaboration is lacking. Although a few scholars like Liang and Zhu (2002) have studied inter-regional research collaboration in China, and Fu et al. (2011) have compared inter-institutional collaboration and international collaboration, these studies have all been descriptive. It is important to fully investigate both international and localised collaboration inside and outside Chinese research institutes in order to get a complete understanding of research collaboration in the Chinese context (Wagner, 2005).

Furthermore, most studies focus on the macro level of research collaboration, such as national or institutional collaboration, while studies of research collaboration between individual Chinese researchers are far from sufficient. In fact, most literature on the topic of individual research collaboration is based on the observations of scholars from western countries (or developed countries), including studies of the motivations for individual researchers' collaborations (Bozeman and Corley, 2004; Fox and Faver, 1984; Melin, 2000), and studies of the factors that influence individual researchers' collaborative behaviours (Bozeman and Gaughan, 2011; Ponomariov and Boardman, 2010; van Rijnsoever and Hessels, 2011). Do researchers from developing countries have similar motivations for research collaboration, and are their behaviours in research collaboration affected by similar factors? These questions still need to be properly answered. A few studies targeted at developing countries have found that research collaboration is not necessarily associated with research productivity, and scholars in developing countries may face structural impediments and institutional barriers when attempting research collaboration (Duque et al., 2005; Toivanen and Ponomariov, 2011; Ynalvez and Shrum, 2011). It is important to consider the different social contexts of the developing world. In China, the impact of unique research cultures (such as the Chinese *guanxi* ethics) on the

outcomes of scientific research and innovation has gained plenty of attention (Cai, 2012; Mok et al., 2009; Shi and Rao, 2010; Yang and Welch, 2010), while their potential impacts on the outcomes of individual research collaboration are still waiting to be assessed.

2.2. Behaviour of emigrants and returnees in research collaboration

It is widely accepted that overseas scholars have played an important role in global knowledge exchange through international mobility and research collaboration. In particular, those who were born in developing countries and received advanced education and training in developed countries are seen as a bridge between developing and developed countries (Yang and Welch, 2010), apparently benefiting both parties (Ponds, 2009).

The collaborative behaviour of overseas scholars is generally discussed in two different ways. Firstly, several studies have investigated the international research collaboration between emigrant scholars and fellow scholars from their country of origin. Baruffaldi and Landoni (2012) have found that collaboration between foreign academics in two European countries (Italy and Portugal) and their country of origin increases the probability of them returning to their home countries and raises scientific productivity in the host countries significantly. A study conducted by Wang et al. (2012) has shown that the majority of Sino-American collaboration in nanotechnology is completed by Chinese–American scientists, and most of their domestic partners are scholars who have returned from the US. Similarly, through co-authorship analysis of Chinese SCI papers in 2010, Wang et al. (2013) found that about 75% of Sino-Singapore collaboration is conducted by Chinese–Singapore scientists, and 65% of Sino-American collaboration is conducted by Chinese–American scientists.

Secondly, other studies have focussed on the behaviour of returnee scholars in international research collaboration, and specifically in collaborations involving their foreign host countries. Jonkers and Tijssen (2008) have analysed Chinese returnee scientists in the field of plant molecular life sciences, and found that the time academics spend in a host country is strongly correlated with their propensity towards collaborations involving this country. Ynalvez and Shrum (2011) report that having training experience in developed countries changes the structure of Filipino scientists' scientific networks, by introducing a higher proportion of foreign collaborators into the network. An analysis of returnee academics in Argentina displays similar results, suggesting that overseas experience increases the propensity to publish internationally co-authored papers, and also to publish in high-impact journals (Jonkers and Cruz-Castro, 2013). Furthermore, Murakami (2014) has studied the collaborative behaviour of Japanese scientists returning from the US, and argues that Japanese scientists are inclined to maintain collaborative networks of Japanese scientists with whom they have previously collaborated and American scientists with whom they frequently collaborated while living in the US.

As shown in the literature mentioned above, after overseas scholars return to their mother county they have a proven "transnational capital", mainly due to international research collaborations. However, not every returnee can be successful and exploit this transnational capital, due to the complex socio-cultural contexts both in the country of origin and the host country. A weak local social network and cultural differences in the country of origin appear to be the main obstacles to efficient localisation of a returnee's transnational capital (Mullings, 2011; Obukhova et al., 2013). Chen (2008) has argued that migrants returning from Silicon Valley fail to maintain meaningful connections with the region after they return to China's prime technology hub, Zhongguancun, because of a lack of local political capital. Ynalvez and Shrum (2011) have claimed that foreign-trained Filipino agricultural scientists do not have a high publication rate due to the internal reward systems of the institutions they work for. In addition to the social, cultural and institutional contexts of the country of origin, Velema (2012) highlights that the nature and quality of the context in host countries where returnees have received their graduate training or work experience also influences their actual contribution to the local scientific community in their country of origin. For example, he finds that returnees coming back from top tier foreign universities have a higher probability of connecting local scientific communities to international scientific networks than those from lower tier universities.

According to Velema (2012), studying the performance of returnee scholars based on their behaviour in international collaboration alone is insufficient. It is important to examine the collaborative behaviour of returnees as a whole, including intra-institutional collaboration and inter-institutional collaboration, in order to get a better understanding of how returnees build local scientific networks and eventually connect them to global networks. This idea requires us to focus on the social, cultural, and institutional contexts of the country of origin, and to try to find some different factors in the Chinese context which may have an impact on the local networking of returnees after they return.

2.3. Alumni linkage and collaborative behaviour

It has been claimed that the strength of the connections between alumni and their alma mater has a significant impact on alumni behaviour. A strong connection encourages alumni to exhibit higher levels of helping behaviour (or prosocial behaviour) towards their alma mater (Heckman and Guskey, 1998). Such helping behaviour may include an alumni's generosity in donations, advising people via verbal communication to attend the alma mater, joining the advisory board, and providing organisational support (Baade and Sundberg, 1996; Leslie and Ramey, 1988; Weerts and Ronca, 2008). As mentioned earlier, some returnee scholars choose to work for their Chinese alma mater after returning to China, which is another way of alumni displaying helping behaviour.

The reasons why the strength of alumni connection is a good predictor of prosocial behaviour are discussed in the studies of Mael and Ashforth (1992) and Heckman and Guskey (1998). Mael and Ashforth (1992) use the theoretical model of organisational identification to examine the impact of alumni linkage on alumni prosocial behaviour, finding that the impact is partially mediated by organisational identification. Their study proves that alumni linkage can be understood as alumni identification with their alma mater. Furthermore, Heckman and Guskey (1998) consider alumni prosocial behaviour to be discretionary collaborative behaviour (DCB), DCB being defined as behaviour performed by alumni in order to help the alma mater outside of formal contractual obligations and without expectation of a direct reward. DCB is similar to organisational citizenship behaviour (OCB), which is commonly referred to in organisational studies (Dutton et al., 1994; O'Reilly and Chatman, 1986). In addition, both studies examine and verify some of the antecedents of alumni prosocial behaviour, including individual and organisational antecedents.

Previous research has demonstrated the relationship between alumni linkage and prosocial behaviour based on organisation theories. Is there a similar relationship between alumni linkage and faculty behaviour in individual research collaboration? Little empirical research has been done on this topic. This paper tries to answer this question by analysing the collaborative propensity of alumni faculty and non-alumni faculty. In accordance with the literature, three hypotheses for the possible relationship between alumni linkage and faculty collaborative propensity are presented, as follows.

Hypothesis 1. Alumni faculty tend to collaborate more frequently with colleagues inside the university (intra-institutional collaboration) than non-alumni faculty.

Several studies have shown that organisational identification has a positive effect on the collaborative behaviour of organisation members (Brown, 2011; Wegge et al., 2006). Strong organisational identification may cause strong intra-group collaboration between members (Dukerich et al., 2002; Kramer, 1993). Compared to non-alumni faculty, alumni faculty identify strongly with the receiving university through alumni linkage; therefore, alumni faculty are inclined to conduct more intra-institutional collaboration than non-alumni faculty.

However, another perspective may tell a totally different story. Research collaboration can be seen as a process which strengthens weak ties in research networks (Eddy, 2010). Given the importance of personal relationships (or *guanxi* in the Chinese context) in career development in China, non-alumni faculty would probably choose to collaborate more frequently with colleagues from the same institution in order to develop academic networks. As for alumni faculty, they have already formed a strong network at their alma mater, where classmates, former fellows from different cohorts and former teachers have all become strong bases for *guanxi* (Tsui and Farh, 1997). Social networking for alumni faculty may not be necessary, or at least not as crucial as it is for non-alumni faculty. Therefore, it would not be surprising to actually see the opposite of H1.

Hypothesis 2. Alumni faculty tend to collaborate more frequently with foreign institutions (international collaboration) than non-alumni faculty.

Hypothesis 3. Alumni faculty tend to produce higher quality research than non-alumni faculty.

H2 and H3 are developed to test the impact of alumni linkage on the returnee scholar's international collaborative propensity and research quality respectively. There are at least two possible reasons why alumni faculty tend to have more international collaborations and produce higher quality research than non-alumni faculty. Firstly, as some scholars argued, a strong alumni–university relationship enhances alumni prosocial behaviour (Heckman and Guskey, 1998; Mael and Ashforth, 1992). One possible reason that alumni faculty return to work at their Chinese alma maters is their willing to offer help (Cai, 2012). Such help may include promoting international collaboration and high quality research by exploiting their transnational capital. Therefore, alumni connection may increase the tendency of alumni faculty to collaborate internationally and produce higher quality research than non-alumni faculty.

Secondly, the weakness of local networks is reported as one of the main obstacles to the efficient localisation of returnees' transnational capital (Mullings, 2011; Obukhova et al., 2013). Alumni faculty usually have better-established networks and easier access to the resources which may allow them to perform better in scientific research than non-alumni faculty. Therefore, alumni faculty may have a better chance in both international collaboration and high quality research than non-alumni faculty.

Besides, H2 itself may provide a strong backing for H3. Since it is widely accepted that international collaboration improves research quality (Jonkers and Cruz-Castro, 2013; Tyfield et al., 2009), the greater tendency of alumni faculty towards international collaboration makes them more likely to produce papers with high citation rates or papers in high-impact journals in comparison with non-alumni faculty.

3. Data and measures

3.1. Overview of the Chang Jiang Scholars Programme

The Chang Jiang Scholars Programme has been active for more than 10 years, and has become a flagship programme for attracting top talent. Between the years 1998 and 2012, Chinese universities recruited a total of 1801 scholars[1] through the Chang Jiang Scholars Programme (Chinanews, 2012). More than 90% of Chang Jiang Scholars have overseas experience, and about 50% are recruited directly from abroad. The recruitment policy has changed twice in the program's history. In 2005, the programme first began to recruit scholars in the humanities and social sciences, and in 2011 the programme expanded its annual recruitment plan for full-time professors, doubled the fund to 200,000 RMB per faculty member per year, and also extended the contract from three years to five years.

According to the *Detailed Rules for the Implementation of the Chang Jiang Scholars Programme* issued by the Chinese Ministry of Education in 1999 (MOE, 1999), overseas scholars need to meet six basic requirements in order to be recruited. These include a maximum age limit (45 years old), highly recognised research achievements, the ability to lead research teams, the ability to develop good academic practices, and so on. The main responsibilities of returnee scholars are: (1) to teach core curriculum; (2) to host national key research projects; (3) to build research teams; (4) to foster academic excellence in specific areas.

Chang Jiang Scholars are undoubtedly a valuable subject for studies of returnee scholars. However, the literature remains largely silent on them. Our targeted group are full-time returnee scholars who have not changed jobs and who were recruited in the first five cohorts of the Chang Jiang Scholars Programme (1998–2004). Scholars recruited after 2004 were not included mainly for two reasons. One is that it is essential to avoid the policy shift of the Programme in 2005 in order to make sure every scholar meets the same selection standards. The other reason is that our aim is to examine the collaborative behaviour of scholars over a long period of time, and we suggest that co-authorship patterns in a short period of time may be unstable and not ideal for the study. A strict three-step selection procedure was developed as shown in Fig. 1. We gathered each scholar's information mainly from their Curriculum Vitaes, personal introductions on host institution websites, and online reports. In the first step, we identified returnee scholars with at least two consecutive years of overseas experience, which included doctoral study, post-doctoral research, or other experience working as researchers, faculty, etc. In the second step, we removed part-time scholars and foreign scholars without a Chinese background. In the last step, we checked the personal backgrounds and author affiliations in publications to find those returnee scholars who had remained at one institution since returning and had not changed jobs. Finally, a total number of 112 scholars remained in our targeted group. The rationale of the complex selection procedure was to reduce unstructured and uncontrollable variables which might disturb research results and make sure that each scholar in the target group was in a similar scenario.

3.2. Data collection and preparation

In most cases, co-authorship data is a good predictor and measure of research collaboration (Melin and Persson, 1996). In this

[1] 1801 Chang Jiang Scholars includes 1190 full-time distinguished professors and 611 part-time visiting professors. If not specified, we refer to Chang Jiang Scholars as full-time distinguished professors in this paper.

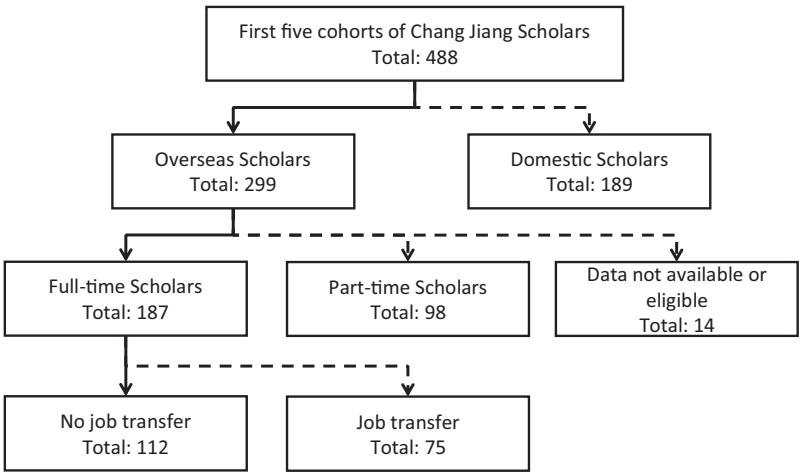

Fig. 1. Three steps of targeted group selection.

paper, we categorise all the publications into four groups in accordance with different types of authorship, as follows.

- Solo-authored papers (non-collaboration).
- Co-authored papers with all the authors based at the Chang Jiang Scholars' institution (intra-institutional collaboration).
- Co-authored papers with at least one author based at a domestic institution other than the Chang Jiang Scholars' institution and with no authors from foreign institutions (domestic collaboration).
- Co-authored papers with at least one author based at a foreign institution (international collaboration).

As with the classification criteria given by Wang et al. (2005), in order to avoid repetitive coding all the papers were coded based on the following priority rule: international collaboration ≻ domestic collaboration ≻ intra-institutional collaboration ≻ non-collaboration ("≻" indicates the coding order). We did not consider combination co-authorship patterns (e.g. co-authored papers with colleagues from a home institution and other scholars from other domestic institutions) because we found that most Chang Jiang Scholars worked as a team rather than as a single person in co-authored papers. In other words, there are usually colleagues or graduate students of Chang Jiang Scholars involved in domestic and international collaboration. Furthermore, Chang Jiang Scholars are all principal investigators who lead a research team or run a research laboratory in their home institutions. The behaviour of Chang Jiang Scholars in research collaboration can be interpreted as the behaviour of their teams in research collaboration. Therefore, it is more appropriate to treat each Chang Jiang Scholar as a team and not as a single scholar when considering co-authorship patterns.

The bibliometric data for selected Chang Jiang Scholars was sourced from Thomson Reuters' Web of Science (WoS). We included articles, reviews, letters, editorials and proceedings papers in our study. One example of the search criteria we used is "AU = HAN ZH AND AD = TSINGHUA UNIV", and possible variations of the institutional addresses were considered. In order to make sure every paper was actually written by returnee scholars rather than other scholars with the same abbreviated names we personally checked each paper. For each scholar, we used the publication data for an 8-year[2] period ranging from the return year (recognised as the year when the first paper affiliated to the receiving university was published) to the end of the eighth year after returning. For example, if a scholar published his or her first paper with the address of the receiving university in 1999, his or her return year was then recognised as 1999, and his or her publications considered in this study ranged from 1999 to 2006. The final dataset had 112 Chang Jiang Scholars with a total number of 5475 publications.

3.3. Measurements

The details of all the variables discussed in this section are listed in Table 1.

3.3.1. Collaborative propensity

The collaborative propensity indicates a scholar's predominant authorship category compared to other authorship categories or the average of all the scholars. It is measured by the authorship category with the largest proportion of papers. For some scholars, who have the same proportion for two or three categories, we further divided the proportion by the average proportion of each category among all the 112 scholars, and found the category with the largest ratio to represent a scholar's collaborative propensity. In this paper, collaborative propensity is computed on an annual basis and then compiled as panel data.

For example, if we know the average percentages of solo-authored, intra-institutionally co-authored, domestically co-authored and internationally co-authored papers among all the 112 scholars for the year 1998 are 10%, 40%, 20% and 30% respectively, and the percentages for each category for *Scholar A* are 20%, 30%, 10% and 50% respectively, we therefore consider that *Scholar A* has a propensity towards international collaboration in the year 1998, as 50% is the largest percentage. By way of further example, if the percentages for each category for *Scholar B* are 5%, 15%, 40% and 40% respectively, and we cannot simply decide the collaborative percentage by the largest percentage, we divide the percentages by the average percentages and get results of 50% (5%/10%), 37.5% (15%/40%), 200% (40%/20%) and 133% (40%/30%) respectively. Based on the results, we consider *Scholar B* to have a propensity towards domestic collaboration, as 200% is the largest new percentage.

3.3.2. Alumni linkage

Alumni linkage describes the connection between returnee scholars and their Chinese alma maters. Alumni faculty who work at the Chinese university where they got their bachelor's degree are said to have an alumni connection.

[2] Covering the publication data for an 8-year period was mainly because that the last scholar in our sample returned in 2005, and we wanted to make sure each scholar could have a full 8 year set of publication.

Table 1
Description of variables in this study.

Variable	Description	Values
Collaborative propensity	Categorised variables describing four types of collaborative propensity of each scholar, including non-collaboration, intra-institutional collaboration, domestic collaboration and international collaboration.	Four mutually exclusive binary variables
Alumni linkage	The value of this variable is 1 if a returnee scholar returns to his or her Chinese alma mater as alumni faculty, and otherwise the value is 0.	Binary variable
Average impact factor	The variable indicates the average 5-year impact factor of journals in which each scholar publishes his or her papers.	Positive number with two decimal places
Year dummies	The value of this variable ranges from 1 to 8, indicating the years after a returnee scholar returns.	Counting numbers
Return year dummy	The value of this variable is 1 if a returnee scholar returns after 1998 (including the year 1998), and otherwise the value is 0.	Binary variable
Field dummies	Categorised variables that describe each scholar's research area. According to OECD's classification, four research areas are included: natural sciences, engineering and technology, medical and health sciences, and others.	Four mutually exclusive binary variables
Institutional location dummy	This variable describes the location of receiving universities. If the receiving university is in Beijing or Shanghai, the value is 1, and otherwise the value is 0.	Binary variable
Institutional status dummy	The value of this variable is 1 if the receiving university is in the C9 League, and otherwise the value is 0.	Binary variable
Foreign PhD dummy	The value of this variable is 1 if the returnee scholar holds a PhD degree granted by a foreign university, and otherwise the value is 0.	Binary variable
Region dummies	Categorised variables that describe the geographic zone where scholars worked or studied before returning. Asia & Pacific, Europe and North America are included.	Three mutually exclusive binary variables
No. of papers	This variable measures the research outputs of returnee scholars in an 8-year period after their return.	Counting numbers

3.3.3. Research quality

Although the use of citation counts as measures of research quality has provoked various debates, citation-related indicators are still the most widely used tools in research evaluation (Leydesdorff, 2008). We use *the average impact factor of journals* to measure the research quality of returnee scholars.

It has been claimed that the average impact factor of journals is problematic in evaluating the performance of individual scientists (Adam, 2002; Amin and Mabe, 2000). However, within the culture of Chinese scientific research, publishing in high-impact journals has become part of the nationwide push towards research excellence, and the impact factors of journals in which Chinese scholars publish their papers have become important measures for evaluating the quality of scholars' scientific publications. Therefore, the average impact factor of journals is an appropriate measure for evaluating the quality of Chinese returnee scholars' research. In this study, the 5-year impact factor of each journal is sourced from the online version of JCR Reports 2012, and is computed on an annual basis as panel data.

3.3.4. Control variables

Previous studies have shown that collaborative behaviour can be influenced by numerous factors. The most frequently discussed factors include personal characteristics, institutional characteristics and disciplinary difference (Bozeman et al., 2013). Based on the specificity of our samples, we include four sets of control variables in our study, as follows.

Firstly, the *return year dummy* of Chang Jiang Scholars is controlled. Since the Chang Jiang Scholars Programme was launched in 1998, and since the Chinese government also initiated the 985 Project in 1998, the year 1998 can be seen as an important turning point in returnee scholars' collaborative behaviour. We therefore compared the return year to 1998, controlling scholars who returned before 1998 and after 1998 separately.

Secondly, various studies have shown that researchers in different research fields may display different behaviour in research collaboration (Bozeman and Corley, 2004; Bozeman and Gaughan, 2011; van Rijnsoever and Hessels, 2011); therefore, *field dummies* are controlled in this study. We categorised the research fields of Chang Jiang Scholars into the fields of natural sciences, engineering & technology, medical & health sciences, and other fields, based on OECD's classification (OECD, 2007).

Thirdly, some institutional characteristics are controlled, including *institutional location dummy* and *institutional status dummy*. Beijing and Shanghai are the two biggest education hubs in China. Universities located in these places are more likely to collaborate inter-institutionally (Liang and Zhu, 2002); therefore, we consider universities located in Beijing and Shanghai as being different to those in other cities. Meanwhile, some studies have argued that a university's academic status may have an impact on the collaborative behaviour of its members, and that the faculty of universities with a higher status have a greater tendency towards international collaboration (Jeong et al., 2014). China has formed its own "Ivy League", which includes the nine most renowned Chinese universities, known as the "C9 League". We therefore decided the status of receiving universities by judging whether or not they were in the "C9 League".

Fourthly, recent studies have shown that the foreign contexts in which returnees were based, including where they got their overseas experience and what kind of experience they had, may have an impact on their propensity towards international collaboration after returning (Jonkers and Cruz-Castro, 2013; Jonkers and Tijssen, 2008; Velema, 2012). We therefore controlled the *region dummies* where returnees got their overseas experience and the *foreign PhD dummy* deciding whether returnees had a foreign PhD degree.

Gender and tenure are not covered in this study because only one scholar in our target group was female and all the scholars were recruited directly as tenured professors after their return.

3.4. Descriptive statistics

Our targeted group consists of 50 alumni faculty and 62 non-alumni faculty. The alumni faculty accounts for about 45% of the total targeted scholars, which indicates that the phenomenon of returnee scholars working at their Chinese alma mater is quite common in the Chinese context. Among the 112 returnees, 79% of them have a PhD degree from a foreign university, 64% of them returned before 1998, 46% of them work at a member university of the C9 League, and 79% of them were recruited by universities located in Beijing or Shanghai.

Table 2
Descriptive statistics and comparing means.

	Descriptive statistics					Comparing means	
	N	Min	Max	Mean	SD	Alumni	Non-alumni
Alumni linkage (*count*)	896	0	1	0.45	0.499	(*50*)	(*62*)
Collaborative propensity	896	0	4	2.30	1.158	2.38	2.20
Average impact factor	896	0	50.81	2.40	2.682	2.31	2.46
No. of papers	896	0	45	6.12	6.958	5.78	6.40
Return year dummy	896	0	1	0.64	0.481	0.52	0.74
Field dummies	896	1	4	1.94	0.913	1.74	2.10
Institutional status dummy	896	0	1	0.46	0.500	0.40	0.50
Institutional location dummy	896	0	1	0.53	0.502	0.36	0.66
Foreign PhD dummy	896	0	1	0.79	0.406	0.84	0.76
Region dummies	896	1	3	1.88	0.784	1.90	1.85

As shown in Table 2, the comparison between alumni faculty and non-alumni faculty shows similarities in some areas, such as in the share of scholars with a foreign PhD, and country regions; while in other areas there are differences between the two subgroups. Firstly, the average collaborative propensity of alumni faculty is a little higher than that of non-alumni faculty, while both of the average research quality (*average impact factor*) and research production (*No. of papers*) of non-alumni faculty are higher than those of alumni faculty; secondly, 74% of non-alumni faculty returned after 1998, a higher proportion than that of alumni faculty (52%); thirdly, the field distributions for alumni and non-alumni faculty are different, the proportion of alumni faculty having majored in natural sciences (46%) being larger than that of non-alumni faculty (27%), while the proportions of non-alumni faculty who majored in engineering & technology (47%) and medical & health Sciences (15%) were greater than those of alumni faculty (40% and 8% respectively); lastly, more of the non-alumni faculty were recruited by member universities of the C9 League and universities located in Beijing or Shanghai.

4. Analyses and results

Based on the hypotheses we developed in Section 2 and the variables we organised to test the hypotheses, two sets of regressions are presented to evaluate the impact of alumni linkage on collaborative propensity and research quality.

(1) Pooled logistic regressions are run to test the impact of alumni linkage on returnee scholar collaborative propensity (results in Tables 3 and 4).
(2) Pooled OLS regressions are run to test the impact of alumni linkage on the average impact factor of the journals in which returnee scholars publish their papers (results in Table 5).

4.1. Alumni linkage and collaborative propensity

Table 3 gives logistic estimates for two different models. Both models are the standard logistic regressions for data that are pooled over time. Model 1 tested the impact of alumni linkage on Chang Jiang Scholar collaborative propensity towards intra-institutional collaboration by controlling the *field dummies*, *return year dummy*, *foreign PhD dummy*, *region dummies*, *institutional status dummy* and *institutional location dummy*. Model 2 introduced an interaction effect between the alumni linkage and *year dummies* in the regression in order to examine year-specific effects of the alumni linkage. For both models, the dependent variable is coded as 1 if the returnee's collaborative propensity is towards intra-institutional collaboration and as 0 otherwise. Similarly, Table 4 presents results for the impact of alumni linkage on returnees' collaborative propensity towards international collaboration, and the dependent variables for Models 3 and 4 are both coded as 1 if the returnee's collaborative propensity is towards international collaboration and as 0 otherwise. A detailed explanation of how the results test the first two hypotheses is presented as follows.

Firstly, H1 is rejected as the results in Model 1 show that non-alumni faculty tend to carry out more intra-institutional collaboration than alumni faculty. Alumni linkage significantly predicts whether a returnee scholar chooses to collaborate only with his/her colleagues from the same institution or shows other collaborative behaviour ($B = -0.289$, $p < 0.05$). The odds ratio shows that the probability of alumni faculty having a collaborative propensity towards intra-institutional collaboration is only 74.9% of the probability of non-alumni faculty (in other words, the probability of non-alumni faculty having a collaborative propensity towards intra-institutional collaboration is 33.5% higher than that for alumni faculty). Also, some other dummies appear to be strong predictors of the dependent variable as well. Scholars holding a foreign PhD degree, returning after 1998, doing research in the field of engineering & technology, or whose institutions are located in cities other than Beijing and Shanghai, are more likely to have a collaborative propensity towards intra-institutional collaboration.

Secondly, H2 is also rejected as the results show that alumni linkage does not significantly predict a scholar's propensity towards international collaboration. There is no significant difference in the odds of a propensity towards international collaboration compared to other collaborative behaviour between alumni faculty and non-alumni faculty. In other words, these two subgroups have similar collaborative propensities when deciding whether to collaborate internationally or not. As for controlling variables, the return year dummy has a strong positive relationship to the dependent variable, while the field of engineering & technology is negatively related to the dependent variable. Furthermore, both the foreign PhD dummy and the field of medical & health sciences exhibit weak negative relationships to the dependent variable.

Thirdly, the yearly impact of alumni linkage on collaborative propensity towards intra-institutional collaboration implies that non-alumni faculty become more dedicated to intra-institutional collaboration as the time after their return increases. As shown in Model 2, the behaviour of non-alumni faculty is strongly related to the dependent variable from the fourth year after their return, and the probability of their collaborative propensity towards intra-institutional collaboration compared to other collaborative behaviour increases every year after this point (the odds ratio increases from 2.170 in the fourth year after scholars return to 2.408 in the eighth year). As for alumni faculty, the yearly impact is not as significant as for non-alumni faculty. There are only significant effects in the fifth, seventh and eighth years after alumni faculty return, and the odds ratios are smaller than for non-alumni faculty in the same year.

In accordance with the results shown in Model 3, the year-specific effects on returnee scholar collaborative propensity towards international collaboration for alumni faculty and

Table 3
Pooled logistic regression on the collaborative propensity towards intra-institutional collaboration.

	Model 1					Model 2				
	B (SE)		Odds ratio	95% CI for odds ratio		*B* (SE)		Odds ratio	95% CI for odds ratio	
Alumni linkage	−0.289	(0.114)**	0.749	0.555	1.009					
Alumni × Year										
Non-alumni × Year = 2						0.076	(0.420)	1.079	0.503	2.315
Non-alumni × Year = 3						0.365	(0.552)	1.440	0.680	3.052
Non-alumni × Year = 4						0.775	(0.825)**	2.170	1.030	4.570
Non-alumni × Year = 5						1.046	(1.086)***	2.847	1.348	6.014
Non-alumni × Year = 6						1.255	(1.350)***	3.509	1.650	7.460
Non-alumni × Year = 7						1.474	(1.704)***	4.366	2.032	9.380
Non-alumni × Year = 8						1.791	(2.408)***	5.993	2.726	13.173
Alumni × Year = 1						0.551	(0.709)	1.736	0.779	3.866
Alumni × Year = 2						0.289	(0.551)	1.335	0.594	2.999
Alumni × Year = 3						0.010	(0.426)	1.011	0.442	2.308
Alumni × Year = 4						0.378	(0.600)	1.459	0.652	3.266
Alumni × Year = 5						0.722	(0.838)*	2.058	0.926	4.574
Alumni × Year = 6						0.465	(0.652)	1.592	0.713	3.554
Alumni × Year = 7						1.061	(1.182)***	2.891	1.297	6.443
Alumni × Year = 8						0.891	(0.994)**	2.438	1.097	5.419
Foreign PhD dummy	0.362	(0.263)**	1.436	1.003	2.057	0.385	(0.278)**	1.469	1.014	2.129
Return year dummy	0.575	(0.285)***	1.778	1.299	2.433	0.604	(0.301)***	1.830	1.325	2.527
Field dummies										
Engineering and technology	0.555	(0.296)***	1.742	1.249	2.429	0.586	(0.313)***	1.796	1.276	2.528
Medical and health sciences	0.204	(0.296)	1.226	0.764	1.968	0.212	(0.308)	1.236	0.758	2.016
Others	0.068	(0.306)	1.070	0.611	1.875	0.066	(0.315)	1.068	0.599	1.906
Institutional location dummy	−0.439	(0.104)***	0.645	0.470	0.885	−0.465	(0.105)***	0.628	0.453	0.871
Institutional status dummy	0.190	(0.208)	1.209	0.863	1.693	0.202	(0.217)	1.224	0.864	1.733
Region dummies										
Europe	0.155	(0.193)	1.168	0.845	1.614	0.163	(0.200)	1.178	0.844	1.642
Asia and Pacific	0.172	(0.228)	1.188	0.815	1.732	0.185	(0.238)	1.203	0.816	1.774
Constants	−0.833	(0.121)***	0.435	0.252	0.750	−1.724	(0.070)***	0.178	0.083	0.384
Observations			896					896		
Pseudo R^2			0.136					0.178		

Notes: odds ratio: if >1, the probability of one group (in the presence of the independent variable) having propensity towards intra-institutional collaboration is higher than another group (in the absence of the independent variable); if <1, that probability is lower that another group.

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

non-alumni faculty are quite similar. Model 4 shows that both groups are less likely to collaborate internationally three or four years after their return. In addition, alumni faculty show overall weaker yearly effects and slightly larger odds ratios in most years than non-alumni faculty, which indicates that alumni faculty may have more chances for international collaboration than non-alumni faculty.

4.2. Alumni linkage and research quality

Three separate regressions are run to test the impact of alumni linkage on the research quality of returnee scholars. As shown in Table 5, Model 5 included the *collaborative propensity dummies*, *region dummies*, *field dummies*, *institutional status dummy*, *institutional location dummy*, *return year dummy* and publication outputs (*No. of papers*) as controlling variables. We also introduced the interaction effect between alumni linkage and collaborative propensity in Model 6 and the yearly effect of alumni linkage in Model 7.

H3 is accepted in accordance with the result that the alumni linkage has a weak but significant impact on the average impact factor of journals in which returnee scholars publish their papers ($B = 0.142$, $p < 0.1$). The small positive coefficient indicates that alumni faculty have a slightly greater chance of publishing papers in high-impact journals than non-alumni faculty. In other words, alumni faculty may have some advantages in terms of achieving high quality research when compared to non-alumni faculty. The result seems inconsistent with the comparing means as shown in Table 2, which can be explained by the different standard deviations of the two means. Non-alumni faculty have a higher standard deviation of means of average impact factors than alumni faculty, indicating that the average impact factors of alumni faculty are much closer to their mean. In addition, coefficients of some other controls echo some previous studies. For example, a scholar with a propensity towards international collaboration is more likely to produce papers in high-impact journals (similar results see e.g. Beaver and Rosen, 1979) than scholars with other collaborative propensities; and scholars in the field of medical and health sciences are more likely to publish papers in high-impact journals, because journals in medical and health sciences on average usually have higher impact factors (Glänzel and Moed, 2002). Also, it is not surprising to see that scholars returning to work at one of the C9 League universities are more likely to publish papers in high-impact journals than those working at other Chinese universities.

Most importantly, as both the alumni linkage and collaborative propensity have significant impacts on the average impact factor, we further tested the interaction effect of the alumni linkage and collaborative propensity on the average impact factor and found the effect to also be significant. Based on the results shown in Model 6, both alumni faculty and non-alumni faculty who have a propensity towards international collaboration are more likely to publish papers in high-impact journals, but alumni faculty have a much larger coefficient than non-alumni faculty (1.991 compared to 1.116). Furthermore, alumni faculty with propensities towards domestic collaboration or intra-institutional collaboration are also more likely to publish papers in high-impact journals, while non-alumni faculty only do well in intra-institutional collaboration with a stronger and larger coefficient than alumni faculty (0.934 compared to 0.679). The results here suggest that alumni faculty have on average greater chances of publishing papers in high-impact

Table 4
Pooled logistic regression on the collaborative propensity towards international collaboration.

	Model 3					Model 4				
	B (SE)		Odds ratio	95% CI for odds ratio		*B* (SE)		Odds ratio	95% CI for odds ratio	
Alumni linkage	0.049	(0.200)	1.050	0.723	1.524					
Alumni × Year										
Non-alumni × Year = 2						−0.384	(0.268)	0.681	0.315	1.473
Non-alumni × Year = 3						−0.643	(0.213)	0.526	0.238	1.164
Non-alumni × Year = 4						−1.049	(0.152)**	0.350	0.150	0.818
Non-alumni × Year = 5						−1.295	(0.124)***	0.274	0.112	0.667
Non-alumni × Year = 6						−1.295	(0.124)***	0.274	0.112	0.667
Non-alumni × Year = 7						−1.167	(0.138)***	0.311	0.131	0.741
Non-alumni × Year = 8						−1.591	(0.099)***	0.204	0.078	0.530
Alumni × Year = 1						−0.164	(0.357)	0.849	0.373	1.934
Alumni × Year = 2						−0.470	(0.271)	0.625	0.267	1.464
Alumni × Year = 3						−0.960	(0.180)**	0.383	0.153	0.961
Alumni × Year = 4						−0.699	(0.223)	0.497	0.206	1.197
Alumni × Year = 5						−1.107	(0.160)**	0.331	0.128	0.853
Alumni × Year = 6						−1.107	(0.160)**	0.331	0.128	0.853
Alumni × Year = 7						−1.269	(0.141)**	0.281	0.105	0.751
Alumni × Year = 8						−0.960	(0.180)**	0.383	0.153	0.961
Foreign PhD dummy	−0.417	(0.141)*	0.659	0.434	1.001	−0.435	(0.141)**	0.647	0.422	0.992
Return year dummy	0.604	(0.381)***	1.829	1.216	2.750	0.623	(0.394)***	1.865	1.233	2.821
Field dummies										
Engineering and technology	−0.755	(0.100)***	0.470	0.310	0.713	−0.781	(0.099)***	0.458	0.300	0.699
Medical and health sciences	−0.544	(0.168)*	0.581	0.329	1.023	−0.564	(0.168)*	0.569	0.319	1.015
Others	−0.584	(0.199)	0.558	0.277	1.124	−0.604	(0.199)*	0.546	0.268	1.115
Institutional location dummy	0.055	(0.215)	1.056	0.709	1.575	0.058	(0.220)	1.059	0.705	1.591
Institutional status dummy	−0.149	(0.187)	0.861	0.563	1.317	−0.154	(0.189)	0.857	0.556	1.322
Region dummies										
Europe	−0.145	(0.177)	0.865	0.579	1.290	−0.152	(0.178)	0.859	0.572	1.291
Asia and Pacific	0.277	(0.306)	1.319	0.837	2.079	0.285	(0.314)	1.329	0.836	2.113
Constants	−1.032	(0.119)***	0.356	0.185	0.686	−0.159	(0.359)*	0.853	0.374	1.946
Observations			896					896		
Pseudo R^2			0.133					0.165		

Notes: odds ratio: if >1, the probability of one group (in the presence of the independent variable) having international collaborative propensity is higher than another group (in the absence of the independent variable); if <1, that probability is lower that another group.

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

journals due to their overall better performance in both domestic and international collaboration than non-alumni faculty.

Furthermore, the results of the interaction between the alumni linkage and year dummies are also enlightening. As shown in Model 7, the yearly effects for non-alumni faculty appear to be much more positive than for alumni faculty. Papers produced by non-alumni faculty in the sixth year and eighth year after their return are published in journals with an average higher impact ($B = 0.574$, $p < 0.05$ and $B = 0.953$, $p < 0.01$), which indicates that non-alumni faculty have made apparent improvements in research quality after they return. As for alumni faculty, there is a weak positive relationship between the average impact factor and the papers produced by alumni faculty in the first year and sixth year after they return ($B = 0.792$, $p < 0.1$ and $B = 0.820$, $p < 0.1$), which indicates that alumni faculty are doing better in terms of publishing in high-impact journals than non-alumni faculty in the first year. However, in later years, there is no sign that alumni faculty are better than non-alumni faculty in terms of research quality.

5. Discussion

The recruiting of overseas talent has become a widely used strategy among Chinese universities in order to raise the quality of their teaching and research. The return of overseas talent may have a significant impact on the future development of the Chinese research system (Jonkers, 2009). This paper aims to examine the individual collaborative behaviour of returnee scholars after their return and find out how the alumni linkage influences their collaborative propensities. The most important findings are that, (1) non-alumni faculty tend to carry out more intra-institutional collaboration than alumni faculty; (2) the effect of alumni linkage on returnee scholar tendency towards international collaboration is not significant; and (3) alumni faculty tend to publish papers in higher impact journals than those of non-alumni faculty. To better understand the results and explain the unexpected impact of alumni linkage on returnee scholar collaborative propensity, the ternary relationship between the alumni linkage, individual collaborative propensity and research quality is discussed as follows.

First of all, alumni faculty do not show a strong tendency towards intra-institutional collaboration, which is contrary to our expectations. We have hypothesised in Section 2.3 that the alumni linkage, which can be interpreted as one form of organisational identification (Mael and Ashforth, 1992), may strengthen a scholar's intra-institutional collaboration just as organisational identification can do (Dutton et al., 1994). However, the results show the opposite, which indicates that the alumni linkage strengthening a scholar's intra-institutional collaboration may not be applicable when it comes to Chinese returnee scholars in research collaboration. A possible reason for this is that the intra-institutional network of alumni faculty is already well established when they return, and there is no need for alumni faculty to strengthen their intra-institutional ties via intense intra-institutional collaboration, they just need to maintain existing intra-institutional ties. According to the "average" collaborative behaviour of alumni faculty and non-alumni faculty presented in Fig. 2, alumni faculty carry out more intra-institutional collaboration than non-alumni faculty in the first three years after returning (about 10% more on average), and the average percentage of intra-institutional collaboration papers written by alumni faculty is stable at around 50% over eight years. The data further

Table 5
Pooled OLS regression on research quality.

	Model 5		Model 6		Model 7	
Alumni linkage	0.142	(0.266)*				
Collaborative propensity dummies						
Intra-institutional collaboration	0.548	(0.332)			0.510	(0.338)
Domestic collaboration	0.583	(0.370)			0.556	(0.372)
International collaboration	1.215	(0.361)***			1.217	(0.360)***
Alumni × Propensity						
Non-alumni × Intra-institutional collaboration			0.934	(0.460)**		
Non-alumni × Domestic collaboration			0.782	(0.533)		
Non-alumni × International collaboration			1.116	(0.409)***		
Alumni × Non-collaboration			0.478	(0.551)		
Alumni × Intra-institutional collaboration			0.679	(0.386)*		
Alumni × Domestic collaboration			0.986	(0.441)**		
Alumni × International collaboration			1.991	(0.527)***		
Alumni × Year						
Non-alumni × Year = 2					0.321	(0.348)
Non-alumni × Year = 3					0.955	(0.925)
Non-alumni × Year = 4					0.199	(0.279)
Non-alumni × Year = 5					0.637	(0.458)
Non-alumni × Year = 6					0.574	(0.259)**
Non-alumni × Year = 7					0.444	(0.281)
Non-alumni × Year = 8					0.953	(0.306)***
Alumni × Year = 1					0.792	(0.459)*
Alumni × Year = 2					0.744	(0.523)
Alumni × Year = 3					0.739	(0.454)
Alumni × Year = 4					0.567	(0.370)
Alumni × Year = 5					0.417	(0.385)
Alumni × Year = 6					0.820	(0.428)*
Alumni × Year = 7					0.496	(0.388)
Alumni × Year = 8					0.604	(0.399)
Region dummies						
Europe	−0.374	(0.284)	−0.402	(0.279)	−0.362	(0.288)
Asia and Pacific	−0.433	(0.381)	−0.499	(0.379)	−0.401	(0.386)
Field dummies						
Engineering and technology	−0.492	(0.309)	−0.476	(0.302)	−0.505	(0.314)
Medical and health sciences	1.508	(0.540)***	1.570	(0.554)***	1.495	(0.547)***
Others	0.147	(0.450)	0.093	(0.454)	0.139	(0.453)
Institutional status dummy	0.580	(0.247)**	0.505	(0.256)*	0.582	(0.248)**
Institutional location dummy	0.021	(0.239)	0.025	(0.240)	0.007	(0.247)
Return year dummy	0.658	(0.279)**	0.630	(0.271)**	0.684	(0.278)**
No. of papers	0.002	(0.013)	0.001	(0.013)	−0.002	(0.014)
Foreign PhD dummy	0.241	(0.272)	0.269	(0.272)	0.239	(0.272)
Constants	0.994	(0.461)**	0.823	(0.481)*	0.518	(0.514)*
Observations	896		896		896	
R^2	0.139		0.146		0.148	

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

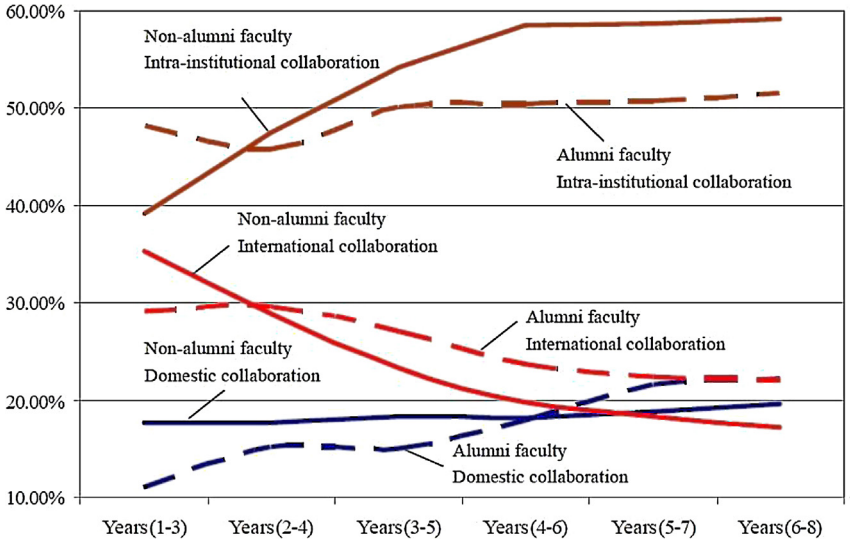

Fig. 2. Average percentage of papers published in three collaborative categories by alumni and non-alumni faculty (data is compiled in six overlapping three-year periods beginning with the return year).

confirms our assumption that the alumni faculty have stronger intra-institutional networks than non-alumni faculty, especially in the initial years after they return, and that the intra-institutional networks of alumni faculty stay steady over time.

Secondly, the non-alumni faculty's strong tendency towards intra-institutional collaboration indicates that building intra-institutional research teams and strengthening local networks become their prime motivation in conducting research collaboration. Networking is important, especially in the Chinese context. It is claimed that personal connection (*guanxi*) plays an important role in business success in China (Xin and Pearce, 1996), and is considered a common phenomenon deeply embedded in Chinese culture. In Chinese universities, *guanxi* is also an important part of human capital, which can be helpful for a scholar seeking academic promotion and research grants (Shi and Rao, 2010; Yang, 2005). Obviously, non-alumni faculty do not collaborate with colleagues frequently for no reason. They must see academic networks as an important referral network, and view intra-institutional collaboration as an effective way of building academic networks and developing their careers. For alumni faculty, former classmates, teachers and tutors are all important components of their academic networks at their alma maters. As a result, alumni faculty do not need to collaborate extensively with their colleagues in order to build a network; instead, a bit of effort is required to maintain the existing network. Again, Fig. 2 provides support for our argument. Compared to the alumni faculty's steady percentage increase in the category of intra-institutionally co-authored papers, the same category for non-alumni faculty climbs sharply from 40% in the first three years to 60% in the fourth three years, and remains highest thereafter. It is important to note that the tendency of non-alumni faculty towards intra-institutional collaboration keeps increasing from the fourth year to the eighth year after they return (as shown in Model 2 of Table 3), which implies that it may take a long time to build a well-developed local academic network, and that this network building never stops, even years after they return.

Thirdly, we cannot come to the conclusion that alumni faculty are more likely to collaborate internationally than non-alumni faculty based on the regression results in Table 4. Both alumni faculty and non-alumni faculty show a decrease in the average percentage of internationally co-authored papers after they return to China. As shown in Fig. 2, the percentage for alumni faculty drops from 29% to 22%, while that for non-alumni faculty drops from 35% to 17%, which also echoes the yearly effect of the alumni linkage presented in Model 4. The decreasing tendency of Chang Jiang Scholars towards international collaboration can be explained in several ways. On the one hand, international collaboration usually has time-cost problems, and may not be so productive in the short-term (Katz and Martin, 1997). In Chinese scientific culture, research productivity appears to be more important than research quality (Li et al., 2012). When research productivity becomes an important measure for evaluating the performance of returnees, returnee scholars are highly motivated to enhance their research productivity through the easiest means of research collaboration, just like early-career faculty (Jones, 2010). This explains why both alumni faculty and non-alumni faculty are more likely to collaborative nationally than internationally. On the other hand, weak local social networks may jeopardise the localisation of returnee scholar transnational capital (Mullings, 2011; Obukhova et al., 2013), which may be one of the main obstacles for returnees when they attempt to maintain meaningful connections with foreign institutions (Chen, 2008). Therefore, it makes sense that the share of internationally co-authored papers drops much faster with non-alumni faculty than with alumni faculty, and the negative yearly effects of non-alumni faculty are much stronger than those of alumni faculty. Although both groups have a decreasing tendency towards international collaboration over the years, alumni faculty engage more frequently in international collaboration in most years than non-alumni faculty, as shown in Fig. 2.

Lastly, alumni faculty are more likely to publish papers in high-impact journals for two main reasons. One probable reason is that the frequent international collaboration of alumni faculty raises the overall possibility of publishing in high-impact journals. Fig. 2 indicates that alumni faculty have a higher proportion of international collaborations than non-alumni faculty in most years, and that the propensity towards international collaboration is positively related to the average impact factor of journals (see Models 5 and 7). Another reason is that the alumni connection may strongly motivate alumni faculty members to achieve academic excellence, and may also give them preferential treatment and resources with regard to high quality research. As a result, alumni faculty perform relatively stronger in terms of both domestic collaboration and international collaboration than non-alumni faculty (see Model 6). Of course, it is also worth noting that, non-alumni faculty appear to be "slow starters", who greatly raise their chances of publishing in high-impact journals in the later years after their return, while such "improvement" is not so apparent with alumni faculty.

6. Conclusions

This study began with the expectation that alumni faculty and non-alumni faculty would differ significantly in their collaborative behaviour after returning from abroad. The results confirm that alumni linkage has a significant impact on returnee scholar collaborative propensity towards intra-institutional collaboration, and on a scholar's chances of publishing papers in high-impact journals. This study contributes to the literature and knowledge of research collaboration in several ways. Firstly, we have targeted the Chang Jiang Scholars Programme, which is one of the most successful and influential talent attraction policies in China of the past 10 years, and prove that Chang Jiang Scholars can be a good resource when studying returnee scholars. Secondly, we provide a better understanding of social-organisational factors in individual collaborative behaviour by examining the impact of alumni linkage on the individual collaborative behaviour of returnee scholars. Lastly, we address the intra-institutional, domestic collaboration, and international collaboration of returnee scholars, which enriches the literature on different types of individual research collaboration in the Chinese context.

Our study's implications for Chinese university policy are clear. Firstly, as alumni faculty tend to publish papers in higher impact journals than non-alumni faculty, recruiting overseas alumni faculty should be encouraged in Chinese universities. Most importantly, in order to increase the chances of bringing back overseas alumni, fostering and maintaining the alumni relationship with overseas talent should be treated as an indispensable part of the institutional recruitment programme. Secondly, the value of transnational capital lies in a returnee scholar's ability to create meaningful connections with global academic networks after their return (Chen, 2008). Since it is disappointing to see that both alumni faculty and non-alumni faculty display great decreases in their tendencies towards international collaboration, universities must try to remove obstacles which may hinder a returnee's willingness to conduct international collaboration. Some possible moves may include building an open, free and friendly academic environment to help ease the stress of returnees with relatively weak academic networks, developing a reward system which encourages high quality research rather than research productivity, and implementing preferential policies and other support in order to encourage returnees to take part in international collaboration. With regard to overseas scholars who decide to come back, we suggest that they choose universities with which they either have prior

collaborations or personal connections (e.g. where a former classmate or teacher works). As Chen (2008) states, those who are embedded deeply in both transnational networks and local networks appear to experience the most success. We therefore believe that the strength of local networks is an important basis for returnees in using their transnational capital.

Potentially due to the limited size of the targeted group, the impact of alumni linkage on returnee scholar propensity towards international collaboration is insignificant, and needs to be tested in the future. Also, judging collaborative patterns for papers based solely on co-authorship type may ignore the complexity behind the intention of collaboration. In a further study, we will include more returnee scholars and conduct follow-up questionnaire surveys to acquire more empirical evidence on how the alumni linkage influences individual collaborative behaviour.

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