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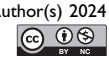

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Promising the earth: Forms of capital promised and pursued in Australian-Chinese research collaborations

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Abstract

Science is a space of both collaboration and competition, illustrated by international research collaboration (IRC) and its advantages for individual countries, institutions and scientists. IRC also brings together countries positioned unequally in global epistemic hierarchies. Little is known about how scientists navigate these tensions within IRC. We explore this through a study of Australian–Chinese IRC, drawing on interviews with Australian scientists and Bourdieu's theoretical framework. We identify specific capitals that are sought and promised in Australian–Chinese IRC, namely, scientific, economic and 'environmental' capital, with successful collaboration depending also on social and cultural capital. Differences in how Australia and China are positioned in global academic and scientific fields, and differences between national scientific fields, mean that collaboration facilitates access to forms of capital unobtainable in scientists' home settings. Because the benefits of IRC are fundamentally relational and promissory, these will change alongside the global hierarchies that are, themselves, being reshaped by IRC.

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Introduction

Science is increasingly collaborative, with teamwork across national borders growing exponentially (Powell et al., 2017). Global threats such as climate change and pandemics make such cooperation critical. But science is also a space of competition. International research collaboration (IRC) is valued by governments because it strengthens *national* knowledge economies (Australian Academy of the Humanities, 2015); universities, because it boosts institutional ranking (Quacquarelli Symonds, 2022); and individual scientists, as a way of increasing funding success (among other reasons) (Brosnan et al., 2022; Dusdal & Powell, 2021). In IRC, competing individual, institutional and national interests play out through collaboration and ultimately influence global knowledge production. Simultaneously, IRC occurs between countries positioned unequally in global epistemic hierarchies. Ascertaining how scientists from different countries navigate these competitive dynamics through their collaboration is important for understanding the future of science. This article is based on a qualitative study of the motivations and experiences of scientists from one relatively small knowledge economy – Australia – as these individuals collaborate with the world's largest knowledge producer – China – in a knowledge area originating in China: traditional Chinese medicine (TCM). Following Bourdieu (1988, 2004), we argue collaboration depends on the promised exchange of a range of capitals that derive their value from the fields of science and academia in which scientists, universities and national governments compete.

In taking this theoretical and methodological approach, the article contributes to the sociology of IRC. To date, IRC has predominantly been studied in the field of information science using bibliometric methods to produce statistics on international co-authorship trends (Chen et al., 2019). This reveals changing patterns of IRC, such as that 15% of Australian research papers now include a Chinese co-author, up from 1% in 1998 (Laurenceson & Zhou, 2019). Internationally co-authored papers are shown to receive higher citations (Dusdal & Powell, 2021), but the full range of IRC's costs and benefits, and how and why these are produced, are not yet well understood due to methodological limitations (Australian Academy of the Humanities, 2015; Chen et al., 2019; Dusdal & Powell, 2021). For instance, a recent bibliometric study found that geographical and cultural distance between given countries negatively impacts rates of collaboration (Vieira et al., 2022), but equally important to know is how such distances are bridged when scientists from culturally distant places – such as Australia and China – do collaborate.

We draw on interviews with Australian scientists to understand how shifting international relations, epistemic politics, and individual and institutional agendas are managed and mobilised within their collaborations with Chinese research partners. We pay particular attention to the relative positions of Australia and China in global knowledge hierarchies and how these are reproduced or reconfigured through our participants' collaboration activities. We begin by outlining how previous sociological work has

conceptualised global knowledge hierarchies and situated Australia and China, before moving on to discuss how Bourdieu's framework can inform analyses of IRC and our own empirical case.

Australia and China in the global knowledge system

In sociology, knowledge production and circulation has often been understood through world-systems analysis and postcolonial frames that point to hierarchical global systems containing a North/South differentiation, systematically structuring the inequalities between countries and regions of the core and periphery. This global system broadly dictates the agendas and capacities of the knowledge-making institutions and groups within it (Collyer et al., 2019; Connell, 2007). The ontologies and epistemologies of the global North (a socio-political, not geographical position) have come to dominate world knowledge production (Connell, 2007). Scientists and other knowledge experts in the periphery or 'Southern tier', while disadvantaged, are capable of responding to the challenges of a system dominated by the metropole (the institutions of the global North) (Collyer et al., 2019; Keim, 2014), including by fostering more diverse epistemologies (Sepúlveda et al., 2022; Zhang & Datta Burton, 2022). To understand the changing dynamics of knowledge production in the North/South, Connell et al. (2018, p. 740) argue there is an urgent need 'to know about the structure, institutions and workforce of the global knowledge economy, its diversity of situations, and especially the relationships through which it operates and the dynamics of change in these relationships'. In IRC, these relationships are to the fore.

Australia's position in the global system is ambiguous. Widely assumed part of the global North by virtue of its First World status, the strength of Australia's trade capacity has historically shifted between core and periphery (Tsokhas, 1996). In the global knowledge economy, Australia's relatively peripheral status is indicated by the way scientists have long looked to the metropole (especially the UK and USA) for graduate and postgraduate training, benefitting from mentorship and connections with individuals in these regions (Connell & Wood, 2002). Australian scholars have been shown to import, more often than export, knowledge and techniques from the metropole (Collyer, 2014; Connell & Wood, 2002). In particular, Australia has relied on IRC to boost its own knowledge economy.

For most of this century, the USA and UK have been Australia's primary research partners (Laurenceson & Zhou, 2019). When Connell and Wood (2002) interviewed Australian natural scientists 20 years ago, their international connections were almost exclusively to the Anglophone world and no participants were working with China; science was 'quasi-globalized'. These relationships have changed dramatically. Having already overtaken the UK, China replaced the USA as Australia's principal research collaborator in 2022 (Clarivate, 2024). Notably, IRC takes place in a wider political context, and Australia and China's strengthened research relationship has coincided with worsening diplomatic relations and Australian government concern over China's influence on Australian universities.

China's surge to 'science superpower', surpassing the USA in 2019 to become the top global knowledge producer (in terms of number of documents; Clarivate,

2024), is part of a wider shift in knowledge production, with Asian countries making increasingly significant contributions in fields dominated by the global North (Powell et al., 2017). The rise of these 'subaltern' knowledge producers has the potential to change not only collaboration patterns but knowledge hierarchies (Zhang & Datta Burton, 2022). The inclusion of TCM – a domain of 'alternative medicine' historically marginalised in the West – as a designated area of research cooperation in the China-Australia Free Trade Agreement (ChAFTA) in 2015, and in the World Health Organization's International Classification of Diseases (ICD) in 2019, is perhaps a sign of shifting epistemic politics.

Ten years ago, Collyer (2014) tentatively placed China in the 'semi-periphery' of the world knowledge system: those countries with a few relatively high-ranked universities and some representation in citation indices, but with an emphasis on obtaining academic credentials in 'core' countries. East Asian countries, including China, have invested significantly in PhD scholarships to allow students to travel to the metropole and collaborate with prestigious Western institutions and supervisors (Shen & Jiang, 2023). Individuals who return are rewarded with high status and secure employment and, in turn, produce work that helps to boost Asian universities' international rankings (Shen & Jiang, 2023). This is one strategy that has begun to shift global patterns of knowledge production, potentially complicating the core–periphery relations of previous decades. Another is China's incentivisation of researchers to publish in English, partly as a way of promoting Chinese knowledge on the international stage amid a shift from internal knowledge production to a 'going out' policy (Xu, 2020). Publishing in English is in turn a motivation for IRC. Niu's (2014) study of Australian–Chinese IRC highlights the role of co-authorship in cementing and rewarding collaborative work, finding that Chinese partners are eager to publish in high-impact English-language journals with the help of Australians. To our knowledge, this is the only previous qualitative study of Australian–Chinese IRC, though unfortunately the motivations of the Australian researchers are not clearly specified.

We argue in this article that the global knowledge economy, conceptualised as a system, requires further scrutiny if it is to reveal the social processes linking the experiences and strategies of researchers with the national and global events that impact scientific collaboration. The notion of a system recalls that of a bounded entity with all elements connected and operating to assist with its overall functioning, and with a stable, internal environment (Parsons, 1970, pp. 830, 849). Unlike the biological system upon which the concept is patterned, Parsons envisaged the social system as a 'plurality of individual actors interacting with each other', an interaction which, over time, produces patterns of mutual expectations that eventually become a set of norms, which in turn form the social structure (Cohen, 1968, p. 98; Collyer, 2018). In this functionalist schema, the social system is fundamentally a mechanism for managing and reducing (potential) social conflicts and deviations from the status quo. Other sociologists did not necessarily follow Parsons' approach to viewing the social system as essentially beneficial, but instead regarded it as creating and perpetuating systematic inequalities (e.g. Wallerstein, 1974). A particular critique of this conceptual framework is its determinism: the inability to successfully incorporate the agency of individuals (e.g. Dahrendorf, 1959; Gouldner, 1970) and its inadequate explanations of social change. How the changing

global positions of Australia and China shape and are shaped by the collaborations of individual scientists is precisely our concern in this study. In contrast to a system, we propose Bourdieu's concept of field, arguing that it better captures some of the dynamics we want to investigate. In conjunction with the related concepts of capital and habitus, it can account for scientists' strategies to compete in the socially stratified, but dynamic, global space of knowledge production.

Global science and academia as Bourdieusian 'fields'

For Bourdieu (1988, 2004), the field refers to a social space (such as an academic, scientific, or healthcare field), involving a configuration or network of relations with a specific distribution of power. A field is always a site of struggle and contestation, dominated by the logics of the economic field where actors vie for influence and control over specific resources or 'capitals', similar to players in a game (Bourdieu & Wacquant, 1992). Some fields are more autonomous than others, and more distant from the economic field, with the specific 'game' determined internally (Bourdieu, 2000). In *Homo Academicus* (1988), Bourdieu analyses the academic field, identifying the characteristics and outputs that operate as forms of capital in the various disciplines and the university sector as a whole. While the evaluation of academic practice has historically been largely self-determined, Bourdieu argues that the academic field is increasingly heteronomous, that is, influenced by the state and industry (Bourdieu, 1988). This is consistent with more recent work on 'academic capitalism', where academic work is shown to be increasingly focused on the instrumental pursuit of grants and publications which translate into monetary reward for universities (Collyer, 2013, 2015). Elsewhere, Bourdieu examines the field of science, one he regards as having been traditionally autonomous, because it functions around specialised knowledge where 'good science' can only be evaluated by other specialists. As such, the field is structured by 'the logic of peer competition' (Bourdieu, 2004: vii), where scientists compete for symbolic capital. These two examples show that actors may compete within several fields at once: scientists seek recognition from peers in the field of science by generating specific forms of knowledge, but also operate in the academic field where research funding and institutional reputation are especially prized.

The habitus is the connection between the structure of the field and an individual's scheme of perceptions (Bourdieu, 1988, 2000). This system of dispositions, acquired and reinforced through socialisation, shapes an individual's practices and positions actors unequally within the field (Bourdieu & Wacquant, 1992). Rather than an explanatory device, a focus on habitus is a call to elucidate the principles of actors' perceptions, assessments and actions (Medvetz & Sallaz, 2018). For example, a key question becomes how training within a particular national context may give rise to different behavioural patterns that influence how researchers navigate and exert power within the academic or scientific field. While habitus typically focuses on individuals, Zhang and Datta Burton (2022) identify a Chinese 'national habitus' in the life sciences, involving dispositions towards knowledge production that shape China's ability to participate in the global knowledge economy. For instance, following various scientific controversies, China has suffered reputational damage (low symbolic capital). Zhang and Datta Burton (2022) argue that these controversies and China's pursuit of global recognition

in science need to be understood in the context of a long history of marginalisation in the Western-dominated global epistemic hierarchy (see also Xie, 2018). We build on their interpretation by identifying the specific forms of capital circulating in Chinese–Australian collaborations – an approach that considers the global context of science.

Capital is the third key aspect of Bourdieu's framework. Specific configurations of capital shape the strategies, opportunities and positioning of actors in the field, and can be translated and exchanged for other forms (Bourdieu & Wacquant, 1992). Bourdieu gives four categories of capital: economic, which includes material and finite resources; cultural, which includes tastes and educational levels; social, which includes the networks that provide actors with access to other forms of capital; and symbolic, which includes recognition, reputation and prestige. Braun Střelcová et al. (2022) have explored the capitals mobilised by European researchers working in China. Moving to China provided greater access to economic capital (research funding), particularly for researchers in engineering and the natural sciences, but also cultural capital, in part because these disciplines are highly internationalised. However, the European researchers struggled to gain social capital in the local academic field, being treated as 'guest professors' rather than colleagues and insiders.

These recent Bourdieusian analyses point to global fields of science and academia where nationality enables access to different kinds of capital. We interrogate this further by identifying the forms of capital pursued in Australian–Chinese IRC. Our focus on TCM as a case study is particularly revealing given that this area represents a subaltern form of knowledge and Australian scientists' TCM collaborations appear to challenge global epistemic hierarchies.

Studying TCM as a case of international research collaboration

TCM in global science

The recent trajectory of the TCM research field is indicative of China's rise in global science and a potential shift in the global epistemic hierarchy, as well as Australia's evolving research relationship with China. TCM has been promoted by the Chinese government since the 1950s as a 'scientific' form of Chinese medicine taught in Chinese universities and hospitals alongside biomedicine (Zhan, 2009). However, as a form of 'alternative medicine' based on the vitalist concept of *qi*, TCM's effectiveness, and the very possibility of its scientific validation, are contested in the West (Derkatch, 2016). Nevertheless, scientific research on TCM has grown rapidly since the turn of the century – led by China, but with increasing participation from other countries (Huang et al., 2015).

As well as being included in ChAFTA, TCM research is conducted in universities across Australia, often in collaboration with Chinese researchers and/or funded by Chinese organisations (Brosnan et al., 2022). Elsewhere, we have described the factors that make TCM research attractive to Australian scientists, including its many components (such as a vast array of medicinal herbs) that can be incorporated as boundary-objects into Western scientific paradigms and infrastructures (Brosnan et al., 2022). In this article, using the same dataset, we focus on the dynamics of collaboration with China.

Methods

The aim of our study was to determine how and why TCM has been taken up as a research area by Australian scientists, and how partnerships with China have featured. Working in an interpretative paradigm, our qualitative case study was designed to produce a detailed analysis of the collaborative strategies and experiences of scientists in TCM. Semi-structured interviews were used to explore scientists' career backgrounds, pathways into TCM research, perspectives on TCM and experiences of collaboration.

Purposive sampling enabled the identification of key informants who could offer 'information rich' perspectives on the topic (Patton, 2015). A sampling frame was constructed by searching Australian university websites for staff members working in the area. We found 200 researchers (excluding PhD students) at 29 universities, indicating that three-quarters of Australian universities have at least one staff member who has conducted some TCM research. From this list and using our existing knowledge of the field, we were able to identify several clusters of relevant researchers and leaders in the field. These were approached for interview.

Ten scientists across seven universities, in four Australian states, agreed to participate. Their backgrounds are in a range of disciplines, including computational genetics, plant biology, physiology, pharmacology, biochemistry and Western clinical medicine. As found in the broader Australian context (Brosnan et al., 2022), for most of our participants, TCM is just one of their research areas, among other more typical scientific and clinical subjects. In this article, participants are de-identified and occasionally direct quotes are not attributed to a specific participant, to prevent deductive disclosure.

Interviews lasted around an hour and participants spoke at length of the opportunities and challenges that come with working on TCM and collaborating with China. Thematic analysis of the interviews moved iteratively between existing literature and the data to identify and interpret recurring themes (Willis, 2019). The relevance of Bourdieu's framework was established during the analysis phase, and an additional layer of coding applied to the data to tease out the forms of capital referred to by scientists in their accounts – especially when discussing their partnerships with China. We present this aspect of the analysis here.

Findings

Our participants describe a range of capitals sought and promised in Australian–Chinese IRC. The Australian scientists' perceptions of what is valued and how and where to obtain valued resources shed light on the operation of a global academic field. In this field, research funding and articles in prestigious journals are key forms of, respectively, economic and cultural capital. But participants also play the game of the more autonomous scientific field, pursuing scientific capital in the form of 'good science'.

Importantly, our findings show that IRC is founded on the promise of these gains; that is, it is future-oriented, entered into in the expectation that benefits will follow. Interdisciplinary (domestic) research collaboration has also previously been shown to be held together by an orientation towards future outcomes – the promise of new forms of knowledge (Brosnan & Michael, 2014). Here we show that the promise of a

range of capitals is the organising principle of Australian–Chinese IRC. New knowledge is just one promised outcome. We discuss in turn scientific, economic, social and cultural capital and, lastly, introduce 'environmental' capital as a promissory Australian asset.

Scientific capital

For Bourdieu, '[s]cientific capital is a particular kind of symbolic capital, a capital based on knowledge and recognition' (Bourdieu, 2004, p. 34). As described earlier, good science is primarily (and ideally) defined by internal rules set by other scientists (Bourdieu, 2004). Judgements of scientific quality include using the 'right' methods and processes to produce knowledge. Our analysis suggests both Australian and Chinese scientists seek to gain scientific capital through their IRC. However, what counts as scientific capital is shaped by geopolitical epistemic hierarchies, in which some types of knowledge have greater symbolic capital because of where they are produced (Zhang & Datta Burton, 2022, p. 29).

According to our participants, research conducted in the West has greater scientific capital than that of the East, being seen as more credible. Chinese TCM researchers seem motivated to collaborate with Australia to improve their access to (Western) scientific capital, which they hope will, in turn, increase TCM acceptance in the West. Zhang and Datta Burton (2022, p. 30) note that Western scientific endorsement is also highly valued within China. Scientist 2 explains:

> The clinical trials in China are not enough. They need to actually do it here, or somewhere in one of the developed countries. Their results are actually believed. So they use [specific herb] extensively in China at the moment, so there are huge amounts of data available on how effective it is. It just needs to be developed through proper clinical trials in Australia.

There are several ways through which Australian-based science is constructed as more 'believable' than Chinese-based research. One is in relation to governance, with research processes in Australia, and the West, seen as more transparent:

> Historically the methodology of studies in China and Eastern Europe generally are very questionable, and there are heavy influences, publication bias and other things that get involved. So the regulatory authorities, like the TGA [Therapeutic Goods Administration] and that in Australia, the regulatory authorities around the West want to see these studies done in the West. (Scientist 4)

Another aspect of the comparative credibility of Australian science is with respect to the way science is performed, Australian research being viewed as better aligned with international scientific standards and epistemologies than TCM research in China:

> I guess to some extent some of the TCM that is done in China is quite empirical, whereas at our end it's more hardcore research, if I can say, that is needed, with a scientific demonstration of

> again mode of actions and interactions and effects and things like that and clinical trials. (Scientist 5)

> Convincing [TCM doctors in China] of the fact that controlling against a placebo is the ultimate proof for Western doctors has been hard. So gradually they've understood and learnt that, and so we're getting there. (Scientist 4)

These explanations from participants reflect wider discourses about China as 'maverick' science producer which lags behind Western scientific and regulatory standards – discourses that feed into the 'subaltern anxieties' driving China's strategies to gain Western recognition (Zhang & Datta Burton, 2022). By collaborating with Australia and doing 'proper' science according to Western norms, Chinese TCM researchers are more likely to have their work published and recognised internationally; that is, to gain scientific capital.

Our findings indicate that scientific capital flows simultaneously in an inverse direction when Australian TCM researchers collaborate with China, because TCM science receives greater recognition in China than in Australia. This suggests that scientific capital operates differently according to location. Participants describe the challenges of conducting research in an area treated with scepticism by many scientists and doctors in Australia:

> [I]n Australia, there's a huge resistance to [TCM research] because the view is, the ingrained belief is that this is all placebo effect … Unfortunately I think a lot of people are unwilling to actually believe any evidence that you present to them. (Scientist 1)

> [T]here is a social stigma as to complementary medicine [in the scientific community]. So the view to that is it's not hard science. (Scientist 9)

Not only does TCM research receive little scientific recognition in Australia, but it is actively and publicly disparaged by sceptic organisations which have campaigned against complementary and alternative medicine's location in universities (Brosnan, 2015). Most interviewees have encountered these organisations directly or indirectly and are aware of the lack of symbolic capital attached to TCM research. However, in China, TCM research is well developed and supported. Participants argue that Australia needs to work with China to make any impact in TCM research. Describing the vast numbers of TCM researchers in East Asia, one scientist comments:

> So, can we make a dint on our own [as a research group in Australia]? No, not really. You've got so much support there in China, you are better off working with a team that have done a lot of the work there already, and you try and help to translate what you need to translate here. (Scientist 4)

Scientist 4 refers to translating research findings between China and Australia, but forms of capital are translated at the same time. Conducting TCM research with China opens the door for Australian scientists to access capital unavailable in Australia. Another participant describes the scientific capital flowing to his research in China, but not Australia:

> We actually pioneered this sort of approach to systems biology to Chinese medicine, and it's actually kind of funny because no one knows about what I do in Australia. Very few people do. But in China, I am told by my colleagues I am actually famous [*laughter*]. (Scientist 1)

This suggests the operation of a separate field of science in China, one in which TCM research is seen as legitimate, able to meet the requirements of 'good science'. Australian scientists can play the game of this other field and gain capital that can later be translated into valued resources in the Australian academic field, particularly economic capital.

Economic capital

A central theme in the interviews is the significance of research funding. Our participants make clear that they cannot work on TCM research without funding, most of which they seek externally. However, because of TCM's low scientific capital in the West, the usual Australian funding sources are largely inaccessible:

> [I]t's not a field that easily gets NHMRC [National Health and Medical Research Council] grants or ARC [Australian Research Council] grants, and so you don't see people sort of nurtured across the country to do this sort of research (Scientist 4).

A particular barrier is that TCM challenges Western pharmacological models, working with combinations of herbs in traditional formulas instead of studying single molecules. Discussing this, Scientist 8 comments:

> So, I'm a bit fearful of [the future of TCM research in Australia] because, especially grants I think are very difficult to get because I think people don't understand the thinking.

China, on the other hand, provides recognition and economic support for TCM research. Scientist 1 believes that doing his work without the support of a Chinese pharmaceutical company would be 'impossible':

> It is far easier, from my perspective, to get research funding from a company in China than it is from the ARC or the NHMRC.

A number of participants have been able to source significant levels of funding from China. Scientist 7 describes a collaboration with a Chinese research institute where his requests for funding were readily met:

> The third time I went to them, I said, 'I need more money', so I said, 'a million?' They gave me a million. The fourth time I said '1.6 million'; they said '1.6 million'. I said, 'three million?' They gave me three million.

In these collaborations, economic capital flows from China to Australia, enabling Australian scientists to do the research that eventually translates into other forms of

capital for Chinese partners (including back into economic capital through commercial application).

The attraction of economic capital from China for overseas researchers is not specific to the TCM research field (Braun Střelcová et al., 2022). In Australia, government investment in science has dropped by 16% since 2009 (Scully, 2022) and universities have oriented towards internationalisation as 'entrepreneurial institutions', seeking cooperation with overseas partners offering financial benefit (Sidhu & Christie, 2015, p. 312). Our participants describe these entrepreneurial endeavours within their own institutions, revealing that TCM collaborations often come about in the wider context of Australian universities' efforts to source funding from China. One scientist explains that TCM collaborations were established after a chance meeting with a pharmaceutical company on a trip to recruit fee-paying students from China. Another describes a TCM collaboration as a top-down arrangement directed by university management:

> [T]he university decided it was going to move into the area of Chinese traditional medicine… The [senior university manager] decided that this was an area of potentially big research collaboration with China.

For Australian universities, TCM holds promise as an area in which lucrative partnerships might be forged with China. All our participants have had some success in obtaining Chinese research funding, often through institution-level agreements, but another theme through the interviews are the challenges involved in negotiating such arrangements. Establishing research partnerships always incurs 'transaction costs' such as time and money (Lee & Bozeman, 2005) and may not produce anticipated benefits. Several participants describe negotiations around funding from Chinese partners that have ended in disappointment:

> It's been horrendous trying to negotiate deals with them to get funding. It took us two years before we actually managed to sign a contract and got any money to do the work. They promised the earth and delivered very little. (Scientist 2)

Another participant acknowledges that the situation is sometimes reversed, with Australian scientists over-promising on what they can deliver in terms of scientific outcomes, in order to secure funding from China:

> With the pressure to get money on joint projects, some scientists on our side from Australia tend to promise more or tend to make, you know, the other side dream a bit about what can be achieved just because there is an interest in getting joint projects running and financial support and sometimes … we promise the moon. (Scientist 5)

These observations point to the delicate promissory politics of IRC: a promise of future benefit is essential to establish collaboration, but 'promising the earth', as in promising too much, runs the risk of disappointing partners and compromising future collaboration.

A further obstacle described is when Chinese company funding is proffered in exchange for poorly conceived projects that would threaten the scientific reputation of the Australian researchers; that is, economic capital, so valued and translatable in the academic field, comes at a cost to scientific capital:

> Sometimes there would have been a lot of money [from China] but the quality of the projects was very poor and therefore, you know, we also have to make sure our credibility is maintained and that we just don't jump on projects that are not very realistic or that are poor quality even though there would be money. It's not all about the money, it's also about the quality of what we can deliver. (Scientist 5)

This last problem is a general issue in university–industry partnerships, where the corporate side may have a poor understanding of what kinds of questions basic science can address (Bozeman et al., 2016). When it comes to Australian–Chinese partnerships there are additional cultural barriers that make navigating and negotiating expectations more complex. The ability to establish collaborations that can produce economic and scientific capital is determined by access to social and cultural capital, two kinds of resources that are closely linked.

Social and cultural capital

Relationships with international institutions and researchers are of growing importance in Chinese academic life, driven by top-down policies (Xie, 2018). Our interviewees describe visiting China, hosting visiting delegations in Australia, signing memoranda of understanding between Australian and Chinese institutions and the involvement of 'very senior people' in inter-institutional TCM meetings. However, participants report that these formal negotiations do not easily translate into scientific collaboration.

For our non-Chinese interviewees, it seems a certain level of social and cultural capital must be accrued before Chinese partners will work with them; that is, knowing the right people and having the right knowledge to be deemed trustworthy is the first step in developing a productive partnership. The experiences of Scientist 2 are typical:

> There is one thing that I really have noticed, is that it takes a lot of time to actually go from pleasantries and handshakes to actually on the ground collaboration. I think a couple of years is the actual minimum before you even got to the stage of discussing projects that you are going to do work on or anything. There is a lot of bridge building and trust building before you get to that stage.

Participants refer to difficulties navigating cultural differences, 'the hierarchy in China', and needing to adapt to Chinese institutional expectations:

> We had delegations after delegations and you go there [to China] and all you meet is a group of 20 executives and we have a meeting for two hours and you go around the table and you have a translator, so by the time everybody has said, 'We are so honoured to have this delegation from

> [Australian university]', around the table, and then we've reciprocated, the two hours are gone and then there's five minutes to talk about it [the collaboration]. (Scientist 5)

From what participants describe, connections with senior university staff are an important form of social capital in the Chinese academic field. However, collaborations work better when direct contact is made with individual researchers who understand the science; that is, succeeding in the field of *science* requires a different kind of social and cultural capital:

> When we have direct access to the actual scientist and we can talk about the actual research, yeah it clicked quite well with a number of them. (Scientist 5)

Some participants have developed relationships with individual scientists over a long period and these personal links have been especially important following the deterioration in Australia and China's diplomatic relationship. Participants do not feel these national issues have affected their existing collaborations built on mutual trust:

> They understand that we want to leave politics out of the science and no, it hasn't [affected the collaboration] and that's only because we have a very good relationship with them for many years. (Scientist 10)

Scientists in Australia also look for Chinese collaborators who have the 'right' kind of knowledge and social connections. Participants express reservations about the quality of research in some Chinese institutions and the risks of collaborating with such partners. Connections to the West are a form of social and cultural capital recognised by Australian researchers and help to facilitate a collaboration:

> It's also targeting and selecting the right partners. It's not always so easy unless we already know scientists that are there that have worked in Western countries or that are renowned and that we know personally. (Scientist 5)

For the Australian scientists, 'good' collaborators are judged by their standing and connections in the global field of science, a field in which the metropole is still at the core. Once again, implied in these judgements is that the quality of science in Australia is more consistent than in China; that is, Australian science is more closely aligned with the dominant values of the global field – values defined by the West. The slipperiness of these socio-political and epistemological hierarchies is also sometimes evident. In the following comment, the participant describes his Chinese collaborators' connections to the USA as a marker of quality, and constructs Australia's position as somewhat peripheral by comparison:

> [Chinese collaborators] have also partnered recently with [large research institute in the USA], which is very well known … So, they're not slackers by any stretch of the imagination [*chuckles*]. They also have an agreement, I think, with [a prestigious American hospital]. So we're talking about sort of the top tenth of a percent of the prominent cancer research

> people that they try to work with, and we are in a sense a little of an outlier in little old [Australian city].

As China 'goes out' to the world and builds social capital in the global academic and scientific fields, Australian researchers stand to gain more from collaborating with China (such as being brought into networks with high-profile research centres of the global North). China's increasing access to Western forms of scientific capital also potentially reduces its need for Australian collaborations. But according to our participants, Australia has something else to offer China: environmental capital.

Environmental capital

Environmental capital has previously been proposed as a form of primarily cultural capital comprising 'knowledge about the environment' (Karol & Gale, 2004, p. 5). We use environmental capital to refer to the symbolic capital associated with having a clean natural environment. According to our participants, this is a type of capital to which Australia can lay claim, and which is sought after by Chinese TCM researchers and medicine manufacturers. Scientist 2 explains that the state government in his region of Australia aims to use the local environment as a selling point to attract Chinese investors:

> the State Government is interested in potentially clean green production within [Australian state], because the Chinese particularly are interested in having [TCM herbs] grown in areas where there is lack of pollution, where they don't have the same capabilities.

The Australian Federal Government also repeatedly draws attention to its environmental capital in the guides produced for Australian businesses on 'Complementary Medicines in China', suggesting that 'it seems likely Chinese companies will be interested in sourcing "clean, green and safe" raw materials from Australia in the future' (Commonwealth of Australia, 2017, p. 9).

Environmental capital has the potential to translate into economic capital for Australia, if TCM medicines and ingredients can be produced there and sold in China. Scientist 10 explains:

> We have a pristine environment here in Australia and so, it would be a potential export market [to China].

According to this participant's own research, the quality of the environment affects the quality of TCM materials, with anti-cancer compounds in a specific organism being found in higher concentrations in Australia than in China:

> We put that down to the fact that China was polluting a lot of its waterways and there was a lot of environmental stress on [these organisms].

But Australia's environmental capital is also under threat. Another participant describes how an initiative to grow TCM herbs in the country came to an abrupt end:

> We were very excited about it, the State Government was really very excited about it, we went through a number of places that could be our potential customer for the herbal medicine growing in [Australian state] and not in China. But what killed my project was the [major bushfire, which destroyed the plantations] … After that, you know, nobody was interested in those things.

With the risk of bushfire and other disasters increasing, this example underscores the economic implications of climate change for Australia and its future capacity to trade in the global market – either in raw commodities or knowledge. Along with the difficulties of establishing social and cultural capital and of maintaining higher levels of scientific capital than China, it emphasises the fragility of Australia's position as a valued collaborator for China.

Conclusion

Our study highlights a range of capitals that are promised and pursued in Australian–Chinese IRC. For our Australian scientists, co-authorship is not the primary motivator (cf. Niu, 2014), but funding and recognition for their TCM research contributions (i.e. economic and scientific capital). For Chinese partners, Australia promises Western research validation (scientific capital) and clean materials (environmental capital) that can translate into more marketable TCM products (economic capital). Forging these partnerships initially requires social and cultural capital, including having and making strategic connections at an institutional level as well as being seen as credible scientists, worthy of collaboration. Such judgements are made in the context of global academic and scientific fields where Western knowledge paradigms continue to set the rules of the game.

Bourdieu's framework helps to capture the nuanced dynamics of capital exchange in IRC, especially by connecting individual strategies to the larger field(s) in which actors are located. Our analysis shows that IRC is shaped by scientists' participation in multiple, overlapping fields. In the field of science, scientists look for recognition from other scientists for the content of their research – scientific capital – and therefore wish to collaborate to increase this recognition. However scientists are also required to compete in the academic field where more generic forms of economic capital dominate. This becomes especially clear when our participants describe tensions between the entrepreneurial agenda of universities pushing for TCM partnerships and the Australian scientists' judgements of scientific quality. The pressures of these various competitions can lead to actors on both sides 'promising the earth' in order to establish IRC as a mechanism to gain more capital.

How does IRC provide access to capital? We have shown that collaboration allows Australian and Chinese TCM researchers potential access to resources unobtainable in their national setting. Most notably, Australian researchers can access funding for TCM projects, and Chinese researchers, Western validation for their research. This symbiotic relationship suggests that distinct sets of rules shape research within China and Australia, and the existence of academic and scientific fields functioning at the national as well as global level. IRC allows actors to mobilise resources from one field and

translate them into a form recognised in the other. By collaborating with China where there is more recognition for TCM research, Australian researchers can gain funding and publications that are ultimately valued at home and in the global academic field.

A limitation of our study is the reliance on interviews with Australian scientists, and it will be important for future research to verify the motivations they ascribe to their Chinese collaborators. TCM is also one small area of Australian–Chinese IRC and further work is needed to identify collaborative dynamics in other disciplines. TCM is a somewhat unusual IRC area given its subaltern status in the West. At the same time, IRC in TCM may be illustrative of, and contributing to, shifting global epistemic hierarchies and China's growing status in world science. Zhang and Datta Burton (2022, p. 17) point out that IRC alters how science is done and what kinds of knowledge are valued: 'the rise of Chinese-led but transnationally organised science has formulated alternative ways of validating knowledge *within* contemporary Western science' (emphasis in original). Australian scientists' efforts to research and collaborate within the 'Chinese' knowledge domain of TCM is one marker of the evolution of the scientific field and these two countries' positions within it. Beyond these country-level comparisons, another question for future research is how IRC interacts with local institutional contexts to shape national academic fields. In Australia and especially in China, there is diversity and a stratification of universities with institutions differently oriented to global versus local engagement and to the state (Hong, 2018).

IRC connects the past and future of global knowledge production. Our study shows that IRC is founded on accrued social/cultural capital, but also, crucially, on the promise of future capital. These capitals are in a delicate and dynamic relation to each other, dependent on the rules of the field and positioning of research partners. Interestingly, in Braun Střelcová et al.'s (2022) study, the capital advantages experienced by European scientists in China faded over time; there was a limit on how much cultural and economic capital could be gained by playing the game of another field. Australia currently trades largely on its scientific reputation, attractive to China with its subordinate scientific habitus (Zhang & Datta Burton, 2022). However, this dynamic could be negated by decreasing public investment in science in Australia and China's rising scientific profile. Perhaps recognising Australia's tenuous position, Australian governments are now literally promising the Earth, promoting the natural environment as a scientific resource. This, too, is in danger. Our study highlights the need for Australia to consider future strategies in IRC to sustain its position in global science and its own knowledge economy. The importance of IRC is only increasing, and the forms of capital that bring partners together are being gradually redistributed, not least through IRC itself.

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