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Dialogue Among Civilizations? A Bibliometric Analysis of Research Collaboration Between the ‘West’ and the Islamic Republic of Iran, 2008-2016

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Abstract
International collaboration has become an increasingly common feature of academic work in recent decades. Engaging in such collaboration may be particularly challenging when relationships between host countries are tense or unpredictable, as they are between the ‘West’ and the Islamic Republic of Iran. On the other hand, however, collaboration may be facilitated by the many highly skilled Iranians who have migrated to Western countries.

In this study, I explore research collaboration between the West and Iran through an analysis of co-authored publications indexed in the Web of Science Core Collection for the nine-year period between 2008 and 2016. The findings of the study are discussed in relation to two conceptual frameworks, namely the centres and peripheries model of the global academic system, and the concept of a ‘Dialogue among civilizations’.
Acknowledgments

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<th>Description</th>
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<tr>
<td>AI</td>
<td>Activity Index</td>
</tr>
<tr>
<td>CAP</td>
<td>Changing Academic Profession (survey)</td>
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<tr>
<td>CC</td>
<td>Core Collection</td>
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<tr>
<td>CNCl</td>
<td>Category normalised citation impact</td>
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<td>GIPP</td>
<td>Global Institutional Profiles Project</td>
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<tr>
<td>IAU</td>
<td>International Association of Universities</td>
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<td>RSI</td>
<td>Relative Specialisation Index</td>
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<td>WoS</td>
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Chapter One: Introduction

Statement of the Problem

International collaboration has become an increasingly common feature of academic work in recent decades. Such collaboration is, perhaps, most visible in research, where it has been measured both through international co-authorship of publications and through international surveys of the academic profession. These measures of international research collaboration indicate that levels of collaboration vary considerably between countries, institutions, and disciplines (Gazni, Sugimoto, & Didegah, 2012; Huang, Finkelstein, & Rostan, 2014).

International research collaboration may be driven by the motivations of individual academics as well as by institutional and national rationales. Motivations and rationales are linked to the diverse range of benefits that individuals, institutions and nations hope to gain from collaboration (Beaver, 2001; de Wit, 2002; Gazni et al., 2012; Knight, 2008; Royal Society, 2011; Wagner, Brahmakulam, Jackson, Wong, & Yoda, 2001). International collaboration has been facilitated by developments in communications technologies, the lower costs of international travel, and the international mobility of academic staff. At the same time, collaboration across borders is constrained by inadequate funding, the legal and regulatory context for international collaboration, and geopolitical factors. Political tensions between countries shape the environment for international higher education (Altbach & de Wit, 2015). As such, engaging in international academic collaboration may be especially challenging when relationships between host countries are tense or unpredictable, as they are between the countries of the ‘West’ and the Islamic Republic of Iran.

In this study, I explore research collaboration between the ‘West’ and the Islamic Republic of Iran through an analysis of co-authored publications indexed in the Web of Science Core Collection for the nine-year period between 2008 and 2016.

While several bibliometric studies have explored international research collaboration from an Iranian perspective (Hayati & Didegah, 2010; Nikzad, Jamali, & Hariri, 2011), I have not found any published studies that have presented a thorough
analysis of research collaboration between the West and Iran from both the Western and Iranian perspectives.

Context

The ‘West’ and Iran have a long and complex historical relationship in which the West has been viewed both as a political, military, and cultural threat to Iran, and a model for reform. During the nineteenth and twentieth centuries, a succession of Iranian rulers adopted Western knowledge, technology, and institutions in a bid to strengthen and modernise the country. Under the Pahlavi Shahs (1925–1979), Western political, economic and cultural influence became increasingly pervasive and, in the 1960s and 1970s, many Iranian intellectuals such as Jal Al-e Ahmad, argued that Iran had become “Westoxicated” (Hanson, 1983).

There is no doubt that resentment against Western influence contributed to Iran’s Islamic Revolution in 1979, or that relations between the West and Iran deteriorated sharply thereafter. The tense relationship between Iran and the West has shaped the environment for academic collaboration between the two sides. During the presidency of Mahmoud Ahmadinejad (2005–2013), for example, Iran’s Ministry of Intelligence reportedly warned the country’s academics that they would be suspected of spying if they had contact with institutions in other countries or travelled overseas to attend international conferences (Tait, 2007).

Furthermore, the United Nations, the European Union and some individual countries have imposed several rounds of sanctions on Iran in response to the country’s nuclear program. In addition, the United States has imposed successive rounds of sanctions on Iran beginning with those imposed during the 1979-1981 Iran hostage crisis (BBC News, 2015). The impact of these sanctions regimes on research collaboration between the West and Iran is difficult to assess. However, it is clear that, in the United States at least, sanctions have the potential to impact research collaboration with Iran (Bohnhorst et al., 2011; Institute of International Education, 2015; Miller, Dong, & Briscoe, 2016).
The context for research collaboration between the West and the Islamic Republic of Iran appears to have improved with the election of Iranian President Hassan Rouhani in 2013. President Rouhani pledged to engage with the West, and he has encouraged greater collaboration between Iranian and foreign academics (Labi, 2014). The agreement of the Iran nuclear deal in 2015, and the lifting of some of the sanctions against Iran in 2016, also appear to have contributed to a more fruitful environment for research collaboration between the two sides. It is noteworthy, for example, that partnership agreements between Iranian and European universities were signed within weeks of sanctions being lifted (Havergal, 2016). However, the context for collaboration between the two sides has deteriorated since the election of President Donald Trump in the United States in November 2016 as exemplified by two travel bans which sought to bar Iranian citizens (among others) from entering the United States for a 90 day period (see, for example, BBC News, 2017; Merica, 2017).

On the other hand, research collaboration between the two sides may be facilitated by the long history of migration of highly skilled Iranians to Western countries. Scholars such as Altbach (2001) have argued that a country’s academic diaspora may “serve as point of ongoing contact and exchange” between their home and host countries (p. 208). Many Iranians study at higher education institutions in Western countries. According to a recent estimate from the UNESCO Institute of Statistics, approximately 50,000 students of Iranian origin are studying abroad (2016a), with Western countries representing the top five destinations (2016b). In the United States at least, the “vast majority” of Iranian students study at the graduate level (Institute of International Education, 2015). Some of these students will return home to take up positions in Iranian higher education institutions, while others may find employment at Western higher education institutions. Still other Iranians may take up academic positions at Western institutions after completing their education in Iran. While the total number of Iranian academics employed by higher education institutions in Western countries is not known, 1,475 scholars of Iranian origin are hosted by higher education institutions in the United States (Institute of International Education, 2015). These and other internationally mobile Iranian born academics are ideally situated to facilitate collaboration between the West and Iran.
Purpose of the Study

The purpose of this study is to explore research collaboration between the ‘West’ and the Islamic Republic of Iran by analysing the bibliometric data associated with publications indexed in the Web of Science Core Collection that were co-authored by academics in Western countries and Iran for the nine-year period between 2008 and 2016.

For the purposes of this study, the West’ is defined as those countries that are both identified as members of Western civilization by Huntington (2011) and were considered to be part of the Western bloc during the Cold War.

The Research Questions

Central question.

The central research question that guides this study is: How do the ‘West’ and the Islamic Republic of Iran engage in research collaboration with each other?

Sub-questions.

1. To what extent do Western countries and Iran engage in research collaboration with each other? Are research links between Western countries and Iran symmetrical?
2. How does collaboration between Western countries and Iran influence each country’s relative specialisation in particular research fields?
3. How does collaboration between Western countries and Iran influence the citation impact of each country’s publications?
4. To what extent is research collaboration between the West and Iran facilitated by academics who have simultaneous institutional affiliations in both the West and Iran?

Limitations

I do not understand Farsi, the predominant and official language of Iran (Encyclopædia Britannica, 2016), or any language other than English. Accordingly, my literature review will be limited to English language sources, and these may differ in important ways from sources written in other languages (Egger & Smith, 1998). In particular, Farsi language
sources may treat the complex historical relationship between the West and Iran quite differently from English language sources on this subject.

**Organisation of the Thesis**

This thesis is organised into five chapters as follows. Following this introduction, in Chapter Two, I present a critical review of literature on international research collaboration, and an analysis of the context for research collaboration between the ‘West’ and Iran in order to situate my study.

In Chapter Three, I describe the research design and methods that guide this study. In Chapter Four, I present and analyse the findings of the study. In Chapter Five, I summarise the major findings of the study, discuss them in relation to the two conceptual frameworks for understanding international academic collaboration presented in the literature review; describe the limitations of the study; and suggest directions for future research.
Chapter Two: Literature Review and the Context for Collaboration between the West and Iran

In this chapter, I present a critical review of the literature on international research collaboration; and an analysis of the context for collaboration between the ‘West’ and the Islamic Republic of Iran in order to situate my study.

International collaboration has become an increasingly common feature of academic research in recent decades, although it is important to note that the extent and nature of such collaboration varies across nations, institutions and disciplines. There are a number of factors that facilitate and constrain international collaboration, and these factors play out in different ways according to the context in which collaboration takes place. I suggest here that, while geopolitics may constrain research collaboration between the West and Iran, high rates of international mobility among Iranian born academics may act as a valuable resource in facilitating collaboration between the two sides.

International Research Collaboration – an Introduction

International collaboration may take place within the context of formal arrangements between nations, higher education institutions, or academic units within those institutions. It may also arise from informal arrangements between individual academics. International research collaboration has been measured both through surveys of the academic profession, and through bibliometric analyses of co-authored publications indexed in databases such as the Web of Science (maintained by Clarivate Analytics) and Scopus ® (maintained by Elsevier).

The Changing Academic Profession (CAP) 2007-2008 survey, a survey of 26,000 academics in 19 countries across four continents (Huang et al., 2014), found that 41% of academics engaged in research collaboration with colleagues in other countries, while 31% co-authored publications with such colleagues (Rostan, Finkelstein, & Huang, 2014).

At the same time, recent studies show that the percentage of publications involving international co-authorship increased from 14% to 18% between 2000 and 2009 in the
Web of Science (Gazni et al., 2012) and from 25% to 35% between 1996 and 2008 in Scopus (Royal Society, 2011). The methodological issues associated with using international co-authorship as a proxy for international collaboration will be discussed in the Research Design and Methods chapter.

**International Research Collaboration – Individual Motivations, Institutional and National Rationales**

International research collaboration may be driven by the motivations of individual academics as well as by institutional and national rationales. Motivations and rationales are linked to the benefits that individuals, institutions and nations hope to gain from collaboration.

Individual academics may be motivated to engage in research collaboration, including collaboration across borders, by a range of factors including: the desire to access expertise, funding, equipment, and data; to make progress on projects more quickly and efficiently; to network with other researchers; or to advance themselves professionally by increasing their visibility, productivity, or citation rate (Beaver, 2001; Gazni et al., 2012; Royal Society, 2011; Wagner et al., 2001).

In addition to the motivations of individual academics discussed above, institutional and national rationales are also import drivers of international research collaboration. The Royal Society (2011) suggests that the three main factors driving international academic collaboration at the national level are: (1) **quality** (“the added value gained by bringing together different skills, knowledge and perspectives”); (2) **efficiency and effectiveness** (“the drive to combine intellectual, financial and infrastructural resources, to achieve more than one nation could manage alone”); and (3) **necessity** (the need to address global challenges such as climate change and pandemics, “which require large-scale co-operation” (p. 104).

Several scholars have also considered the rationales driving internationalization in higher education more broadly. Knight (2008) defines internationalization as “the process of integrating an international, intercultural or global dimension into the purpose, functions
or delivery of higher education at the institutional and national levels” (p. 21). Knight (2008) and de Wit (2002) both suggest that there are four broad categories of rationales for internationalization: (1) Political rationales such as engaging in international academic collaboration in order to invest in future political relations between countries; (2) economic rationales such as internationalizing research in order to aid technological development and boost economic growth; (3) sociocultural rationales such as providing support to promote country studies; and (4) academic rationales such as collaborating internationally in order to enable countries and institutions to engage in research projects that would not be possible on the basis of local resources and/or expertise alone (de Wit, 2002).

Motivations and rationales may differ between collaborators, especially between those in developing and developed countries. For example, a recent study of collaboration between scientists in South Africa and Germany found that, in addition to being motivated by the desire to share skills and knowledge, scientists in South Africa were also motivated by the need to access funds and by their lack of domestic contacts. Their German partners, on the other hand, were motivated by “South African” topics or research opportunities, such as access to the South African Large Telescope (SALT) (T. Schubert & Sooryamoorthy, 2010).

While the above discussion illustrates some of the reasons why individuals, institutions and nations may wish to collaborate across borders, it is important to note that rates of international research collaboration vary across nations, institutions, and disciplines. In the discussion below, I will first discuss the ways in which opportunities to engage in international research collaboration are conditioned by the status or position of nations and institutions in the global academic system. Second, I will discuss variations in rates of international research collaboration across disciplines.

National and Institutional Differences in International Collaboration: Centres and Peripheries in the Global Academic System

As Altbach (2006) points out, the global academic system is a “highly unequal” one in which powerful universities and national academic systems – the centres – dominate the production and distribution of knowledge, while smaller and weaker institutions and
systems – the peripheries – are dependent on them. The position of a country in the global academic system is influenced by a number of factors including its size, wealth and geographic location; the international status of its language; it’s level of scientific development; the resources invested in its research and higher education system; and the ways in which its higher education system is organized and regulated (Altbach, 2006; Enders, 2006; Enders & Musselin, 2008; Gazni et al., 2012; Marginson & van der Wende, 2009; Wagner et al., 2001).

The academic centres, according to Altbach (2006), are the leading research universities, which are primarily located in the larger and wealthier countries, particularly those where English is one of the official languages. According to the 2016 Academic Ranking of World Universities (ShanghaiRanking Consultancy, n.d.), for example, 50 of the top 100 ranked universities in the world are located in the United States. Together with institutions based in Australia, Canada, and the United Kingdom, institutions in wealthy English speaking countries account for 68 of the world’s top 100 universities, while institutions located in the non-English speaking but relatively wealthy countries of Western Europe account for another 22 of these universities. The flow of talented academics and students runs predominantly from the peripheries to the academic centres, while new knowledge, advanced training, and academic norms and values flow largely in the opposite direction (see, for example, Altbach, 2006).

The centres and peripheries model is evident both in surveys of the academic profession and in analyses of internationally co-authored publications. In their analysis of data from the Changing Academic Profession (CAP) 2007-08 survey, for example, Rostan, Ceravolo, and Metcalfe (2014) found that participants were more likely to report that they engaged in international research collaboration if they worked in small countries rather than in large countries; in mature economies rather than in emerging economies; and in countries where English is not the main language or one of the official languages.

Similarly, Gazni et al. (2012), found that a country’s rate of contribution to internationally co-authored publications was influenced both by its level of economic development and its level of scientific development. They note that that just six countries
– Canada, France, Germany, Italy, the United Kingdom, and the United States - account for 82% of all internationally co-authored publications indexed in the Web of Science between 2000 and 2009. At the same time, the authors found that the most internationally collaborative countries as measured by the proportion of publications that involved international co-authorship were Switzerland, Belgium, Denmark and Austria, leading them to speculate that the relatively small size of these countries contributed to their higher rates of international collaboration.

Schubert and Glänzel (2006) also observed the influence of geopolitical location, and cultural and linguistic ties in their analysis of cross-national preferences in co-authorship, references and citations. They found that there were strong ties, for example, between the countries of the Far East; and between the countries of Latin America, Spain and Portugal.

Research links between some country pairs are asymmetric. For example, a recent study found that, while Germany (a central country) is South Africa’s third most important research partner as measured by the number of co-authored publications, South Africa (a semi-peripheral country) is only Germany’s 46th most important partner (T. Schubert & Sooryamoorthy, 2010).

As Altbach (2006) notes, even within countries at the centre of the global academic system, there are many peripheral institutions. At the same time, high quality universities exist in other countries. According to the 2016 Academic Ranking of World Universities (Shanghai Ranking Consultancy, n.d.), for example, two of the world’s top 100 universities are located in Israel.

Academic staff affiliated with highly cited institutions may be more likely than those at other institutions to co-author publications with colleagues in other countries. For example, Gazni et al. (2012) calculated that, among the top 20 institutions as measured by the number of citations their publications received, the percentage of publications that were internationally co-authored was markedly higher than the world average across each of five broad fields of study (Life Sciences, Physical Sciences, Medicine, Multidisciplinary, and Social Sciences). More generally, the Changing Academic
Profession (CAP) survey of 2007-2008 found that academic staff working at universities were more likely than their colleagues at other higher education institutions to collaborate with international colleagues in their research (Rostan & Höhle, 2014).

**Disciplinary Differences**

In addition to variations across nations and institutions, several studies have found that rates of international research collaboration vary markedly across disciplines. For example, in their analysis of Web of Science documents published between 2000 and 2009, Gazni et al. (2012) found that Space Science was the most internationally collaborative field, with nearly 44% of publications being internationally co-authored, while Social Sciences, general, was the least internationally collaborative field, with just over 6% of publications being internationally co-authored. A broader difference between the hard and soft disciplines is evident in the Changing Academic Profession (CAP) survey of 2007-2008, which indicates that 40% of academics in hard disciplines co-author publications with colleagues in other countries, compared with 21% in soft disciplines (Rostan, Finkelstein, et al., 2014).

It is interesting to note that international collaboration can influence a country’s relative specialisation in particular research fields, as measured by the proportion of publications that those fields account for at the country level compared to the proportion of publications that the same fields account for worldwide. Glänzel (2001) demonstrated four different ways in which international collaboration can influence a country’s relative research specialisations. The profile of a country’s publications that involve international collaboration may: (1) be similar to that of its domestic publications; (2) deviate from the world distribution of fields more than its domestic publications; (3) deviate from the world distribution of fields less than its domestic publications; or (4) not conform to any of the above patterns.

**International Research Collaboration - Facilitating Factors**

The literature on international academic collaboration indicates that some factors facilitate collaboration while other factors constrain it. Facilitating factors include developments in
communications technologies; the lower costs of international travel; and the international mobility of academic staff. Constraining factors include geopolitics; legal and regulatory issues; and inadequate funding.

**Communications technologies.**

Developments in communications technologies – including email, cell phones, the internet, and free telephone calls over the internet - have made it easier and cheaper for individuals, institutions and nations to collaborate across borders. It should be noted, however, that these technologies cannot entirely replace face to face interactions. Some scientists suggest that face to face interaction may help to build trust and confidence between researchers, and that it can be important when collaboration involves learning physical skills or conveying tacit knowledge (Wagner et al., 2001). It is also important to note that modern communications technologies are not equally available to all individuals, institutions and nations.

**Travel.**

In recent decades, it has become cheaper to travel internationally, making it easier for academics to work together across borders.

**International mobility of academic staff.**

International research collaboration is also facilitated by the international mobility of academic staff. Several studies have found that academics who have experience of living, studying or working in another country have higher rates of engagement in international academic collaboration than their non-mobile colleagues. These studies also indicate that different types of international mobility and experience abroad influence international academic collaboration to different degrees. For example, Rostan and Höhle’s (2014) analysis of CAP survey data indicates that the academic staff who are most likely to engage in international research collaboration are those who entered the country of their current employment academically fully qualified. This group is followed by: academic staff who were born in the country of their current employment but who left the country temporarily to work or study abroad during their professional careers; then by
those who were born in another country and entered the country of their current employment as students. All three of these internationally mobile groups were significantly more likely to engage in international research collaboration than academic staff who had no experience abroad.

Similarly, Scellato, Franzoni, and Stephan (2015) found that migrant researchers, both those that were born in another country, and those who had spent time abroad for doctoral training, postdoctoral work, or employment have larger international research networks than those who lack international experience. Consistent with Rostan and Höhle’s (2014) findings, the authors found that the higher rates of international collaboration among migrant researchers was driven primarily by those who migrated for a postdoctoral position or employment having already received their doctoral training. They note that these results suggest that research links established during doctoral training are portable. This proposition is also consistent with their finding that more than 43% of foreign-born researchers report research collaborations with their country of origin.

**Academic diasporas.**

As noted earlier, the flow of talented academic staff runs predominantly from the peripheries to the academic centres. While the migration of academic staff has traditionally been framed as ‘brain drain’ for the sending country, scholars such as Altbach (2001) suggest that a country’s academic diaspora may also “serve as point of ongoing contact and exchange” between their home and host countries (p. 208). It is important to note, however, that in some cases, relations between countries and their diasporas are characterised by mutual suspicion, “where governments view diaspora as potentially subversive actors, and vice versa” (Pellerin & Mullings, 2013, p. 106). Indeed, Zeleza (2013) found that the attitudes of African diaspora academics in North America towards collaborating with their countries of origin were strongly influenced by the circumstances in which they left. He found that those who left as a result of a war, or who became political exiles, were less likely to collaborate with their countries of origin than those who left for more mundane reasons.
**Synchronous international mobility – academics with simultaneous institutional affiliations in more than one country.**

While the international mobility of academic staff has received considerable attention in the higher education literature, most studies have addressed what Markova, Shmatko, and Katchanov (2016) describe as diachronic international scientific mobility, that is, the movement of academic staff between countries over time. Synchronous international scientific mobility - that is, simultaneous affiliations with institutions in different countries, has received little attention.

Some scholars claim that academic staff who are affiliated with multiple institutions, including institutions in different countries, may facilitate knowledge transfer between those institutions (Borchgrevink & Scholz, 2013) or promote resource use efficiency and collaboration (Hottenrott & Lawson, 2017). Publications authored by academic staff with multiple institutional affiliations may reflect agreements between institutions to share researchers (Katz & Martin, 1997). On the other hand, however, there are cases of assessment- or income-driven institutional affiliation in which affiliations “act purely as a PO-Box for researchers with little or no actual research undertaken there” (Hottenrott & Lawson, 2017, p. 294).

Markova et al. (2016) found that 15% of authors who had Russian institutional affiliations, and who had at least three publications in the Web of Science between 2008 and 2013, were also affiliated with institutions in other countries during the study period, while 85% had Russian affiliations only. Even this study, however, does not necessarily give us an accurate measure of the extent of synchronous international mobility since it cannot be assumed that authors who had both Russian and non-Russian affiliations during this period were affiliated with these institutions at the same time.

**International Research Collaboration – Constraining Factors**

While developments in communications technologies; the cheaper cost of international travel; and the diachronic and synchronous international mobility of academic staff may facilitate international collaboration, there are also many factors that constrain such collaboration. These factors include geopolitics; the legal and regulatory context for international collaboration; and inadequate funding.
Geopolitics.

As Altbach and de Wit (2015) note, political tensions between countries shape the environment for international higher education. Geopolitics may lead to travel restrictions; prohibitions on collaboration with particular countries; and the arrest and detention of researchers, all of which may constrain international collaboration. It is interesting to note, for example, that in the International Association of Universities (IAU) 4th Global Survey, visa restrictions imposed on international students, researchers and academics was ranked as the second most significant external obstacle to internationalization for respondents in North America, the Middle East, and Africa (Egron-Polak & Hudson, 2014). At the same time, however, international academic collaboration may offer a way of promoting mutual understanding between countries, and this may be especially valuable when formal government to government relations are tense, hostile or non-existent.

Legal and regulatory context for international research collaboration.

Academic staff who engage in international collaboration need to pay close attention to the laws and regulations of both their own country and those of their collaborator(s) (Bohnhorst, McQuaid, Bolton Tsantir, Amundson, & Anderson, 2011). Recurring issues in international research projects include different regulations regarding: intellectual property (IP) rights, liability, and the ethical treatment of human subjects. Some of the most serious constraints on international research collaboration are those that arise from sanctions regimes imposed by international organisations or national governments (Bohnhorst et al., 2011; Sakamoto & Chapman, 2011).

Funding.

Although advances in communication technologies and reductions in the cost of international travel have lowered the costs of international collaboration, costs can still be considerable. These costs may include travel and living costs for academics who travel abroad, the transport of equipment and materials, and costs associated with hosting international colleagues. Indeed, in the International Association of Universities (IAU) 4th
Global Survey, respondents from all regions of the world ranked lack of funding as the most significant internal obstacle to internationalization, while limited public funding to support internationalization was ranked as the most significant external obstacle (Egron-Polak & Hudson, 2014). Although there appears to be an increasing desire among academics to collaborate across borders, research is largely funded at the national level, and national funding systems tend to reflect perceived national, rather than international, needs (see, for example, Mayer, 2011).

Research Collaboration between the West and the Islamic Republic of Iran

In my review of the literature on international research collaboration above I have discussed individual motivations and institutional and national rationales for international research collaboration; demonstrated that engagement in international research collaboration is conditioned by national and institutional factors, as well as disciplinary differences; and outlined some of the factors that facilitate and constrain research collaboration across borders. However, international research collaboration must be understood within the specific context in which it takes place. In this study, I explore research collaboration between the countries of the ‘West’ and the Islamic Republic of Iran. In the second part of this chapter, I start by providing an overview of the key characteristics of those countries that are usually considered to be part of the West as they relate to international collaboration in research. Secondly, I describe the key characteristics of Iran as they relate to international research collaboration. Finally, I describe the context for international research collaboration between the West and Iran.

The ‘West’

There is no agreed definition of the ‘West’ but, for the purposes of this study, the West shall be defined as those countries that are both classified as members of Western civilization by Samuel Huntington (2011), and were also broadly aligned with the United States during the Cold War. In this study, then, the West comprises the countries of Western Europe together with Australia, Canada, New Zealand, and the United States of America (see Table 1).
According to Huntington, there is a combination of characteristics that differentiates the West from other civilizations, namely: its inheritance from previous civilizations, particularly Classical civilization; Western Christianity, that is Catholicism and Protestantism; European languages; the separation of church and state; the rule of law; social pluralism; representative bodies; and a sense of individualism together with a tradition of individual rights and liberties (Huntington, 2011, pp. 69-72).

While there are many variations between (and within) individual Western countries, it is possible to make some broad generalizations about the West on the basis of the country indicators presented in Table 1. These indicate that many Western countries are located at the centre of the global academic system. First, Western countries are relatively wealthy. The World Bank (2017) classifies all Western countries as high income economies. Second, the majority of Western countries contribute a greater percentage of their GDP to Research and Development than the world average of 1.69%, although there are several exceptions (UNESCO Institute for Statistics, n.d.-b). Third, English is a major language in several Western countries – Australia, Canada, Ireland, Malta, New Zealand, the United Kingdom, and the United States – but by no means the majority of them (BBC News, n.d.). Fourth, the higher education systems of most Western countries are classified as universal systems in Trow’s (1973) schema. That is, more than 50% of the relevant age cohort is enrolled in higher education. Notable exceptions are Luxembourg with just 17% of the relevant age cohort enrolled in higher education and Malta at 47% (UNESCO Institute for Statistics, n.d.-a).

It is also worth noting that internet penetration is estimated at over 80% of the population in all but three Western countries, compared to internet penetration of 49% across the world as a whole (Internet World Stats, 2017b). As noted earlier, developments in communications technologies, including the internet are widely acknowledged to facilitate international collaboration. Most Western countries are not particularly large as measured either by land area or population but it is interesting to note that the United States, which hosts 50 of the world’s top 100 top ranked universities (ShanghaiRanking Consultancy, n.d.), is both large and populous.
Table 1: The West – Country Indicators

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<td>83,718</td>
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<td>51%</td>
<td>42,924</td>
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<td>82,523</td>
<td>114</td>
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<td>82%*</td>
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<td>24</td>
<td>65%</td>
<td>13,890</td>
<td>20</td>
</tr>
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<td>73%*</td>
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<td>66%</td>
<td>18,758</td>
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<td>23</td>
<td>62%</td>
<td>14,504</td>
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<td>69</td>
<td>NO</td>
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<td>92%</td>
<td>87%*</td>
<td>16,265</td>
<td>33</td>
<td>61%</td>
<td>9,914</td>
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<td>547,557</td>
<td>46</td>
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<td>94,021</td>
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<td>58%</td>
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<td>141,670</td>
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<td>52%</td>
<td>73,952</td>
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<td>56,114</td>
<td>201</td>
<td>410,450</td>
<td>56</td>
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<td>90%</td>
<td>****</td>
<td>97</td>
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<td>91</td>
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<td>176</td>
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<td>104</td>
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<td>1,509</td>
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<td>76%</td>
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<td>13,018</td>
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<td>89,215</td>
<td>7</td>
<td>48%</td>
<td>43,022</td>
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<td>569,676</td>
<td>168</td>
<td>2,590</td>
<td>174</td>
<td>NO</td>
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<td>94%</td>
<td>19%*</td>
<td>1,564</td>
<td>69</td>
<td>77%</td>
<td>1,203</td>
<td>67</td>
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<td>171</td>
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<td>61%</td>
<td>289</td>
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<td>33,690</td>
<td>135</td>
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<td>CHRN</td>
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<td>79%*</td>
<td>51,397</td>
<td>13</td>
<td>61%</td>
<td>31,142</td>
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<td>CHRN</td>
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<td>81%*</td>
<td>12,322</td>
<td>39</td>
<td>58%</td>
<td>7,102</td>
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<td>365,245</td>
<td>60</td>
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<td>77%*</td>
<td>16,561</td>
<td>30</td>
<td>63%</td>
<td>10,385</td>
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<td>10,348,648</td>
<td>87</td>
<td>91,605</td>
<td>106</td>
<td>NO</td>
<td>CHRN</td>
<td>68%</td>
<td>66%*</td>
<td>19,138</td>
<td>25</td>
<td>54%</td>
<td>10,357</td>
<td>25</td>
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<td>HI</td>
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<td>46,418,269</td>
<td>29</td>
<td>500,210</td>
<td>49</td>
<td>NO</td>
<td>CHRN</td>
<td>77%</td>
<td>90%*</td>
<td>71,888</td>
<td>11</td>
<td>51%</td>
<td>36,923</td>
<td>9</td>
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<tr>
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<td>3.16</td>
<td>9,798,871</td>
<td>89</td>
<td>407,310</td>
<td>57</td>
<td>NO</td>
<td>CHRN</td>
<td>95%</td>
<td>62%*</td>
<td>34,076</td>
<td>19</td>
<td>64%</td>
<td>21,773</td>
<td>13</td>
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<td>8,286,976</td>
<td>96</td>
<td>39,516</td>
<td>132</td>
<td>NO</td>
<td>CHRN</td>
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<td>38,731</td>
<td>16</td>
<td>70%</td>
<td>27,049</td>
<td>12</td>
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<td>1.70</td>
<td>65,138,232</td>
<td>22</td>
<td>241,930</td>
<td>78</td>
<td>YES</td>
<td>CHRN</td>
<td>92%</td>
<td>56%*</td>
<td>170,852</td>
<td>3</td>
<td>52%</td>
<td>88,296</td>
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<td>United States</td>
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<td>321,418,820</td>
<td>3</td>
<td>9,147,420</td>
<td>3</td>
<td>YES</td>
<td>CHRN</td>
<td>89%</td>
<td>86%*</td>
<td>566,116</td>
<td>1</td>
<td>34%</td>
<td>191,536</td>
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<tr>
<td>World</td>
<td>1.69</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>49%</td>
<td>34%*</td>
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</tbody>
</table>

Legend
*** No data available

Notes
Consistent with Huntington’s characterisation of Western civilization, the major religion of all Western countries is Christianity.

Considering these indicators, it is unsurprising that Western countries are among the most productive countries as measured both by the number of publications and the number of internationally co-authored publications that they publish. According to 2016 data generated using the InCites analytical tool with publications sourced from the Web of Science, seven of the top 10 countries as ranked by the number of publications published are Western – Australia, Canada, France, Germany, Italy, the United Kingdom, and the United States (the other three top 10 countries are mainland China, India, and Japan). Nine of the top 10 producers of internationally co-authored publications are also Western - Australia, Canada, France, Germany, Italy, the Netherlands, Spain, the United Kingdom, and the United States (the other top 10 producer of internationally co-authored publications is mainland China).

The relative power of the countries of the West has given rise to the concept of Westernization. As Knight (2008) notes, while some believe that the increased flow of people, ideas and cultures across borders together with developments in communications technologies allow countries to promote their culture internationally, others argue that these forces may erode national cultural identities and that native cultures risk being Westernized. Westernization is a particularly salient concept for international academic collaboration. Indeed, in the International Association of Universities (IAU) 4th Global Survey, African respondents reported that they view the dominance of a ‘western’ epistemological approach as the second most important societal risk of the internationalization of higher education, while respondents from the Middle East view the loss of cultural identity as the second most important risk associated with this process.

**The Islamic Republic of Iran**

In contrast to the predominantly Christian countries of the West, the major religion of Iran is Islam, and the country has been an Islamic Republic since 1979. Iran is an ethnically diverse country located in southwestern Asia (Encyclopædia Britannica, 2016), and it's
major and official language is Persian (or Farsi) (BBC News, 2016; Encyclopædia Britannica, 2016). It is a relatively large country as measured both by land area and by population, and it is classified as an upper middle income economy by the World Bank (2017). In common with most Western countries, Iran’s higher education system is classified as a universal system in Trow’s (1973) schema since more than 50% of the relevant age cohort is enrolled in higher education (see country indicators for Iran displayed in Table 2).

**History and Politics of Iran**

Iran, or Persia as it was called before 1935, has a long and proud history, and the Persian empire has been described as “one of the greatest empires of the ancient world” (BBC News, 2016). In contrast to most modern Muslim states, Iran was not formally colonised by European powers. It has, however, frequently been subject to “foreign invasions, meddling … [and] influence” (Wright, 2015, p. 5). Relatively recent examples of foreign interference in Iran include: the British and Russian invasion of the country in 1941; and the involvement of the American and British intelligence forces in the overthrow of the democratically elected Prime Minister Mohammad Mossadegh in 1953, and the subsequent restoration of Mohammad Reza Shah Pahlavi, Iran’s last monarch, to full power.

There is no doubt that resentment against Western meddling in Iran contributed to the 1979 Islamic Revolution led by Ayatollah Khomeini, and the overthrow of the pro-Western Pahlavi monarchy (1925–1979). Shortly after the revolution, Iran was proclaimed an Islamic Republic following a referendum. The constitution of the new Islamic Republic established a set of Islamic institutions that mirror republican branches of government and sometimes have more power than them (Wright, 2015). Cutting across this formal power structure, is an informal power structure in which Conservative (or Principlist), Pragmatist, and Reformist factions within the political elite compete for influence (Rakel, 2007). Under the constitution, ultimate power is held by the Supreme Leader, a position held by Ayatollah Khomeini from 1979 until his death in 1989, and Ayatollah Khamenei since 1989.
Table 2: The Islamic Republic of Iran – Country Indicators

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<tbody>
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<td>17</td>
<td>1,628,760</td>
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<td>18</td>
<td>24%</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21%</td>
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</tr>
</tbody>
</table>

Notes:
[6] Calculated using figures from The World Bank (n.d.)
Higher Education and Science in Pahlavi Iran (1925 – 1979)

Higher education in Iran reflects the country’s history and politics. Although the Academy of Jundi Shapur, established in the third century AD, became one of the most important centres of higher learning in the world (Nakosteen, 1964), by the nineteenth century, Iranian reformers sought to introduce European-style education as part of a broader set of reforms intended to address Iran’s perceived military, political and commercial weakness vis a vis Europe. In 1851, Iran’s first European-style higher education institution, the Dar al Fonun (the Academy of Applied Sciences) was established (see, for example, Ringer, 2001) and, in 1934, Reza Shah Pahlavi established Tehran University, Iran’s first modern university. Both the organization and the curriculum of the new university were strongly influenced by the French university. The French-Iranian model instantiated at Tehran University served as a model for subsequent Iranian universities until it was eclipsed by the American model.

Following the overthrow of Prime Minister Mossadegh and the restoration of the monarchy in 1953, American influence grew in many spheres of Iranian life, including in its higher education system. In 1962, Shiraz University “metamorphosed” into Pahlavi University, Iran’s first American-style university (Doerr, 1968). In addition to adopting the organizational structure of the American university, Iranian higher education institutions increasingly relied on American educational materials (Hamdhaidari, 2008). Decrying the increase of Western influence in Iranian life under the Pahlavi shahs (1925–1979), many Iranian intellectuals such as Jal Al-e Ahmad declared that Iran had become “Westoxicated” (Hanson, 1983).

During the Pahlavi era, Iran’s higher education system was small and elitist, as well as Western influenced. By 1979, the gross enrollment rate was only 5% (Bazargan, 2007). The number of publications published in international scientific journals was also rather low, although this number grew in the last few years before the Islamic Revolution (see Table 3).
Higher Education and Science in the Islamic Republic of Iran (1979 to date)

Iran’s higher education system has witnessed major changes since the Islamic Revolution in 1979. In addition to expanding the rate of student enrolment in higher education from 5% to 72% (UNESCO Institute for Statistics, n.d.-a), Iran has also dramatically increased its scientific research output as measured by the number of publications it publishes in international scientific journals. Nevertheless, these developments did not happen immediately, and Khosrokhavar and Ghaneirad (2006) describe the years that followed the Islamic Revolution as “catastrophic” for scientific research in Iran. There are several reasons for the decline of scientific activity during this period including the closure of Iran’s universities for the “Cultural Revolution”, the sharp reduction in the number of professors employed by the country’s universities, and the war with Iraq.

Ayatollah Khomeini was highly critical of Iran’s westernized education system, stating: “our universities are foreign dependent. … Our university students are Westoxicated (gharbzadeh). … Many of our university professors are at the service of the West. … The university must become Islamic” (Kayhan newspaper - cited in Behdad, 1995). In 1980, he ordered the closure of all Iran’s universities and launched the Cultural Revolution, with the aim of “Islamizing” and “Purifying” them (Borjian, 2011) Most of Iran’s universities remained closed for three years (two years for medicine).

1 Data exported April 15, 2017.
As a result of the “Purification” process undertaken during the Cultural Revolution, many professors were excluded from Iran’s universities, while others emigrated to Western countries (Khosrokhabar & Ghaneirad, 2006). According to the Ministry of Culture and Higher Education, 16,222 professors were employed in the country’s universities before they were closed. When they reopened, there were only 9,042 (cited in Hakimzadeh, 2006), amounting to a loss of about 44% of the pre-Revolution total.

In addition to the Cultural Revolution, and the reduction in the number of professors at Iran’s universities, scientific research was hindered by the Iran-Iraq war (1980-1988) during which few resources were available for the development of higher education and science. Khosrokhavar and Ghaneirad (2006) note, however, that the war with Iraq may have contributed to the long term development of higher education and science in Iran as the role of scientists in developing the equipment associated with modern warfare became increasingly apparent. Nevertheless, during the war with Iraq, investment in Research and Development fell from 0.27% to 0.23% of GDP (Goodarzi & Ghazinoori, 2013). This difficult period for Iranian science is reflected in the sharp decline in the number of Iranian publications published in international scientific journals during the 1980s (see Table 4).

<table>
<thead>
<tr>
<th>Year</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>341</td>
</tr>
<tr>
<td>1981</td>
<td>266</td>
</tr>
<tr>
<td>1982</td>
<td>163</td>
</tr>
<tr>
<td>1983</td>
<td>151</td>
</tr>
<tr>
<td>1984</td>
<td>143</td>
</tr>
<tr>
<td>1985</td>
<td>138</td>
</tr>
<tr>
<td>1986</td>
<td>183</td>
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<tr>
<td>1987</td>
<td>165</td>
</tr>
<tr>
<td>1988</td>
<td>164</td>
</tr>
<tr>
<td>1989</td>
<td>153</td>
</tr>
</tbody>
</table>

Following the end of the Iran-Iraq war, however, the conditions for scientific research improved. Since that time Iran’s political elites have generally been supportive

\(^2\) Data exported April 15, 2017.
of the development of higher education and science, and this support has translated into funding for better salaries for academic staff as well as for building new laboratories (Khosrokhavar, Etemad, & Mehrabi, 2004). The number of public research centres in Iran increased from 79 in 1988 to 154 in 1997 (Goodarzi & Ghazinoori, 2013), although investment in Research and Development remained “more or less constant” at 0.33% of GDP during the 1990s (Goodarzi & Ghazinoori, 2013). An important milestone in the development of science in Iran came in 1988-89, when the Ministry of Culture and Higher Education officially authorised universities to initiate doctoral programs in the hard sciences (Khosrokhavar & Ghaneirad, 2006). Before the Islamic Revolution, Iranians who wished to obtain doctorates had to enroll in PhD programs in universities in the West. Another milestone in the development of higher education and science in Iran came in 2000, when the Ministry of Culture and Higher Education was given responsibility for all activities related to science and technology, and was renamed the Ministry of Science, Research and Technology (Bazargan, 2007).

Several plans have pledged to increase funding for Research and Development in Iran. For example, the Supreme Council of the Cultural Revolution’s ‘National Master Plan for Science and Education’ (2011) pledged to increase investment in research to 4% of GDP. According to figures from the UNESCO Institute for Statistics (n.d.-b), however, in recent years investment in Research and Development has declined as a proportion of GDP, falling from a high of 0.67% in 2008 to 0.33% in 2012. Nevertheless, the growth in Iran’s scientific output has been impressive.

While support for the development of higher education and science has been common among all factions of Iran’s political elite since the end of the war with Iraq, views on international academic collaboration have been more divided. While President’s Mohammad Khatami (1997–2005) called for regulations to be simplified to facilitate international academic collaboration (Plan and Budget Organization, cited in Borjian, 2011), during President Mahmoud Ahmadinejad time in office (2005-2013), Iran’s Ministry of Intelligence reportedly warned the country’s academics that they would be suspected of spying if they had contacts with institutions in other countries or traveled overseas to attend international conferences (Tait, 2007). Iran’s current President Hassan Rouhani
(2013 to date) has, like President Khatami, promoted the idea of an outward looking Iran, and he has encouraged greater collaboration with foreign academics (Labi, 2014).

**Increase in number of Iranian scientific publications.**

In 1996, for the first time, the number of Iranian publications (717) surpassed its pre-revolutionary peak (669 papers in 1978). Since that time, Iran has experienced continuous year-on-year growth in its publication output (see Table 5).

<table>
<thead>
<tr>
<th>Year</th>
<th>Publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>3,937</td>
</tr>
<tr>
<td>2004</td>
<td>5,162</td>
</tr>
<tr>
<td>2005</td>
<td>6,908</td>
</tr>
<tr>
<td>2006</td>
<td>9,255</td>
</tr>
<tr>
<td>2007</td>
<td>13,456</td>
</tr>
<tr>
<td>2008</td>
<td>17,481</td>
</tr>
<tr>
<td>2009</td>
<td>20,344</td>
</tr>
<tr>
<td>2010</td>
<td>22,606</td>
</tr>
<tr>
<td>2011</td>
<td>29,145</td>
</tr>
<tr>
<td>2012</td>
<td>30,664</td>
</tr>
<tr>
<td>2013</td>
<td>31,146</td>
</tr>
<tr>
<td>2014</td>
<td>33,175</td>
</tr>
<tr>
<td>2015</td>
<td>37,988</td>
</tr>
<tr>
<td>2016</td>
<td>43,687</td>
</tr>
</tbody>
</table>

Iran's most productive fields include Engineering, Clinical Medicine and Chemistry, although there are some differences in the ranking of fields between the Scopus and Web of Science databases (Erfanmanesh & Didegah, 2013). Sotudeh (2010) found, however, that Iran performed at or above the global level in just two or 21 of 136 subfields, depending on the measure of relative citation used.

**Iranian publications involving international research collaboration.**

Iran appears to collaborate primarily with advanced scientific countries in its research endeavours (Harirchi, Melin, & Etemad, 2007; Hayati & Didegah, 2010; Nikzad et al., 2011). However, two studies found that, in contrast to global trends, the percentage of Iranian publications involving international collaboration declined between 1998 and 2007 (Erfanmanesh & Didegah, 2013; Hayati & Didegah, 2010).

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3 Data exported April 15, 2017.
In common with global trends (see, for example, Glänzel, 2001), Hayati and Didegah (2010) found that Iranian publications involving international collaboration received more citations than the country’s domestic publications. On the other hand, however, Guerrero Bote, Olmeda-Gómez, and Moya-Anegón (2013) found that collaboration with Iran had a negative impact on the normalised citation rates of many countries.

**Dialogue Among Civilizations? The Context for Research Collaboration between the West and Iran**

Research collaboration between the ‘West’ and the Islamic Republic of Iran may be understood as collaboration between centres and peripheries in the global academic system. It may also be understood, however, as collaboration between cultures or civilizations. Huntington argues that cultural or civilizational identities have become an increasingly salient factor in international politics, and that “an intercivilizational quasi war developed between Islam and the West” in the aftermath of the 1979 Islamic Revolution in Iran (Huntington, 2011, p. 216).

In response to Huntington’s ‘Clash of Civilizations?’ thesis, however, former Iranian President Khatami (1997-2005) emphasized the need for a “dialogue of civilizations and cultures”, especially between the United States and Iran. He suggested that the two countries exchange “professors, writers, scholars, artists, journalists, and tourists” (CNN, 1998). President Khatami later proposed that the United Nations designate 2001 as the ‘Year of Dialogue Among Civilizations’ (Pars Times, 1998), and his proposal was accepted (United Nations General Assembly, 1998). The Iranian President’s belief in the role of international academic and cultural cooperation in promoting peace and mutual understanding echoed the beliefs of many scholars (see, for example, Altbach & de Wit, 2015).

In the following section of the literature review, I discuss the factors that may constrain and facilitate research collaboration between the ‘West’ and the Islamic Republic of Iran. Some of the factors that may constrain such collaboration may be interpreted within the framework of intercivilizational conflict. At the same time, however,
one of the facilitating factors, the international mobility of Iranian born academics, seems to represent a valuable opportunity for a dialogue among civilizations.

**Geopolitics.**

Relations between the countries of the 'West' and the Islamic Republic of Iran have been characterized by mutual suspicion and sometimes outright hostility in the period since the Islamic Revolution. Tense relations between the two sides have influenced the context for research collaboration between them in several ways.

First, these tensions have led to a number of visa restrictions that may inhibit research collaboration. Most recently, United States' President Donald Trump issued two travel bans, both of which sought to bar Iranian citizens (among others) from entering the United States for a 90 day period (see, for example, BBC News, 2017; Merica, 2017). In response to the first of these bans, Iran announced that it would implement a reciprocal measure to stop citizens of the United States from entering the country (Reuters, 2017). In addition, British nationals who wish to visit Iran, and who are not part of an organized tour, must have a sponsor in Iran in order to apply for a visa (Foreign and Commonwealth Office, 2017).

Second, some academics affiliated with higher education institutions in the West have been arrested by the Iranian authorities, including Homa Hoodfar, a retired Iranian-Canadian professor from Concordia University, who was held for 112 days on charges that she collaborated with a hostile government (CBC News, 2016).

Tension between the two sides may also constrain research collaboration in less direct ways. The Ministry of Intelligence official who warned Iran’s academics that they would be suspected of spying if they collaborated with institutions in other countries did so in the context of accusing Western intelligence agencies of using academic contacts to recruit Iranian academics to espionage networks (Tait, 2007).

**Legal and regulatory context – sanctions imposed on Iran.**

While all institutions and academic staff who engage in international collaboration need to pay attention to the laws and regulations of their own country and those of their
collaborator(s), those who engage in academic collaboration with Iran may have the added difficulty of navigating sanctions regimes, particularly if they are based in the United States.

The United Nations, the European Union and several individual countries imposed several rounds of sanctions on Iran in response to the country’s nuclear program, although many of the sanctions against Iran were lifted in 2016 following the Iran nuclear deal. In addition, the United States has imposed successive rounds of sanctions on Iran beginning with those imposed during the 1979-1981 Iran hostage crisis (BBC News, 2015).

A detailed analysis of the ways in which these sanctions regimes may have influenced, or continue to influence, academic collaboration with Iran is beyond the scope of this literature review. However, we can make the following observations. First, the sanctions imposed by the United States Treasury Department’s Office of Foreign Assets Control (OFAC) appear to prohibit collaborative research with researchers in Iran (Bohnhorst et al., 2011). Second, in the United States at least, some of the ways in which sanctions may impact international higher education are complicated (Bohnhorst et al., 2011; Institute of International Education, 2015; Miller, Dong, & Briscoe, 2016), and they are not always clearly understood by the institutions and individuals subject to them. Third, partnership agreements between Iranian and European universities were signed within weeks of many sanctions against Iran being lifted in early 2016 (Havergal, 2016), indicating that sanctions have acted as a constraint on academic collaboration between the West and Iran.

**Funding.**

As discussed earlier, while a majority of Western countries contribute a greater percentage of their GDP to Research and Development than the world average, Iran has consistently contributed much less. Furthermore, it is unclear how much funding is available in the West or Iran to support international collaboration in general, and collaboration between the West and Iran in particular.
Communications technology.

As discussed earlier, developments in communications technology have made it easier for individuals, institutions and nations to collaborate across borders. Internet penetration greatly exceeds the world average in all Western countries and Iran. Iran has experienced strong growth in internet penetration since the turn of the century, with the number of internet users growing from just 250,000 in 2000 to nearly 57 million users in 2016, representing an internet penetration rate of 70%, (Internet World Stats, 2017a).

International mobility of academic staff.

As discussed earlier, international research collaboration is facilitated by the international mobility of academic staff. Many Iranians study at higher education institutions in Western countries. According to a recent estimate from the UNESCO Institute of Statistics, approximately 50,000 students of Iranian origin are studying abroad (2016a), with Western countries representing the top five destinations (2016b). In the United States at least, the “vast majority” of Iranian students study at the graduate level (Institute of International Education, 2015). Some of these students will return home to take up positions in Iranian higher education institutions, while others may find employment at Western higher education institutions. Other Iranians may take up academic positions at Western institutions after completing their education in Iran. While the total number of Iranian academics employed by higher education institutions in Western countries is not known, 1,475 scholars of Iranian origin are hosted by higher education institutions in the United States (Institute of International Education, 2015). These and other internationally mobile Iranian born academics are ideally situated to facilitate collaboration between the West and Iran. The role of international migration in facilitating international collaboration with Iranian researchers is illustrated in a recent survey of Iranian scientists who had published internationally co-authored papers in the Web of Science. Harirchi, Melin, and Etemad (2007) found that 50% of their respondents had received their last university degree outside of Iran, most commonly in the United Kingdom or the United States, and that many of their foreign collaborators were of Iranian origin.

It is important to note that the desire (or otherwise) of Iranian born academics working at universities in the West to engage in research collaboration with Iran may be
influenced by their reasons for leaving Iran. Moreover, while Iranian nationals who hold academic positions at universities in the West may facilitate collaboration between their host countries and Iran, those who are dual citizens may face specific risks if they travel to Iran. The Iranian government does not recognize dual citizenship, and, for this reason, the governments of most Western countries warn such citizens that it is unlikely that they will be able to provide them with consular assistance in Iran (see, for example, Australian Government, 2016; Foreign and Commonwealth Office, 2017; Government of Canada, 2016; New Zealand Government, 2017). The situation may be particularly difficult for dual citizens of Iran and the United States as the United States does not have diplomatic or consular relations with Iran (U.S. Department of State, 2016).

Rationale for this Study

International academic collaboration between the West and Iran represents an interesting case study of collaboration in the context of tense or non-existent formal relationships between governments. As President Khatami and others have suggested, such collaboration may represent a valuable opportunity to maintain lines of communication between the two sides. Moreover, the speed with which partnership agreements between Iranian and European universities were signed after many sanctions against Iran were lifted in 2016 indicates that there is considerable interest in collaboration on both sides. As discussed above, a small number of studies have addressed Iranian international collaboration by reviewing co-authorship patterns, and these studies have indicated that Iran primarily collaborates with advanced scientific nations, many of which are in the West. However, to date, no studies have presented a thorough analysis of research collaboration between the countries of the West and Iran from both the Western and Iranian perspectives.

Summary of Literature Review and Context for Collaboration

In this literature review I have presented a critical review of the literature on international research collaboration, and an analysis of the context for collaboration between the countries of the ‘West’ and the Islamic Republic of Iran. Specifically, I have discussed the factors that may facilitate and constrain international research collaboration, and the ways in which these factors may apply to collaboration between the West and Iran.
have further suggested that collaboration between the West and Iran may be understood either as collaboration between academic centres and peripheries or as collaboration across cultures or civilizations. In the next chapter, I describe the research design and methods adopted for this study.
Chapter Three: Research Design and Methods

The purpose of this study is to explore research collaboration between the ‘West’ and the Islamic Republic of Iran by analysing publications indexed in the Web of Science Core Collection (WoS CC) for the period between 2008 and 2016. For the purposes of this study, publications involving collaboration between the West and Iran are those that have both authors with addresses in those Western countries that meet the inclusion criteria defined below, and authors with addresses in Iran. In this chapter I: remind the reader of my research questions; explain my rationale for using bibliometrics to address this topic; describe the steps I used to generate and analyse data for this study; and describe the limitations of my methodology.

Research Questions

Central research question.

The central research question that guides this study is: How do the ‘West’ and the Islamic Republic of Iran engage in research collaboration with each other?

Sub-questions.

1. To what extent do Western countries and Iran engage in research collaboration with each other? Are research links between Western countries and Iran symmetrical?
2. How does collaboration between Western countries and Iran influence each country’s relative specialisation in particular research fields?
3. How does collaboration between Western countries and Iran influence the citation impact of each country’s publications?
4. To what extent is research collaboration between the West and Iran facilitated by academics who have simultaneous institutional affiliations in both the West and Iran?

Use of Bibliometrics

In this study, I use bibliometrics to explore research collaboration between the West and Iran at the country level. Bibliometrics may be defined as “the application of quantitative analysis and statistics to publications such as journal articles and their accompanying
citation counts” (Thomson Reuters, 2008). Bibliometric analysis is used to generate indicators of research productivity and performance for authors, journals, research groups, institutions and countries (Andrés, 2009; Rehn, Gornitzki, Larsson, & Wadskog, 2014). It is also “virtually indispensable” for measuring research collaboration (Archambault & Gagné, 2004), including research collaboration between countries.

Bibliometric studies are generally based on data indexed in bibliographic databases (Archambault & Gagné, 2004), particularly the two major multidisciplinary databases, Scopus (maintained by Elsevier) and the Web of Science (WoS) (maintained by Clarivate Analytics). Archambault, Campbell, Gingras, and Larivière (2009) found that, while there are substantial differences in the coverage of these two databases, they are extremely highly correlated on measures of publication output and citations at the country level.

**Data Collection and Analysis**

The present study is based on bibliographic data extracted from publications indexed in the Web of Science Core Collection (WoS CC). The WoS CC is a database of 55 million bibliographic records from journals, conference proceedings and books across the sciences, social sciences, and arts and humanities (Thomson Reuters, 2014b). I decided to use the WoS rather than another large multidisciplinary database for two reasons. First, Clarivate Analytics provides users with a useful web-based analytical tool named InCites that facilitates bibliometric analysis of the InCites dataset of bibliographic records sourced from the WoS CC (Thomson Reuters, 2014a). The InCites tool allows users to generate a range of bibliometric measures related to countries, institutions, journals and individual authors. Second, since 2008, the WoS has explicitly linked authors’ names to addresses using a superscript after the authors’ name (Thomson Reuters, 2017), and this functionality was necessary to answer research question 4, which assesses the extent to which research collaboration between the West and Iran is facilitated by academics who have simultaneous institutional affiliations in both the West and Iran.

For the purposes of clarity, I shall first outline the inclusion and exclusion criteria for this study. I will then describe the steps that I took to collect and analyse the data for
the first three research questions in this study, before describing the steps that I took to collect and analyse the data for research question 4.

**Inclusion/exclusion criteria.**

This study explores research collaboration between the West and the Islamic Republic of Iran at the country level. Since bibliometric analysis is most effective when it is applied to large datasets (World Health Organization, 2013), and I wanted to analyse the growth in the number of publications involving collaboration between the West and Iran by year of publication, only those Western countries with at least 1,000 publications in each year of the study were selected for analysis.

In order to determine which of the Western countries listed in my literature review met this inclusion criterion, I used the InCites tool to generate a list of the number of publications published by each country in my literature review for each year between 2008 and 2016.

As illustrated in Table 6, 19 of the 23 Western countries included in my literature review met the inclusion criteria for the study, namely: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. The remaining four countries (Greenland, Iceland, Luxembourg, and Malta) did not meet the inclusion criteria and were excluded from the study.

| Table 6: Western Countries Included in this Study |
|-----------------|-----------------|-----------------|-----------------|
| **Country**     | **Include?**    | **Country**     | **Include?**    |
| Australia       | ✓               | Luxembourg      |                |
| Austria         | ✓               | Malta           |                |
| Belgium         | ✓               | Netherlands     | ✓              |
| Canada          | ✓               | New Zealand     | ✓              |
| Denmark         | ✓               | Norway          | ✓              |
| Finland         | ✓               | Portugal        | ✓              |
| France          | ✓               | Spain           | ✓              |
| Germany         | ✓               | Sweden          | ✓              |
| Greenland       |                 | Switzerland     | ✓              |
| Iceland         |                 | United Kingdom  | ✓              |
| Ireland         | ✓               | United States   | ✓              |
| Italy           | ✓               |                 |                |
I selected the nine-year period from 2008 to 2016 as the timespan for this study. I chose 2008 as the start date because most records indexed in the WoS from this year onwards include an explicit link from authors’ names to their addresses (Thomson Reuters, 2017), and, as described below, this functionality was necessary to complete the data analysis that I carried out for research question 4.

No restrictions were placed on the disciplinary area, the document type, or the language of publications selected for analysis.

**Data collection and analysis for research questions 1, 2, and 3.**

To answer the first three research questions of the study, I used the InCites tool to analyse the InCites dataset, which is maintained by Clarivate Analytics and sourced from the WoS CC. All data was generated using the ‘Regions’ module of InCites with the ‘Location type’ set to ‘country’ to allow me to generate data on the number, disciplinary areas, and citation impact of publications at the country level. The time period for the InCites dataset was set from 2008 to 2016 except where otherwise indicated. Data was generated on May 8, 2017 using the InCites dataset updated April 15, 2017. This dataset includes Web of Science content indexed through February 3, 2017.

**Research question 1: To what extent do Western countries and Iran engage in research collaboration with each other? Are research links between Western countries and Iran symmetrical?**

Previous bibliometric studies have indicated that Iran primarily engages in research collaboration with advanced scientific countries including several of the Western countries included in the present study (Harirchi et al., 2007; Hayati & Didegah, 2010). The latter study also presented the percentage of countries’ publications that involved collaboration with Iran, but it was carried out for the period 1998-2007. To the best of my knowledge, no studies have analysed the strength of research links between Western countries and Iran for more recent years.

There are several bibliometric indicators that can be used to measure the strength of research links between pairs of countries, the best known of which are probably
Salton’s measure and Jaccard’s measure (both cited in Luukkonen, Tijssen, Persson, & Sivertsen, 1993). However, there are no agreed rules for interpreting these measures. For this reason, following some previous bibliometric studies (see, for example, T. Schubert & Sooryamoorthy, 2010), I assessed the extent to which Western countries and Iran engage in research collaboration with each other by calculating the number of publications co-authored by each Western country and Iran as a percentage of: (1) all publications published by the Western country; and (2) all publications published by Iran for the nine-year study period.

I also compared the number of publications involving collaboration between each Western country and Iran in 2016 with the number of such publications in 2008 to determine whether research collaboration between Western countries and Iran had grown over the study period.

I generated data for this research question using the InCites tool. First, I generated the following measure for each country in the study, including Iran:

- the number of publications during the study period

Second, I generated the following measures for each Western country in the study:

- the number of publications involving collaboration with Iran for the study period
- the number of publications involving collaboration with Iran for each year of the study.

The second part of research question 1 explores the degree to which links between Western countries and Iran are symmetrical. The bibliometric literature demonstrates that research links between some country pairs are asymmetrical. In other words, country A may be a very important partner for country B, but country B is not necessarily a very important partner for country A (see, for example, Glänzel & Schubert, 2001). There are several bibliometric indicators that may be used to assess the degree to which research links between county pairs are symmetrical. One of the clearest measures of symmetry is to compare where country A ranks in the list of country B’s international partners with where country B ranks in the list of country A’s international partners (see, for example, T. Schubert & Sooryamoorthy, 2010).
In this study, I assessed the degree to which research links between Western countries and Iran are symmetrical or asymmetrical by comparing where Iran ranks among the international collaborators of each Western country with the ranking of the same Western countries among Iran’s international collaborators.

For each country in the study, including Iran, I used the InCites tool to generate the following measure:

- a list of the countries with which each country had collaborated during the study period, ranked by the number of joint publications, (generated using the ‘Collaborations with Locations’ field).

**Research question 2: How does collaboration between Western countries and Iran influence each country’s relative specialisation in particular research fields?**

As discussed in the last chapter, Glänzel (2001) demonstrated four different ways in which international collaboration can influence a country’s relative specialisation in particular research fields as measured by the proportion of publications that those fields account for compared to the proportion of publications that they account for worldwide. In this study, I adapted Glänzel’s methodology to examine the ways in which collaboration between Western countries and Iran influences the relative specialisations of both Western countries and Iran.

The formula that Glänzel uses to calculate each country’s Relative Specialisation Index (RSI) is based on its Activity Index (AI). He describes both AI and RSI in one of his earlier publications (Glänzel, 2000) as follows:

Activity Index (AI):

\[
\text{AI} = \frac{\text{the share of the given field in the publications of a given country}}{\text{the share of the given field in the world total of publications}}
\]

Relative Specialisation Index (RSI):

\[
\text{RSI} = \frac{\text{AI} - 1}{\text{AI} + 1}
\]
The RSI for a country can take values in the range -1 to 1. An RSI of greater than zero indicates a higher than average proportion of publications in this field. An RSI of less than zero indicates a lower than average proportion of publications in this field. An RSI of 0 indicates that a country’s proportion of publications in a field corresponds to the “world standard”.

I generated the data for this research question using the InCites tool. First, I generated the following measures for each country in the study, including Iran:

- the number of publications published during the study period
- the number of publications involving international collaboration (with any country) published during the study period.
- the number of domestic publications published during the study period (calculated by subtracting the number of publications involving international collaboration from the total number of publications).

I also generated the world total of publications for the study period by selecting the ‘Global Baseline’ indicator in InCites (Thomson Reuters, 2016).

I then generated a number of measures related to the research specialisations of the countries in my study by using the InCites tool to categorise each country’s publications according to the GIPP (Global Institutional Profiles Project) disciplinary schema. This schema comprises six broad categories of discipline, namely: (1) Arts and Humanities; (2) Clinical, Pre-Clinical & Health; (3) Engineering & Technology; (4) Life Sciences; (5) Physical Sciences; and (6) Social Sciences. Together these six categories cover all fields of scholarly research. The GIPP schema is based on an aggregation of the much narrower WoS subject categories. There is significant overlap between the six GIPP disciplinary areas (Thomson Reuters, 2014a), but this overlap does not influence data analysis as the Relative Specialisation Index simply compares relative distributions of a country’s publications between disciplinary areas to world distribution of publications between the same areas.

I generated the following measures for each country in the study, including Iran:

- the number of publications in each GIPP disciplinary area over the study period
• the number of publications in each GIPP disciplinary area involving international collaboration (with any country) over the study period
• the number of domestic publications in each GIPP disciplinary area published during the study period (calculated by subtracting the number of publications involving international collaboration from the total number of publications in each area).

I also selected the ‘Global Baseline’ indicator in InCites to obtain the world totals for each of the GIPP disciplinary areas.

I then generated the following measures for each Western country in the study:
• the number of publications involving collaboration with Iran for the study period
• The number of publications involving collaboration with Iran in each GIPP disciplinary area for the study period.

Following Glänzel (2001), I used radar charts to visually represent the RSI values for each Western country such that each chart illustrates: (1) the RSI profile for the country’s domestic publications; (2) the RSI profile for Iran’s domestic publications; and (3) the RSI profile for publications involving collaboration between that country and Iran. I then analysed the ways in which collaboration between Western countries and Iran influences the relative research specialisations of both partners by visually inspecting these radar charts.

Research question 3: How does collaboration between Western countries and Iran influence the citation impact of each country’s publications?

Publication citation counts are used as bibliometric indicators of the research impact of individual scholars, institutions, and countries (Archambault & Gagné, 2004). However, the number of citations that a publication receives is influenced by several factors including the research area, year of publication, and document type (Rehn et al., 2014). For this reason, advanced bibliometric citation indicators are “normalised” such that publication citation counts are compared to those for other publications of the same research area, publication year, and document type.
Glänzel (2001) found that while publications involving international collaboration tend to be more highly cited than domestic publications, the impact of international collaboration on citation varies considerably between country pairs, leading him to conclude that international collaboration does not always pay for all partners. Hayati and Didegah (2010) found that Iran’s internationally co-authored publications were more highly cited than its domestic publications. However, Guerrero Bote, Olmeda-Gómez, and Moya-Anegón (2013) found that, for many countries, collaboration with Iran led to a reduction in their normalised citation impact for publications.

Following Guerrero Bote et al. (2013), I assessed the ways in which collaboration between Western countries and Iran influenced the normalised citation impact of both partners’ publications by calculating the difference between the normalised citation score for the publications involving collaboration between each Western country and Iran, and the normalised citation score for all of the (domestic and international) publications of both the Western country and Iran for the study period. In order to make my analysis more robust, I also compared publications involving collaboration between Western countries and Iran with those of publications authored by the partner countries using three additional normalised measures of citation impact for the reasons outlined below.

The category normalised citation impact (CNCI) of a publication is calculated by dividing the number of citations by the expected citation rate for publications of the same type, publication year and subject area (Thomson Reuters, 2014a). Since the CNCI is an indicator of the mean citation impact of a set of publications, however, it can be unduly influenced by a small number of highly cited papers even when it is applied to large sets of publications as it is in this study. Accordingly, the ‘InCites Indicators Handbook’ recommends that the CNCI be used alongside other citation indicators (Thomson Reuters, 2014a). For this reason, I also assessed the ways in which collaboration between Western countries and Iran influenced the citation impact of both countries’ publications for the study period by calculating the following additional measures of citation impact: the average percentile of these publications, the percentage of publications in the top 10%; and the percentage of publications in the top 1%.
The average percentile indicates how a set of publications has performed relative to others in its field, year and document type. Like the CNCI, it is a normalised indicator that may be applied to any set of publications including those of an author, institution or country. A set of publications with a percentile value of one has received higher citation counts than 99% of comparable publications (Thomson Reuters, 2014a).

The percentage of publications in the top 10% and top 1% of publications denotes the percentage of publications in the dataset that belong to the 10% and 1% of the most highly cited publications in the same field, year and document type. These indicators are a useful complement to the CNCI since they may indicate whether high mean citation scores are the result of a few very highly cited publications or a larger number of publications with above average citations (Rehn et al., 2014).

I generated data for this research question using the InCites tool. First, I generated the following measures for each country in the study, including Iran:

- the number of publications published during the study period
- the category normalised citation impact (CNCI)
- the average percentile
- the percentage of publications in the top 10%
- the percentage of publications in the top 1%.

Second, I generated the following measures for each Western country in the study:

- the number of publications involving collaboration with Iran for the study period
- the four normalised citation measures listed above for the publications involving collaboration with Iran for the study period.

**Data collection and analysis for research question 4.**

*To what extent is research collaboration between the West and Iran facilitated by academics who have simultaneous institutional affiliations in both the West and Iran?*

As discussed in the literature review, several studies have found that international mobility is positively associated with international collaboration among academic staff. Most
previous studies have analysed diachronic international mobility, that is, the movement of academic staff between countries over time. The phenomena of synchronous international mobility, that is, academic staff who hold simultaneous institutional affiliations in different countries has received little attention.

In this study, I calculated the percentage of lead authors of publications involving collaboration between Western countries and Iran who held simultaneous institutional affiliations in both Western countries and Iran at the time of publication. Since the Incites analytical tool that I used to answer the first three research questions of this study does not allow users to identify authors with simultaneous institutional affiliations in different countries, data analysis for this research question had to be carried out by manually reviewing the address data for the lead authors of WoS publications involving collaboration between Western countries and Iran.

To answer this research question, I first created a dataset of bibliographic records indexed in the WoS CC that included addresses in both Western countries and Iran as follows.

I carried out individual searches for publications with addresses in each of the countries in my study, including Iran (that is, I carried out a search for publications with addresses in Australia, a search for publications with addresses in Austria, and so on). I executed these searches using the query CU=country code, using the country codes listed in Table 7 below, combined with the additional search criteria outlined below.

<table>
<thead>
<tr>
<th>Table 7: Country Codes Used to Search the WoS CC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong></td>
</tr>
<tr>
<td>Australia</td>
</tr>
<tr>
<td>Austria</td>
</tr>
<tr>
<td>Belgium</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>Denmark</td>
</tr>
<tr>
<td>Finland</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Ireland</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>Netherlands</td>
</tr>
<tr>
<td>New Zealand</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Country</strong></td>
</tr>
<tr>
<td>Norway</td>
</tr>
<tr>
<td>Portugal</td>
</tr>
<tr>
<td>Spain</td>
</tr>
<tr>
<td>Sweden</td>
</tr>
<tr>
<td>Switzerland</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>United States</td>
</tr>
<tr>
<td>Iran</td>
</tr>
</tbody>
</table>

*WoS does not have a country code for the United Kingdom so I conducted the search using the country codes for the four constituent nations of England, Northern Ireland, Scotland and Wales.*
I set the timespan for the search from 2008 to 2016.

Since I wanted to include publications from all disciplinary areas in this study, I checked the following Core Content citation indexes for each country search:

- The Science Citation Index Expanded (SCI-EXPANDED)
- The Social Sciences Citation Index (SSCI)
- The Arts & Humanities Citation Index (A&HCI)
- The Conference Proceedings Citation Index- Science (CPCI-S)
- The Conference Proceedings Citation Index- Social Science & Humanities (CPCI-SSH).
- Emerging Sources Citation Index (ESCI) Index.

No restrictions were placed on document type or the language of the publications selected for analysis.

It is important to note that there were some differences between the WoS CC records that I searched to create the dataset for research question 4, and the InCites dataset that I used for the first three research questions. First, some WoS records may not have matching records in InCites. In particular, the WoS CC is updated more frequently than InCites, and some of the records in the WoS dataset may not yet have been added to the InCites dataset (Clarivate Analytics, n.d.). Second, while the InCites dataset includes records from the two WoS CC book citation indexes (one for Science, and one for Social Sciences and Humanities) (Thomson Reuters, 2014a), I was unable to search these in the WoS CC because my institution, the University of Toronto, does not subscribe to them.

It is also important to note that the search query CU= that I used to search for publications with addresses in the countries in my study captures records that include country addresses in either the C1 (author address) or RP (reprint address) field. The WoS CC does not have the functionality to allow users to search the C1 (author address) field only. Accordingly, these searches captured some records that included reprint addresses in the target countries but not author addresses. However, subsequent
analysis of a sample of these records (described below) indicates that such records accounted for less than one percent of the total records in the dataset.

After I completed these individual country searches, I used the Boolean Operator “OR” to create a dataset of all publications that included addresses in any of the above Western countries (11,787,515 records). I then used the Boolean Operator “AND” to combine: (1) this dataset of publications with addresses in Western countries; and (2) the dataset of publications with addresses in Iran (268,235 records). The resulting dataset comprised only those publications that included addresses in Western countries and in Iran (39,789 records). I exported these records to Excel on May 8, 2017.

Figure 1: Creating a Sample Dataset of Publications Involving Collaboration between the West and Iran

Since it was not feasible for me to visually inspect 39,789 records, I selected a smaller number of records for analysis as Hottenrott and Lawson (2017) did for their study of scholars with multiple institutional affiliations in Germany, Japan and the United Kingdom. Hottenrott and Lawson created their dataset by taking a sample of journals in each of the three fields in which they were interested (bioscience, chemistry and engineering). Since I wanted to analyse the institutional affiliations of lead authors in all fields of study, however, I did not adopt the same sampling strategy. Rather, I used random sampling to select a subset of records from the dataset of publications including addresses in Western countries and Iran as described below.

Figure 1: Creating a Sample Dataset of Publications Involving Collaboration between the West and Iran

Using a 95% confidence level, and a margin of error (or confidence interval) of +/- 3%, I used an online sample size calculator (Creative Research Systems, 2012) to calculate a sample size of 1,039. However, to allow for the possibility that some records
may need to be discarded, I chose to create a slightly larger sample dataset of 1,100 records. I generated a series of 1,100 numbers between 1 and 39,789 using an online random integer generator (Random.org, n.d.). Records corresponding to these numbers were then selected from the complete dataset of publications with addresses in both the West and Iran, and copied to a new Excel spreadsheet for analysis.

I made the decision to analyse the institutional affiliations these publications’ lead authors only because it would not have been feasible to analyse the affiliations of all of the authors of my sample of publications. Moreover, according to Tscharntke, Hochberg, Rand, Resh, and Krauss (2007), while practices vary across countries and research fields, the lead authors of publications traditionally make the greatest contribution to them.

I visually inspected the author address field (C1) for the lead author of each publication in the Excel spreadsheet. In cases where the address data was difficult to read or interpret in Excel (for example, where large numbers of institutional addresses were associated with a single publication, I searched for the relevant bibliographic record in the WoS CC and inspected the address data listed for the lead author there. During this review of the author address (C1) field, I removed 21 of the 1100 records (1.91%) from the dataset as follows. 10 of the 100 records (0.91%) were removed because they did not include author addresses both in one or more of the target Western countries and Iran (one of the countries was included in the reprint (RP) field only). Another 11 of the 1100 records (1%) were removed because, although the author address (C1) field included addresses in both target Western countries and Iran, no explicit link was made between the lead author and the author addresses listed. In these cases, it was not possible to determine the addresses for the lead authors. The dataset for research question 4 contained 1,079 records following these exclusions.

I then categorised all lead authors in the dataset using a modified version of Markova, Schmatko, and Katchanov’s schema (2016) as follows

- **WEST**: one or more affiliations with institutions in Western countries only.
- **IRAN**: one or more affiliations with institutions in Iran only.
- **OTHER**: one or more affiliations with institutions in countries that were not included in this study only.
• SYNCHRONOUS: WEST + IRAN: one or more affiliations with institutions in the West and one or more affiliations with institutions in Iran.

• SYNCHRONOUS: WEST + OTHER: one or more affiliations with institutions in the West and one or more affiliations with institutions in countries that were not included in this study.

• SYNCHRONOUS: IRAN + OTHER: one or more affiliations with institutions in Iran and one or more affiliations with institutions in countries that were not included in this study.

I then calculated the percentage of lead authors who were assigned to each of these categories.

Limitations

Two broad limitations are associated with using bibliometrics to study international research collaboration. The first limitation concerns the relationship between co-authorship and collaboration; while the second limitation relates to biases within the databases that are used for bibliometric analyses. In addition, my decision to analyse the institutional affiliations of lead authors only limits my ability to assess the extent to which research collaboration between the West and Iran is facilitated by academics who have simultaneous institutional affiliations in both the West and Iran.

Relationship between co-authorship and collaboration.

While co-authorship is widely used as a proxy for research collaboration, many scholars have cautioned that it is an imperfect measure of collaboration. Katz & Martin (1997), for example, note that there are many cases of research collaboration that are not ‘consummated’ in co-authored papers. On the other hand, very limited or peripheral forms of interaction may sometimes lead to co-authored publications.

On balance, it seems likely that analyses of international research collaboration based on international co-authorship are more likely to underestimate the frequency of international research collaboration than to overestimate it. For example, the Changing Academic Profession (CAP) survey of 2007-2008, found that, while 41% of respondents
reported that they collaborate with colleagues in other countries, only 31% reported co-authoring publications with them (Rostan, Finkelstein, et al., 2014).

**Biases inherent in bibliographic databases.**

The results of my analyses of collaboration between Western countries and Iran are based on publications in the WoS CC only. They do not cover all publications co-authored by the West and Iran during the period covered by the study. In other words, my results, like those of all bibliometric analyses, are influenced by the selection of publications chosen for analysis.

Bibliographic databases such as the WoS and Scopus ® under-represent some disciplines, publishing countries, and languages (Mongeon & Paul-Hus, 2016). Archambault and Gagné (2004), for example, note that the coverage of many social science and humanities disciplines in the WoS is less extensive than coverage of many natural sciences and engineering disciplines. However, they also assert that there are no suitable alternatives for bibliometric research in the social sciences and humanities. Of even greater relevance to the present study, Moin, Mahmoudi, and Rezaei (2005) note that most journals published in developing countries are not indexed in the WoS, and that only three of the 247 scientific journals published in Iran at the time of their study were sourced by the WoS at that time. Although the WoS now sources 43 publications published in Iran (Thomson Reuters, 2015a, 2015b, 2015c), a considerable increase over the number sourced at the time of Moin et al.’s study, there is little doubt that such a bias still exists. Moreover, all 43 of these publications from Iran are published in English. In addition to the issues of discipline, publishing country, and language biases, citation databases such as Scopus ® and the WoS do not index ‘grey’ literature that may nevertheless involve international research collaboration (Royal Society, 2011).

**Analysis of the Institutional Affiliations of Lead Authors Only.**

My decision to analyse the institutional affiliations of the lead authors only limits my ability to assess the extent to which research collaboration between the West and Iran is facilitated by academics who have simultaneous institutional affiliations in both Western countries and Iran. It is extremely likely that some of the other authors who contributed
to these publications also had simultaneous institutional affiliations in both the West and Iran. Accordingly, my findings almost certainly underestimate the extent to which research collaboration between the West and Iran is facilitated by academics who have institutional affiliations in both the West and Iran.

In this chapter, I have restated my research questions; presented my rationale for using bibliometrics; described how I collected and analysed data for my study; and reflected on the limitations of the research design and methods that I adopted for this study. In the next chapter, I present and analyse the findings of my study.
Chapter Four: Presentation and Analysis of Findings

In this chapter, I present the findings of my study on research collaboration between the ‘West’ and the Islamic Republic of Iran between 2008 and 2016, and discuss them with reference to previous studies on international research collaboration in general, and research collaboration with Iran in particular.

The Strength of Research Collaboration Links between Western Countries and Iran

As illustrated in Table 8, publications involving collaboration with Iran represent a relatively small share of publications for most Western countries, amounting to less than one percent of each country’s publications, and less than two percent of their international publications during the study period. On the other hand, publications involving collaboration with Western countries account for a rather large share of Iran’s publications. Publications involving collaboration with the United States account for over 23% of Iran’s international publications, while those involving collaboration with Canada and the United Kingdom each account for more than 10% each. Publications involving collaboration with Australia, France, Germany, and Italy also account for more than 5% of Iran’s international publications each.

These findings are consistent with previous studies of international research collaboration. Schubert & Glänzel (2006), for example, observed the influence of geopolitical location, and cultural and linguistic ties on cross-national preferences in co-authorship. Given the geopolitical tensions between the West and Iran, and the absence of strong cultural and linguist ties between the two sides, it is not surprising that Iran is not a top collaborating partner for any of the Western countries in this study. At the same time, Gazni, Sugimoto, and Didegah (2012) found that six countries – Canada, France, Germany, Italy, the United Kingdom, and the United States – accounted for 82% of all internationally co-authored publications indexed in the Web of Science (WoS) for the period from 2000 to 2009. It is therefore not surprising that these six countries, along with Australia, represent Iran’s seven most important collaborators as measured by the percentage of the country’s international publications that they account for.
Table 8: International Collaboration between Western Countries and Iran 2008-2016

<table>
<thead>
<tr>
<th>Rank among country's collaborators</th>
<th>Country</th>
<th>% publications co-authored with Iran</th>
<th>% international publications co-authored with Iran</th>
<th>Rank among Iran's collaborators</th>
<th>Country</th>
<th>% publications co-authored with country</th>
<th>% international publications co-authored with country</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Canada</td>
<td>0.72%</td>
<td>1.69%</td>
<td>1</td>
<td>United States</td>
<td>4.63%</td>
<td>23.14%</td>
</tr>
<tr>
<td>29</td>
<td>New Zealand</td>
<td>0.95%</td>
<td>1.90%</td>
<td>2</td>
<td>Canada</td>
<td>2.34%</td>
<td>11.69%</td>
</tr>
<tr>
<td>30</td>
<td>Australia</td>
<td>0.61%</td>
<td>1.42%</td>
<td>3</td>
<td>United Kingdom</td>
<td>2.19%</td>
<td>10.93%</td>
</tr>
<tr>
<td>35</td>
<td>Belgium</td>
<td>0.62%</td>
<td>1.07%</td>
<td>4</td>
<td>Germany</td>
<td>1.81%</td>
<td>9.06%</td>
</tr>
<tr>
<td>36</td>
<td>Sweden</td>
<td>0.60%</td>
<td>1.08%</td>
<td>6</td>
<td>Australia</td>
<td>1.57%</td>
<td>7.86%</td>
</tr>
<tr>
<td>38</td>
<td>Finland</td>
<td>0.79%</td>
<td>1.54%</td>
<td>7</td>
<td>Italy</td>
<td>1.34%</td>
<td>6.71%</td>
</tr>
<tr>
<td>38</td>
<td>Italy</td>
<td>0.43%</td>
<td>1.07%</td>
<td>8</td>
<td>France</td>
<td>1.16%</td>
<td>5.79%</td>
</tr>
<tr>
<td>39</td>
<td>Germany</td>
<td>0.36%</td>
<td>0.80%</td>
<td>10</td>
<td>Spain</td>
<td>0.97%</td>
<td>4.84%</td>
</tr>
<tr>
<td>39</td>
<td>Netherlands</td>
<td>0.41%</td>
<td>0.79%</td>
<td>14</td>
<td>Netherlands</td>
<td>0.74%</td>
<td>3.69%</td>
</tr>
<tr>
<td>39</td>
<td>Spain</td>
<td>0.37%</td>
<td>0.91%</td>
<td>15</td>
<td>Switzerland</td>
<td>0.70%</td>
<td>3.52%</td>
</tr>
<tr>
<td>39</td>
<td>United Kingdom</td>
<td>0.36%</td>
<td>0.85%</td>
<td>16</td>
<td>Sweden</td>
<td>0.68%</td>
<td>3.38%</td>
</tr>
<tr>
<td>39</td>
<td>United States</td>
<td>0.21%</td>
<td>0.81%</td>
<td>17</td>
<td>Belgium</td>
<td>0.61%</td>
<td>3.05%</td>
</tr>
<tr>
<td>43</td>
<td>France</td>
<td>0.33%</td>
<td>0.70%</td>
<td>19</td>
<td>Austria</td>
<td>0.50%</td>
<td>2.49%</td>
</tr>
<tr>
<td>43</td>
<td>Ireland</td>
<td>0.50%</td>
<td>1.11%</td>
<td>23</td>
<td>Finland</td>
<td>0.44%</td>
<td>2.19%</td>
</tr>
<tr>
<td>43</td>
<td>Portugal</td>
<td>0.68%</td>
<td>1.52%</td>
<td>25</td>
<td>Portugal</td>
<td>0.43%</td>
<td>2.13%</td>
</tr>
<tr>
<td>43</td>
<td>Switzerland</td>
<td>0.54%</td>
<td>0.87%</td>
<td>28</td>
<td>New Zealand</td>
<td>0.39%</td>
<td>1.97%</td>
</tr>
<tr>
<td>44</td>
<td>Denmark</td>
<td>0.45%</td>
<td>0.82%</td>
<td>34</td>
<td>Denmark</td>
<td>0.33%</td>
<td>1.65%</td>
</tr>
<tr>
<td>45</td>
<td>Austria</td>
<td>0.69%</td>
<td>1.23%</td>
<td>49</td>
<td>Ireland</td>
<td>0.22%</td>
<td>1.09%</td>
</tr>
<tr>
<td>55</td>
<td>Norway</td>
<td>0.31%</td>
<td>0.58%</td>
<td>52</td>
<td>Norway</td>
<td>0.17%</td>
<td>0.85%</td>
</tr>
</tbody>
</table>
Table 9: Growth in the Number of Publications Involving Co-Authorship Between Western Countries and Iran, 2008-2016

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>3,973</td>
<td>184</td>
<td>295</td>
<td>284</td>
<td>329</td>
<td>466</td>
<td>491</td>
<td>539</td>
<td>659</td>
<td>726</td>
<td>295%</td>
</tr>
<tr>
<td>Austria</td>
<td>1,258</td>
<td>21</td>
<td>41</td>
<td>88</td>
<td>138</td>
<td>177</td>
<td>191</td>
<td>192</td>
<td>214</td>
<td>196</td>
<td>833%</td>
</tr>
<tr>
<td>Belgium</td>
<td>1,542</td>
<td>55</td>
<td>55</td>
<td>106</td>
<td>176</td>
<td>225</td>
<td>224</td>
<td>205</td>
<td>242</td>
<td>254</td>
<td>362%</td>
</tr>
<tr>
<td>Canada</td>
<td>5,912</td>
<td>385</td>
<td>419</td>
<td>514</td>
<td>579</td>
<td>574</td>
<td>742</td>
<td>830</td>
<td>952</td>
<td>917</td>
<td>138%</td>
</tr>
<tr>
<td>Denmark</td>
<td>834</td>
<td>25</td>
<td>30</td>
<td>64</td>
<td>97</td>
<td>105</td>
<td>110</td>
<td>107</td>
<td>138</td>
<td>158</td>
<td>532%</td>
</tr>
<tr>
<td>Finland</td>
<td>1,107</td>
<td>32</td>
<td>34</td>
<td>70</td>
<td>112</td>
<td>140</td>
<td>160</td>
<td>179</td>
<td>178</td>
<td>202</td>
<td>531%</td>
</tr>
<tr>
<td>France</td>
<td>2,927</td>
<td>162</td>
<td>195</td>
<td>243</td>
<td>323</td>
<td>376</td>
<td>406</td>
<td>376</td>
<td>415</td>
<td>431</td>
<td>166%</td>
</tr>
<tr>
<td>Germany</td>
<td>4,579</td>
<td>201</td>
<td>285</td>
<td>348</td>
<td>458</td>
<td>510</td>
<td>603</td>
<td>691</td>
<td>737</td>
<td>746</td>
<td>271%</td>
</tr>
<tr>
<td>Ireland</td>
<td>550</td>
<td>13</td>
<td>20</td>
<td>38</td>
<td>25</td>
<td>24</td>
<td>56</td>
<td>112</td>
<td>128</td>
<td>134</td>
<td>931%</td>
</tr>
<tr>
<td>Italy</td>
<td>3,393</td>
<td>106</td>
<td>108</td>
<td>197</td>
<td>334</td>
<td>392</td>
<td>438</td>
<td>518</td>
<td>607</td>
<td>693</td>
<td>554%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1,863</td>
<td>89</td>
<td>105</td>
<td>147</td>
<td>191</td>
<td>229</td>
<td>273</td>
<td>257</td>
<td>260</td>
<td>312</td>
<td>251%</td>
</tr>
<tr>
<td>New Zealand</td>
<td>998</td>
<td>16</td>
<td>23</td>
<td>66</td>
<td>114</td>
<td>152</td>
<td>146</td>
<td>131</td>
<td>167</td>
<td>183</td>
<td>1044%</td>
</tr>
<tr>
<td>Norway</td>
<td>429</td>
<td>14</td>
<td>26</td>
<td>31</td>
<td>33</td>
<td>43</td>
<td>51</td>
<td>76</td>
<td>71</td>
<td>84</td>
<td>500%</td>
</tr>
<tr>
<td>Portugal</td>
<td>1,076</td>
<td>7</td>
<td>19</td>
<td>56</td>
<td>100</td>
<td>150</td>
<td>175</td>
<td>168</td>
<td>200</td>
<td>201</td>
<td>2771%</td>
</tr>
<tr>
<td>Spain</td>
<td>2,445</td>
<td>59</td>
<td>100</td>
<td>154</td>
<td>231</td>
<td>295</td>
<td>371</td>
<td>384</td>
<td>436</td>
<td>415</td>
<td>603%</td>
</tr>
<tr>
<td>Sweden</td>
<td>1,708</td>
<td>107</td>
<td>122</td>
<td>120</td>
<td>160</td>
<td>192</td>
<td>197</td>
<td>241</td>
<td>280</td>
<td>289</td>
<td>170%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1,781</td>
<td>50</td>
<td>85</td>
<td>138</td>
<td>196</td>
<td>233</td>
<td>258</td>
<td>280</td>
<td>254</td>
<td>287</td>
<td>474%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>5,526</td>
<td>417</td>
<td>443</td>
<td>524</td>
<td>590</td>
<td>613</td>
<td>710</td>
<td>673</td>
<td>731</td>
<td>825</td>
<td>98%</td>
</tr>
<tr>
<td>United States</td>
<td>11,698</td>
<td>597</td>
<td>695</td>
<td>881</td>
<td>1,064</td>
<td>1,279</td>
<td>1,555</td>
<td>1,663</td>
<td>1,879</td>
<td>2,085</td>
<td>249%</td>
</tr>
</tbody>
</table>
Figure 2: Growth in the Number of Publications Co Authored with Iran, 2008 to 2016
Growth in the Number of Publications Involving Collaboration Between Western Countries and Iran

As illustrated in Table 9 and Figure 2, the number of publications involving collaboration between Western countries and Iran grew considerably during the study period, albeit from a very low starting point for some countries. Publications involving collaboration between the United Kingdom and Iran grew the least, with an increase of 98% in the number of publications published in 2016 compared to 2008. This growth in the number of publications involving collaboration between Western countries and Iran has taken place in the context of an enormous increase in the number of publications published by Iran overall. Based on the WoS publication data presented in the literature review, Iran’s publications grew by approximately 150% between 2008 and 2016. While it seems likely that the growth in the number of publications involving collaboration between the West and Iran is related to the growth in the number of publications published by Iran overall, it is hard to demonstrate a causal relationship between the two. On the one hand, research collaboration with the West may contribute to the growth in publications published by Iran. On the other hand, Iran’s increased publication output may be a sign of its scientific advancement, and this may make it an increasingly attractive partner for Western countries. It is also important to note that the increase in both the number of publications published by Iran, and the number of publications involving collaboration between Western countries and Iran may result, at least in part, from an increase in the number of Iranian journals indexed in the WoS between the beginning and end of the study period. As noted in the previous chapter, the number of Iranian journals indexed in the WoS increased from three at the time of Moin et al.’s (2005) study of scientific output in Iran to 43 in 2015.

There is little evidence to suggest that the increase in the number of publications involving collaboration between Western countries and Iran has been influenced by changes in the views and policies on international academic collaboration articulated by Iran’s political establishment. Indeed, for all Western countries except Sweden, the percentage increase in the number of publications involving collaboration with Iran
between 2008 and 2010 was higher than that between 2013 and 2015. That is, the growth in publications involving collaboration between the West and Iran was higher in a two-year period during the anti-international academic collaboration administration of President Ahmadinejad than it was at the beginning of the pro-international academic collaboration administration of President Rouhani. It should be noted, however, that it is not possible to determine how much of the scientific work presented in publications published in 2015 was carried out during President Ahmadinejad’s time in office. It may be that collaboration between the West and Iran has increased more quickly since President Rouhani’s 2013 election but that this has not yet been reflected in co-authored publications.

**Asymmetry of Research Links between Western Countries and Iran**

The data presented in Table 8 clearly demonstrate that research links between many Western countries and Iran are asymmetrical. That is, in general, Western countries are more important research partners for Iran, than Iran is for Western countries. Eight of Iran’s top 10 collaborators are Western countries, and four of Iran’s top six collaborators are economically and academically powerful English-speaking nations: Australia, Canada, the United Kingdom, and the United States. (The two non-Western countries among Iran’s top collaborators are Malaysia and Turkey). On the other hand, Iran does not rank among the top 10 collaborators of any Western country. Indeed, Iran only ranks among the top 30 collaborators of three Western countries: Australia, Canada, and New Zealand. This finding is consistent with the idea that the global academic system is comprised of central and peripheral countries.

Not all research links between Western countries and Iran are asymmetrical, however. The research link between New Zealand and Iran, for example, is more or less symmetrical. Iran is New Zealand’s 29th most important collaborator, with publications involving collaboration with Iran representing 1.90% of New Zealand’s international publications for the study period. At the same time, New Zealand is Iran’s 28th most important collaborator, with publications involving collaboration with New Zealand representing 1.97% of Iran’s international publications. Similarly, the research links that
Denmark, Ireland, and Norway have with Iran are fairly symmetrical in that none of these Western countries is an important partner for Iran; and Iran is not an important partner for them.

**Influence of Collaboration on the Research Specialisation of the Profiles of Western Countries and Iran**

Figure 3a to 3s illustrate the research specialisation profiles of each of the Western countries in my study based on the following six broad GIPP disciplinary categories: (1) Arts and Humanities; (2) Clinical, Pre-Clinical and Health; (3) Engineering and Technology; (4) Life Sciences; (5) Physical Sciences; and (6) Social Sciences. Each chart illustrates the research specialisation profiles of: (1) the Western country’s domestic publications; (2) Iran’s domestic publications; and (3) publications involving collaboration between that Western country and Iran.

These figures clearly illustrate that, for all the Western countries in this study, the research specialisation profiles of publications involving collaboration with Iran resemble the profile of Iran’s domestic publications much more closely than they resemble the profile of the Western country’s domestic publications. This is particularly true for Canada, the United Kingdom, and the United States, where the research profile for publications involving collaboration with Iran are virtually identical to that of Iran’s domestic publications. It is difficult to be certain why the research specialisation profiles of publications involving collaboration between the West and Iran resembles that of Iran’s domestic publications. It may be that Western countries - especially academically powerful English-speaking countries like Canada, the United Kingdom, and the United States - have more to gain from collaborating with Iran in disciplinary areas where the latter is strong, namely Engineering and Technology and the Physical Sciences, than in areas where it is less strong.
Figure 3: Research Specialisation Profiles
It should also be noted that, for several of those Western countries where the research specialisation profile of publications involving collaboration with Iran diverges a little more from the research specialisation profile of Iran’s domestic publications – for example, Austria, Belgium, New Zealand, and Portugal – the proportion of publications in the Physical Sciences is higher among publications involving collaboration between the Western country and Iran than it is in among the domestic publications of either the Western country or Iran.

**Influence of Collaboration on the Citation Impact of the Publications of Western Countries and Iran**

Tables 10 to 13 illustrate the citation impact of collaboration between Western countries and Iran using normalised measures of citation. The data illustrates that, for most Western countries, the mean normalised citation scores for publications involving collaboration with Iran are higher than the scores for their (domestic and international) publications overall. For Iran, the mean normalised citation score of publications involving collaboration with each of the Western countries in the study is higher than the score for its (domestic and international) publications.

Table 10 presents mean category normalised citation impact (CNCI) scores, that is citation scores that have been normalised for publication type, year, and subject area. For each Western country, I present the mean CNCI scores for publications involving collaboration with Iran, and compare these to the scores for the (domestic and international) publications of both the Western country and Iran. The table shows that the scores for publications involving collaboration with Iran are higher than the scores for the Western country’s publications overall for all countries except for Canada. This finding contrasts with Guerrero Bote et al.’s (2013) finding that, for many countries, publications involving collaboration with Iran have lower mean normalised citation scores than that for the country’s publications as a whole. While it is not immediately apparent why my findings diverge from those of Guerrero Bote et al., it should be noted that the earlier study was carried out using data from the Scopus bibliometric database for the publication years 2003 to 2009, whereas my study uses data from the WoS database for the publication years 2008 to 2016. Moreover, the findings from my study are consistent with
the more common finding that, publications involving international collaboration tend to be more highly cited than domestic publications (see, for example, Glänzel, 2001). In common with Guerrero Bote et al.’s (2013) study, collaboration with Western countries resulted in a mean normalised citation advantage for Iran.

Since the CNCI can be unduly influenced by a small number of highly cited papers (Thomson Reuters, 2014a), I also calculated three other normalised measures of citation for the countries in the study: the average percentile, the percentage of publications in the top 10%, and the percentage of publications in the top 1%.

Table 11 presents the average percentile scores of publications involving collaboration between each Western country and Iran; and compares them with the scores for the (domestic and international) publications of both the Western country and Iran. In contrast to the CNCI measure, lower numerical average percentile scores are associated with higher citation impacts. Using this measure of citation impact, collaboration between Western countries and Iran has a positive citation impact for all Western countries including Canada, and a positive citation impact for Iran.

Table 12 presents the percentage of publications in the top 10% of publications of the same subject area, year, and document type for publications involving collaboration between each Western country and Iran; and compares it with the same measure for the (domestic and international) publications of both the Western country and Iran. Using this measure of citation impact, collaboration with Iran has a negative impact for Canada, the Netherlands, and Sweden but a positive impact for the other Western countries in the study. The impact of collaboration with all of the Western countries in the study is positive for Iran.

Table 13 presents the percentage of publications in the top 1% of publications of the same subject area, year, and document type for publications involving collaboration between each Western country and Iran; and compares it with the same measure for the (domestic and international) publications of each Western country and Iran. Using this measure of citation impact, collaboration with Iran is positive for all Western countries except for Canada. Again, the impact of collaboration with all of the Western countries in the study is positive for Iran.
Table 10: Category Normalised Citation Impact of Publications Involving Collaboration between the ‘West’ and Iran

<table>
<thead>
<tr>
<th>Country</th>
<th>Number</th>
<th>CNCI</th>
<th>Number</th>
<th>CNCI</th>
<th>Western Country</th>
<th>Iran</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>654,034</td>
<td>1.39</td>
<td>3973</td>
<td>1.93</td>
<td>0.54</td>
<td>1.17</td>
</tr>
<tr>
<td>Austria</td>
<td>181,509</td>
<td>1.5</td>
<td>1258</td>
<td>3.99</td>
<td>2.49</td>
<td>3.23</td>
</tr>
<tr>
<td>Belgium</td>
<td>250,602</td>
<td>1.73</td>
<td>1542</td>
<td>3.36</td>
<td>1.63</td>
<td>2.6</td>
</tr>
<tr>
<td>Canada</td>
<td>817,159</td>
<td>1.41</td>
<td>5912</td>
<td>1.39</td>
<td>-0.02</td>
<td>0.63</td>
</tr>
<tr>
<td>Denmark</td>
<td>184,263</td>
<td>1.73</td>
<td>834</td>
<td>3.53</td>
<td>1.8</td>
<td>2.77</td>
</tr>
<tr>
<td>Finland</td>
<td>140,402</td>
<td>1.43</td>
<td>1107</td>
<td>4.37</td>
<td>2.94</td>
<td>3.61</td>
</tr>
<tr>
<td>France</td>
<td>876,867</td>
<td>1.46</td>
<td>2927</td>
<td>2.67</td>
<td>1.21</td>
<td>1.91</td>
</tr>
<tr>
<td>Germany</td>
<td>1,288,192</td>
<td>1.45</td>
<td>4579</td>
<td>2.08</td>
<td>0.63</td>
<td>1.32</td>
</tr>
<tr>
<td>Ireland</td>
<td>110,137</td>
<td>1.26</td>
<td>550</td>
<td>5.38</td>
<td>4.12</td>
<td>4.62</td>
</tr>
<tr>
<td>Italy</td>
<td>787,731</td>
<td>1.37</td>
<td>3393</td>
<td>2.5</td>
<td>1.13</td>
<td>1.74</td>
</tr>
<tr>
<td>Netherlands</td>
<td>459,249</td>
<td>1.68</td>
<td>1863</td>
<td>2.53</td>
<td>0.85</td>
<td>1.77</td>
</tr>
<tr>
<td>New Zealand</td>
<td>104,552</td>
<td>1.45</td>
<td>998</td>
<td>5.35</td>
<td>3.9</td>
<td>4.59</td>
</tr>
<tr>
<td>Norway</td>
<td>138,061</td>
<td>1.43</td>
<td>429</td>
<td>6.3</td>
<td>4.87</td>
<td>5.54</td>
</tr>
<tr>
<td>Portugal</td>
<td>158,786</td>
<td>1.12</td>
<td>1076</td>
<td>4.2</td>
<td>3.08</td>
<td>3.44</td>
</tr>
<tr>
<td>Spain</td>
<td>653,746</td>
<td>1.26</td>
<td>2445</td>
<td>3.02</td>
<td>1.76</td>
<td>2.26</td>
</tr>
<tr>
<td>Sweden</td>
<td>284,575</td>
<td>1.55</td>
<td>1708</td>
<td>2.55</td>
<td>1</td>
<td>1.79</td>
</tr>
<tr>
<td>Switzerland</td>
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<td>1.89</td>
<td>1781</td>
<td>3.47</td>
<td>1.58</td>
<td>2.71</td>
</tr>
<tr>
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<td>1,550,540</td>
<td>1.42</td>
<td>5526</td>
<td>1.97</td>
<td>0.55</td>
<td>1.21</td>
</tr>
<tr>
<td>United States</td>
<td>5,478,163</td>
<td>1.37</td>
<td>11698</td>
<td>1.55</td>
<td>0.18</td>
<td>0.79</td>
</tr>
<tr>
<td>Iran</td>
<td>252,718</td>
<td>0.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Green shading: collaboration increases citation impact; red shading: collaboration decreases citation impact.*
Table 11: Average Percentile of Publications Involving Collaboration between the ‘West’ and Iran

<table>
<thead>
<tr>
<th>Country</th>
<th>All Publications (Domestic and International)</th>
<th>Publications Involving Collaboration with Iran</th>
<th>Impact of Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Average Percentile</td>
<td>Number</td>
</tr>
<tr>
<td>Australia</td>
<td>654,034</td>
<td>57.55</td>
<td>3973</td>
</tr>
<tr>
<td>Austria</td>
<td>181,509</td>
<td>58.22</td>
<td>1258</td>
</tr>
<tr>
<td>Belgium</td>
<td>250,602</td>
<td>54.85</td>
<td>1542</td>
</tr>
<tr>
<td>Canada</td>
<td>817,159</td>
<td>58.21</td>
<td>5912</td>
</tr>
<tr>
<td>Denmark</td>
<td>184,263</td>
<td>52.71</td>
<td>834</td>
</tr>
<tr>
<td>Finland</td>
<td>140,402</td>
<td>54.47</td>
<td>1107</td>
</tr>
<tr>
<td>France</td>
<td>876,867</td>
<td>57.24</td>
<td>2927</td>
</tr>
<tr>
<td>Germany</td>
<td>1,288,192</td>
<td>57.34</td>
<td>4579</td>
</tr>
<tr>
<td>Ireland</td>
<td>110,137</td>
<td>62.45</td>
<td>550</td>
</tr>
<tr>
<td>Italy</td>
<td>787,731</td>
<td>57.8</td>
<td>3393</td>
</tr>
<tr>
<td>Netherlands</td>
<td>459,249</td>
<td>52.94</td>
<td>1863</td>
</tr>
<tr>
<td>New Zealand</td>
<td>104,552</td>
<td>57.21</td>
<td>998</td>
</tr>
<tr>
<td>Norway</td>
<td>138,061</td>
<td>54.75</td>
<td>429</td>
</tr>
<tr>
<td>Portugal</td>
<td>158,786</td>
<td>61.16</td>
<td>1076</td>
</tr>
<tr>
<td>Spain</td>
<td>653,746</td>
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</tbody>
</table>

Green shading: collaboration increases citation impact; red shading: collaboration decreases citation impact. Lower numerical scores = higher citation impact.

Table 12: Percentage of Publications Involving Collaboration between the ‘West’ and Iran in Top 10%

<table>
<thead>
<tr>
<th>Country</th>
<th>All Publications (Domestic and International)</th>
<th>Publications Involving Collaboration with Iran</th>
<th>Impact of Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>% in Top 10%</td>
<td>Number</td>
</tr>
<tr>
<td>Australia</td>
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<td>3973</td>
</tr>
<tr>
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<td>1258</td>
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<td>12.64</td>
<td>5912</td>
</tr>
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<td>184,263</td>
<td>16.38</td>
<td>834</td>
</tr>
<tr>
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<td>13.39</td>
<td>1107</td>
</tr>
<tr>
<td>France</td>
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<td>12.94</td>
<td>2927</td>
</tr>
<tr>
<td>Germany</td>
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<td>13.72</td>
<td>4579</td>
</tr>
<tr>
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<td>11.36</td>
<td>550</td>
</tr>
<tr>
<td>Italy</td>
<td>787,731</td>
<td>12.31</td>
<td>3393</td>
</tr>
<tr>
<td>Netherlands</td>
<td>459,249</td>
<td>16.62</td>
<td>1863</td>
</tr>
<tr>
<td>New Zealand</td>
<td>104,552</td>
<td>11.59</td>
<td>998</td>
</tr>
<tr>
<td>Portugal</td>
<td>158,786</td>
<td>10.19</td>
<td>1076</td>
</tr>
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<td>653,746</td>
<td>11.33</td>
<td>2445</td>
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<td>1708</td>
</tr>
<tr>
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<td>1781</td>
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<td>13.37</td>
<td>5526</td>
</tr>
<tr>
<td>United States</td>
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<td>12.99</td>
<td>11698</td>
</tr>
<tr>
<td>Iran</td>
<td>252,718</td>
<td>6.35</td>
<td></td>
</tr>
</tbody>
</table>

Green shading: collaboration increases citation impact; red shading: collaboration decreases citation impact.
### Table 13: Percentage of Publications Involving Collaboration between the ‘West’ and Iran in Top 1%

<table>
<thead>
<tr>
<th>Country</th>
<th>All Publications (Domestic and International)</th>
<th>Publications Involving Collaboration with Iran</th>
<th>Impact of Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>% in Top 1%</td>
<td>Number</td>
</tr>
<tr>
<td>Australia</td>
<td>654,034</td>
<td>1.76</td>
<td>3973</td>
</tr>
<tr>
<td>Austria</td>
<td>181,509</td>
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<td>1258</td>
</tr>
<tr>
<td>Belgium</td>
<td>250,602</td>
<td>2.32</td>
<td>1542</td>
</tr>
<tr>
<td>Canada</td>
<td>817,159</td>
<td>1.84</td>
<td>5912</td>
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<tr>
<td>Denmark</td>
<td>184,263</td>
<td>2.65</td>
<td>834</td>
</tr>
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<td>Finland</td>
<td>140,402</td>
<td>1.95</td>
<td>1107</td>
</tr>
<tr>
<td>France</td>
<td>876,867</td>
<td>1.8</td>
<td>2927</td>
</tr>
<tr>
<td>Germany</td>
<td>1,288,192</td>
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<td>4579</td>
</tr>
<tr>
<td>Ireland</td>
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<td>550</td>
</tr>
<tr>
<td>Italy</td>
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<td>3393</td>
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<tr>
<td>Netherlands</td>
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<td>2.52</td>
<td>1863</td>
</tr>
<tr>
<td>New Zealand</td>
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<td>1.66</td>
<td>998</td>
</tr>
<tr>
<td>Norway</td>
<td>138,061</td>
<td>1.9</td>
<td>429</td>
</tr>
<tr>
<td>Portugal</td>
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<td>1.12</td>
<td>1076</td>
</tr>
<tr>
<td>Spain</td>
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</tr>
<tr>
<td>Sweden</td>
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<td>2.15</td>
<td>1708</td>
</tr>
<tr>
<td>Switzerland</td>
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<td>1781</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1,550,540</td>
<td>1.95</td>
<td>5526</td>
</tr>
<tr>
<td>United States</td>
<td>5,478,163</td>
<td>1.89</td>
<td>11698</td>
</tr>
<tr>
<td>Iran</td>
<td>252,718</td>
<td>0.47</td>
<td></td>
</tr>
</tbody>
</table>

Green shading: collaboration increases citation impact; red shading: collaboration decreases citation impact.

Taking all four of the above measures of normalised citation into consideration, collaboration with Iran appears to confer a citation advantage on all Western countries with the possible exception of Canada. Collaboration with all of the Western countries in the study confers a citation advantage on Iran.

### Lead Authors of Publications Involving Collaboration Between Western Countries and Iran

Figure 4 illustrates the institutional affiliations of the lead authors of my sample of publication involving collaboration between Western countries and Iran for the study period. 61% of lead authors had affiliations with Iranian institutions only, 20% had affiliations with Western institutions only, and 12% had simultaneous affiliations with Western institutions and Iranian institutions at the time of publication. These findings have a confidence level of 95% and a margin of error (or confidence interval) of +/- 3%. This means that we can be 95% confident that between 9% and 15% of lead authors of publications in the WoS CC involving collaboration between the West and Iran between
2008 and 2016 had simultaneous affiliations with institutions in Western countries and Iran at the time of publication. This finding cannot be directly compared to those of previous studies since very few studies have analysed the phenomenon of academics who hold simultaneous affiliations with institutions in different countries, and none have explored the phenomenon of academics who hold simultaneous affiliations with institutions in Western countries and Iran. A recent study by Markova et al. (2016) found that 15% of authors had simultaneous affiliations with both Russian and non-Russian institutions. However, my study explores the simultaneous affiliations of lead authors in Iran and specific Western countries, whereas Markova et al.’s study explored the simultaneous affiliations of authors with institutions in Russia and all other countries.

**Figure 4: Institutional Affiliations of Lead Authors of Publications Involving Collaboration between Western Countries and Iran, 2008 to 2016**
It is also interesting to note that 74% of lead authors had one or more affiliations with institutions in Iran, whereas only 34% of lead authors had one or more affiliations with institutions in Western countries.

Limitations

It is important to note that the following limitations may have influenced the findings of this study.

Underrepresentation of publications published in Iranian journals.

As noted in the previous chapter, journals published in Iran are underrepresented in the WoS. This may mean that my findings underestimate the number of Iran’s publications overall as well as the number of publications involving collaboration between Western countries and Iran.

Increase in the number of Iranian journals Indexed in the Web of Science.

As noted earlier, the growth in both the overall number of Iranian publications, and the number of publications involving collaboration between Western countries and Iran during the study period may have been inflated by an increase in the number of Iranian publications indexed in the WoS between 2008 and 2016. It should be noted, however, that this increase in the number of Iranian journals indexed in the WoS will facilitate more robust bibliometric studies in the future.

Underrepresentation of publications published in Iranian journals.

As discussed in the previous chapter, my decision to analyse the institutional affiliations of the lead authors of my sample of publications only means that my findings almost certainly underestimate the extent to which research collaboration between the West and Iran is facilitated by academics who have simultaneous institutional affiliations in the West and Iran. That is, while my findings indicate that 12% of the lead authors of publications involving collaboration between the West and Iran held simultaneous institutional affiliations in the West and Iran, the percentage of such publications for which at least
one author held simultaneous institutional affiliations in the West and Iran is almost certainly higher than 12%.

In this chapter, I have presented the findings of my study on research collaboration between the West and Iran, and discussed them with reference to previous studies on international research collaboration in general, and research collaboration with Iran in particular. In the final chapter, I summarise the major findings of the study, discuss them in relation to the two conceptual frameworks for understanding international academic collaboration presented in the literature review; describe the limitations of the study; and suggest directions for future research.
Chapter Five: Discussion, Limitations and Conclusion

In this study, I explored research collaboration between the ‘West’ and the Islamic Republic of Iran through a bibliometric analysis of co-authored publications indexed in the Web of Science Core Collection for the nine-year period between 2008 and 2016. In this final chapter of my thesis I summarise the major findings of my study; discuss these findings in relation to the two conceptual frameworks for understanding academic collaboration between the West and Iran that I presented in the literature review; describe the limitations of the study; and suggest directions for future research.

Major Findings of the Study

The major findings of this study are as follows:

- Collaboration between Western countries and Iran as measured by co-authored publications grew considerably during the study period.
- The research links between many Western countries and Iran are asymmetrical. While several Western countries are important research partners for Iran, Iran is not an important research partner for any of the Western countries in my study.
- The research links between some of the smaller Western countries and Iran are symmetrical but weak.
- For all the Western countries in this study, the research specialisation profiles of publications involving collaboration with Iran resemble the profile of Iran’s domestic publications much more closely than they resemble the profile of the Western country’s domestic publications.
- Collaboration between the West and Iran conferred a citation gain for most Western countries and for Iran.
- Over 12% of the lead authors of publications involving collaboration between Western countries and Iran had simultaneous affiliations with institutions in Western countries and in Iran at the time of publication.
- More lead authors (74%) had affiliations with institutions in Iran than with institutions in Western countries (34%).
Discussion of Findings

In the literature review, I suggested that research collaboration between the West and Iran may be interpreted as collaboration between centres and peripheries in the global academic system, or as collaboration between cultures or civilizations. Below I discuss my findings with reference to these two conceptual frameworks.

Centres and peripheries in the global academic system.

As noted in the literature review, scholars such as Altbach (2006) claim that powerful universities and national academic systems – the centres – dominate the production and distribution of knowledge, while smaller and weaker institutions and systems – the peripheries – are dependent on them. The asymmetrical pattern of research links that I found between many Western countries and Iran is consistent with this view of the global academic system. That is, while several Western countries – particularly Canada, the United Kingdom, and the United States - are important research partners for Iran, Iran is not an important research partner for any of the Western countries in my study. This pattern of collaboration may indicate that Iran is in a dependent relationship with the powerful academic centres of the West. The symmetrical but weak pattern of research links that I found between some of the smaller Western countries - including Denmark, Ireland, and Norway - and Iran is also consistent with this conceptual framework since these smaller Western countries also occupy peripheral positions in the global academic system (Altbach, 2001).

The similarity between the research specialisation profiles of publications involving collaboration between Western countries and Iran and Iran’s domestic publications is more difficult to interpret within this conceptual framework. If, as I suggested in the last chapter, collaboration is concentrated in those areas where Iran is strongest because this is where the West has the most to gain from collaboration, this could indicate that the Western countries at the centre of the global academic system are determining the terms of collaboration with Iran. On the other hand, Iran may be choosing to collaborate with the West to advance priority disciplines in Engineering and Technology, and Physical Sciences.
The finding that 74% of lead authors had affiliations with institutions in Iran compared with only 34% who had affiliations with institutions in the West seems inconsistent with the centres and peripheries conceptual framework because it indicates that academics affiliated with institutions in Iran may contribute more to these publications than their colleagues in the West. While practices vary across countries and research fields, the lead authors of publications traditionally make the greatest contribution to them (Tscharntke et al., 2007).

**Dialogue among civilizations?**

While some of the findings of my study may be interpreted within a centres and peripheries conceptual framework, some of them may also be interpreted within the conceptual framework of dialogue among civilizations as put forward by former Iranian President Mohammad Khatami (CNN, 1998). In common with many scholars of international higher education (see, for example, Altbach & de Wit, 2015), President Khatami suggested that international academic cooperation may help to promote peace and mutual understanding between countries and civilizations. The strong growth in the number of publications involving collaboration between academics in Western countries and academics in Iran during the study period may, perhaps, be interpreted as evidence of increasing dialogue between civilizations. While bibliometric analyses alone cannot tell us very much about the nature of these collaborations, the growth in the number of publications involving collaboration between the West and Iran at least increases the potential for dialogue between the two sides.

**Limitations of the Study and Future Research**

Like all studies, this study on collaboration between the West and Iran has some limitations. Although bibliometric analysis is “virtually indispensable” for measuring international research collaboration (Archambault & Gagné, 2004), there are some questions that it cannot answer. As noted in the literature review, international academic collaboration is driven both by the motivations of individual academics and by institutional and national rationales. In particular, this study does not tell us why academics and institutions in the West and in Iran wish to collaborate with each other. Further research could explore the motivations and rationales for academic collaboration between the West
and Iran through interviews or surveys of academics and university administrators who engage in such collaboration. Similarly, interviews or surveys might be used to explore both the nature of collaboration between the two sides, and the ways in which the facilitating and constraining factors discussed in the literature review shape collaboration between them. In particular, the fact that co-authored publications between the West and Iran grew so rapidly in the context of geopolitical tensions between the two sides, and the sanctions that were in place during this period, is remarkable and merits further research.

As noted earlier, bibliometric analysis is also limited by biases inherent in the bibliographic databases used for such analysis. Of particular relevance to this study, journals published in developing countries, such as Iran, are underrepresented (Moin et al., 2005; Mongeon & Paul-Hus, 2016). This means that my findings will underrepresent the number of Iran’s domestic publications over the study period, and, to a lesser extent, the number of publications involving collaboration between Western countries and Iran. While the recent increase in the number of Iranian journals indexed in the Web of Science discussed earlier is undoubtedly a positive development that will facilitate more robust bibliometric studies in the future, it may also have inflated the growth in the number of publications involving collaboration between the West and Iran during the study period.

Despite its limitations, bibliometric analysis could be used to further explore collaboration between the West and Iran. In particular, it would be valuable to explore the role of diachronic international mobility, that is the movement of academic staff between countries over time, in facilitating collaboration between Western countries and Iran. This could be carried out by examining the bibliographic records of academics who have had affiliations with institutions in Iran at some point during their publishing career.

Conclusions

This study has contributed to the literature on international academic collaboration by using bibliometric analysis to explore research collaboration between Western countries and Iran between 2008 and 2016. In contrast to previous studies, I have considered collaboration from the perspective of both Western countries and Iran. As indicated above, I believe that there are many opportunities for further research in this fascinating area.
References


Sotudeh, H. (2010). Are Iranian scientists recognized as their productivity enhances? A comparison of Iran’s impact to global norms in different subfields of Science


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